ELECTRONIC INDUSTRIES &

TELE-TECH

A Caldwell-Clements Publication

SEPTEMBER, 1953

FRONT COVER: PRODUCTION CONTROL OF PRINTED RESISTORS—Business-like device is the heart of a new machine—the "Autobrader"—which puts us one step closer to the automatic factory. Artistic portrayal shows printed resistor board (dimly seen behind transparent plate) in position for test. Two contacts allow red sensing unit to determine that resistance is too high. A valve is actuated which sends stream of abrasive particles through nozzle directed at printed resistor. When enough material has been abraded to bring resistance to predetermined level, abrader shuts off and new resistor board automatically slips into place. Entire operation takes only a few seconds. Unit developed by Emerson also shows promise for the manufacture of other printed circuit components. Complete details on page 78.

DEPARTMENTS

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Publishers also of TELEVISION RETAILING

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TELE-TECH'S CIRCULATION, 21,000

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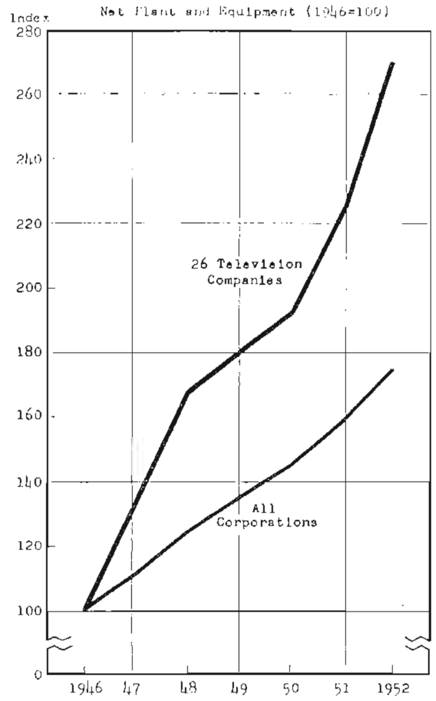
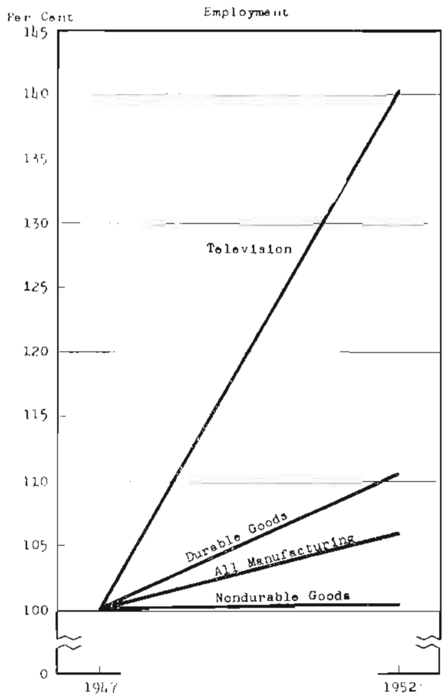
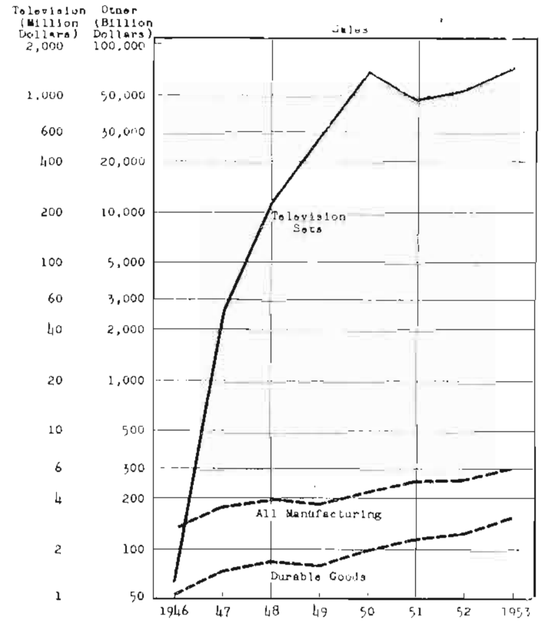
The Rapid Growth of the Television-Electronic Manufacturing Industries







Broadcast Stations in U.S.

	AM	FM	TV
Stations on Air	2395	571	160 VHF 52 UHF
Under Construction (CPs)	136	62	106 VHF 195 UHF
Applications Pending	232	8	375 VHF 176 UHF

Radio and TV Receiver Production

	TV	Radio	
July, 1953		Home	118,000
		Battery	44,000
		Auto	326,000
		Clock	25,000
Total	272,000		513,000
Seven months, 1953 Jan.-July Incl.		Home	2,180,000
		Battery	1,049,000
		Auto	3,405,000
		Clock	1,148,000
Total	4,107,000		7,782,000

TV Set Sales 1953-57, as Affected by Color

The net effect of color-TV developments on total TV set sales in each of the next five years is shown below in summary form. The following table also shows color set sales as a proportion of the total. Compiled by Boni, Watkins, Mounteer & Co., consulting economists, 37 Wall St., New York 5, N. Y.

Net Effect of Color on Total Television Set Sales

	1953	1954	1955	1956	1957
Estimated sales of new sets in absence of color	6,710,000	7,430,000	7,160,000	6,930,000	6,620,000
Buyers of color sets who otherwise would not have bought any	—	30,000	350,000	600,000	800,000
Previous withholders who buy color sets	—	15,000	300,000	400,000	500,000
Total of above	6,710,000	7,475,000	7,810,000	7,930,000	7,920,000
Net new withholders	200,000	475,000	300,000	250,000	225,000
Estimated sales total for year	6,510,000	7,000,000	7,510,000	7,680,000	7,695,000
Estimated sales of color sets	—	50,000	800,000	1,600,000	3,500,000
Color sets as per cent of total	—	0.7%	10.7%	20.8%	45.5%

GOVERNMENT ELECTRONIC CONTRACT AWARDS

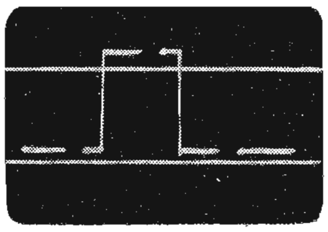
This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in July-August 1953.

Adapters, amplifier	$ 136,261
Ammeters	29,011
Amplifiers	306,339
Analyzers	780,082
Anodes	228,066
Antennas	1,731,917
Auto Pilots	6,039,490
Auto Pilot Components	1,203,548
Batteries	6,370,179
Battery Chargers	101,865
Bridges, impedance	76,133
Brush Assys	50,668
Cables	1,788,048
Cabinets, electrical	153,457
Calibrators	56,709
Capacitors	58,721
Capacitor-Resistor Assys	131,251
Cavities	141,965
Circuit Breakers	349,960
Circuit Demonstrators	95,031
Coil Assys	46,826
Communication Vans	1,624,163
Computers	211,131
Connectors	1,547,310
Consoles	29,009
Control Panels	346,704
Controls, radio set	1,244,466
Converters	124,956
Crystal Holders	112,395
Crystal Kits	44,388
Crystal Units	944,801
Coils	146,867
Dials	48,785
Dynamotors	58,557
Electrocardiographs	60,000
Facsimile Sets	49,303
Filters	129,933
Fluxmeters	189,253
Generators	13,665,263
Handsets-Headsets	614,000
Indicators	9,348,349
Insulation Sheet	66,405
Insulation Tape	44,247
Intercom. Stations	37,648
Inverters	3,139,673
Keyboxes	54,029
Keyers	1,163,539
Loran	36,000
Mag. Sound Recorders	32,324
Measuring Sets	37,193
Meters	637,754
Microlinks	17,900
Microphones	39,750
Mixing Equipment	7,701
Motors	867,960
Multimeters	1,466,198
Modulators, video	363,460
Oscillators	439,082
Oscillographs	426,893
Panel Assys	29,028
Panels, generator control	774,597
Panel Mountings	34,326
Panoramic Adapters	62,199
Panoramic Indicators	59,633
Plotters, function	29,799
Plugs	28,940
Positioning Mechanisms	195,478
Potentiometers	207,090
Power Supplies	72,470
Preamplifier Strips	34,972
Public Address Sets	30,708
Q Meters	54,543
Radar Components	480,667
Radar Sets	1,082,556
Radio Beacons	394,573
Radio Receivers	601,957
Radio Sets	22,756,721
Radomes	157,856
Reactors	39,810
Recorder-Reproducers	800,065
Recording Units	300,967
RF Assys	2,535,396
Reflectors, radar	39,158
Regulators	156,337
Relays	623,686
Relay Equipment	256,364
Repeaters	380,709
Reproducers, sound	121,121
Resistors	319,625
Room Screens	132,900
Side Bands, single radio	1,031,350
Signal Tracers	26,524
Simulators	1,082,710
Solenoids	62,787
Sonar Sounding Sets	148,154
Switches	668,364
Synchros	969,043
Synthetic Quartz	146,447
Telegraphs	125,689
Telegraph Monitors	118,740
Telephones	1,185,514
Telephone Central Sets	4,846,080
Telemetering Systems	64,216
Teletype	52,283
Teletypewriters	4,195,323
Temperature Controls	155,182
Tensionmeters	28,093
Terminal Boards	28,530
Terminal Boxes	216,500
Terminal Sets	202,686
Test Sets	984,419
Test Stands, generator	1,295,698
Testers	790,942
Theater TV	65,174
Tower Section Sets	129,253
Trainers, radio	1,927,079
Trainers, Ground Instruc.	3,998,876
Transformers	2,428,549
Transmitters	7,603,272
Transmitter Elements	73,572
Transmitter Kits	40,828
Transmitter-Receivers	287,650
Transistors	748,177
Tubes, electron	20,935,574
Tuning Units	87,403
Tuning Assys, remote	62,360

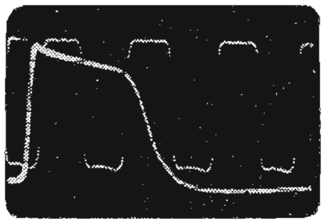
(SEE "AS WE GO TO PRESS" STARTING ON PAGE 11, FOR LATEST INDUSTRY NEWS)

The New Du Mont
CATHODE-RAY OSCILLOGRAPH
TYPE 301-A

Carry your laboratory to the field!



Quantitative analysis of pulse with amplitude calibration lines showing pulse to be 1.1 volts. Internally generated blanking markers indicate 10 μsec pulse width.



Trigger output pulse. Internally generated amplitude calibration standard indicates 110 p-p volts.

Performance and versatility you would expect only in a larger, heavier laboratory-bench instrument — ruggedness and dependability geared to the requirements of field use — portability that will revolutionize your field servicing techniques — these, and many other features combine to make up the new Du Mont Type 301-A cathode-ray oscillograph.

The new Du Mont 301-A has been designed for field test and maintenance of airborne equipment, computers, microwave relays, and all other field or laboratory applications requiring a *quantitative, wide-band* oscillograph.

PRICE $935* *Also available with "ruggedized" tubes @ **$985**

SPECIFICATIONS

CATHODE-RAY TUBE — Tight-tolerance Du Mont Type 3WP1; overall acceleration, 1400 volts.

VERTICAL DEFLECTION — Deflection Factor: 0.28 p-p volts/inch. Sinusoidal Frequency Response: down not more than 20% at 10 cps and 4 mc. Rise Time: 0.08 μsec max. Undistorted Deflection: 2 inches minimum. Signal Delay: built-in delay of 0.35 μsec.

LINEAR TIME BASE — Sweep Range: driven sweeps only, continuously variable in duration from 200,000 μsec to 10 μsec. Maximum Sweep Speed: 0.55 inches/μsec.

TRIGGER GENERATOR — (available at front panel) Range: 45-5500 cps. Rise Time: less than 0.5 μsec. Duration: 1-2 μsec approx.

VOLTAGE CALIBRATION — Attenuator is calibrated to 0.3, 1, 3, 10, 30, and 100 volts/inch. Precision ±2%. Calibrator output available at front panel.

TIME CALIBRATION — Blanking markers at 10,000, 1000, 100, 10, and 1 μsec intervals. Accuracy ±5%. Available at front panel.

PRIMARY POWER — 115 volts, 50-1000 cps, 110 watts. Standby heater 15 watts.

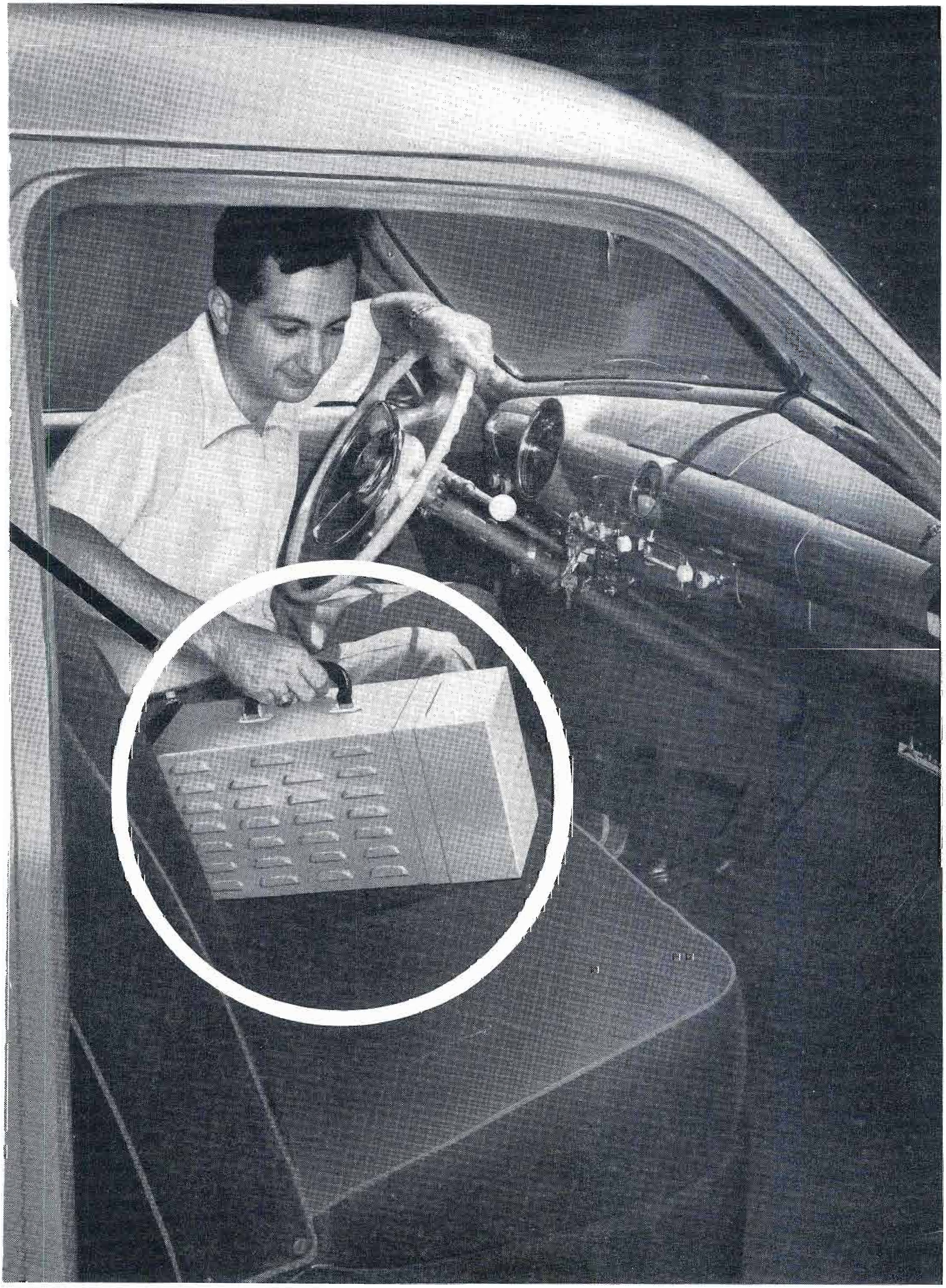
PHYSICAL CHARACTERISTICS — Two protective handles on front panel, carrying handle on top of cabinet; supporting foot for instrument folds under cabinet. Size: Height, 9⅛"; width, 6½"; depth, 16⅝"; weight, 20 lbs. complete, 17½ lbs. without cover and accessories.

ACCESSORIES SUPPLIED — Calibrated scale, filter; CABLES, 4' and 6', terminated in BNC connectors; input termination, 75 ohm, plug-in adapter; PROBES, Cathode Follower, Passive, Detector. Adapters (2), BNC to binding post. (Probes, cables and terminations fit in protective cover.)

Write to Technical Sales Department for 301-A Bulletin.

DU MONT *for Oscillography*

Instrument Division, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.



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TELE-TECH* & ELECTRONIC INDUSTRIES is edited for top-level engineers and executives throughout the electronic industries. It gives the busy engineering executive authoritative information and interpretation of the latest developments and new products, with emphasis on subjects of engineering import and timeliness. Special attention is given to:

MANUFACTURING

—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, computing.
—Military equipment including radar, sonar, guided missiles, fire controls.
—TV-FM-AM receivers, phonographs, recorders, reproducers.

OPERATION

—Fixed, mobile and airborne communications in commercial, municipal, aviation and government services.
—Broadcasting, video and audio recording, records, audio and sound systems, motion picture production.
—Military, civilian and scientific electronic computing and control systems.
* U. S. Pat. Off.

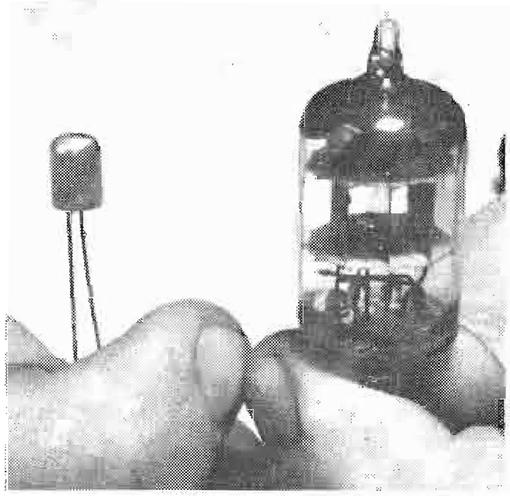
THE ELECTRONIC INDUSTRIES DIRECTORY
Published annually as an integral section of TELE-TECH in June

As We Go To Press...

Bell Labs Develops Silicon Junction Diode

Bell Telephone Labs. has developed a silicon alloy junction diode suitable for use in computers and telephone switching systems. One of its most noteworthy characteristics is its high back-to-forward resistance ratio of 100,000,000 to 1. Back leakage current is less than in previous diodes, being kept to about 0.0001 μa. The new unit is one-third of the size of conventional silicon diodes. Present plans call for its use in the memory system of a transistor-operated digital computor.

Under the sponsorship of the Laboratories, the Du Pont Co. recently developed a method for the commercial manufacture of high purity silicon, thus opening up an almost limitless source of the material for electronic applications.



Tiny size of new silicon alloy junction diode is illustrated by comparison with conventional two-element vacuum tube. Encased elements is no larger than a match head. Unit developed by Bell Labs. has high back-to-forward ratio

Ninth NEC to Convene in Chicago

The ninth annual National Electronics Conference will convene Sept. 28-30, 1953, at the Hotel Sherman in Chicago. The technical program offers 99 papers, and is supplemented by over 140 exhibits by electronic manufacturers. President of the 1953 conference is Dr. J. D. Ryder of the Univ. of Illinois. It is sponsored by the IRE, AIEE, Illinois Inst. of Technology, Northwestern Univ., and Univ. of Illinois. Participating are Purdue Univ., Univ. of Wisconsin, RTMA/,SMPTE.

Advance registration may be made by writing to National Electronics Conference, Inc., Karl Kramer, Executive Secretary, 852 E. 83 St., Chicago 19, Ill.

Details of the technical program are given on page 150.

Jeep-Maker to Produce TV "Package"

Willys Motors, Inc., which came into existence last April when Kaiser Mfg. Corp. bought Willys-Overland Motors, will offer broadcasters a TV "package" consisting of a 1-kw transmitter operating in the UHF region, camera, projector, console and other equipment. The package is designed for stations serving areas of 50,000 population or less. A prototype transmitter now in production is scheduled to be submitted to FCC for approval around the end of Sept., 1953. Some 100 technicians are being added to Willys' Benore Road electronic division in Toledo, Ohio.

Color TV Standards Placed Before FCC

The many thousands of engineering man-hours spent to develop compatible color TV standards have come to fruition. On July 23, 1953, the National Television System Committee petitioned the FCC for adoption of transmission standards for color TV. Early approval is expected. Already General Electric, Philco and Sylvania have filed requests with the Commission to accept the NTSC standards. On June 25, 1953, RCA petitioned for similar standards. For engineering details, see page 63.

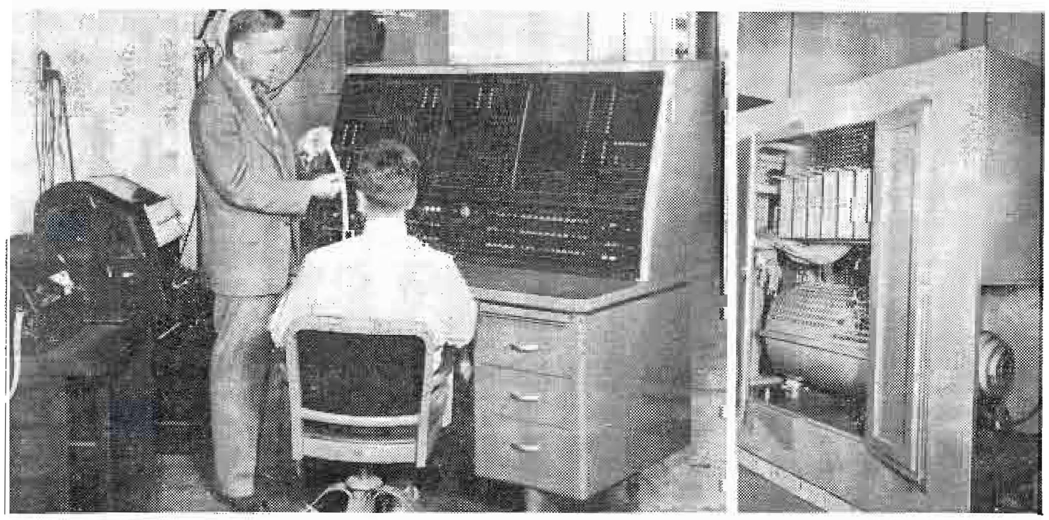
Preview of Electronic Flight Plan Storage System

A magnetic memory system which may solve many air traffic control problems by electronically storing and comparing flight plans of as many as 2000 airplanes at once is being developed by Remington Rand's Engineering Research Associates Div. in St. Paul, Minn., for the Civil Aeronautics Administration. It will be ready for demonstration this fall.

Flight plan information sent by teletype is compared with other flight plans recorded on a rotating magnetic drum, and then revised, cancelled or brought up to date, according to circumstances. The results are transmitted back to the sending station, completing an automatic circuit of information in which no human operation is required. Teletype characters can be processed at the rate of 23,000 per second, and up to 312,000 characters can be retained. This high speed device is also suitable for passenger reservation and filing systems.

The flight plan for a specific aircraft is not identified by its location on the drum surface, but by inspection of characters within its plan. Search through the first 18 characters of all 2000 plans takes only 0.4 second.

Engineers J. L. Hill (l) and R. C. Skoe inspect teletype tape of flight plan system. Drum at right



MORE NEWS on page 15

Uniformity

We have used every type of GA&F Carbonyl Iron Powder thus far produced. The overall quality and batch-to-batch uniformity of your products have always been gratifying to us. Because of this product dependability, we feel that incoming inspection of your powders is unnecessary.

Richard D. Poneman

President

Pyroferric Company, Inc.
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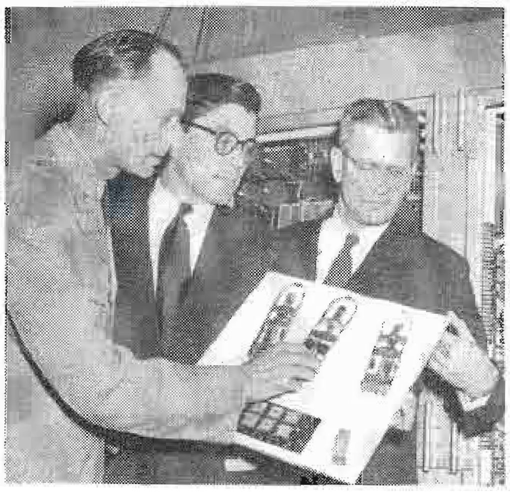
GA&F. CARBONYL IRON POWDERS

As We Go To Press . . . *(Continued)*

Venerable Computer Gets New Memory

One of the oldest and most famous large-scale high-speed computers, ENIAC (Electronic Numerical Integrator and Computer), has been given a new memory. Devel-



Col. W. M. Tisdale (l), I. L. Aurback (c), and Dr. I. Travis examine new static magnetic memory components for Army's ENIAC computer

oped by Burroughs Corp., the new static magnetic memory employs a specially designed magnetic core, has an information access rate of 50,000 ten-digit words per second, and will enable ENIAC to memorize ize 120 words at any particular instant. The giant computer was built by the U. of Penna. Moore School of Electrical Engineering during the last years of World War II, and is now in operation at the Army's Ballistics Research Labs., Aberdeen Proving Ground, Md.

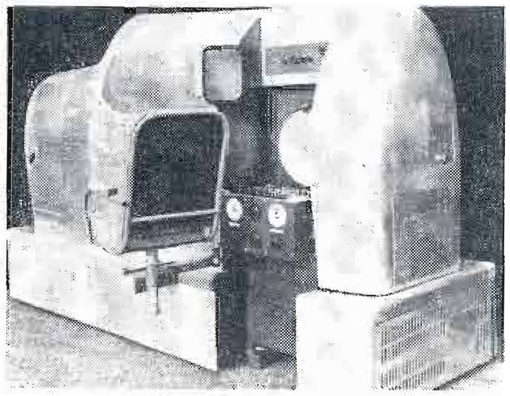
Senate Committee Approves Global TV Study

The Senate Foreign Relations Committee has approved a measure calling for the establishment of a nine-member commission to study and make recommendations for setting up a global TV and communications system for military and propaganda purposes. The President would appoint five members, including at least one from the telecommunications industry, and a specialist in educational TV. In addition, two members would be appointed from the Senate, and two from the House.

It may be recalled that TELE-TECH & ELECTRONIC INDUSTRIES pioneered for the acceptance of this global TV-communications system last year. Details are given in the Aug., Oct., Nov. 1952 issues.

Electronic Flight Duplicators

Eastern Airlines has ordered seven Model 501 Curtiss-Wright Dehmel Electronic Flight Duplicators for delivery during the first half of 1954. Used for advanced flight instruction, the units are built around a single-seat cockpit equipped with all the basic equipment and con-



Single seat cockpit of electronic flight duplicator contains flight controls of an airliner

trols of an airliner. Each duplicator contains six major components embracing flight controls, flight simulating devices, and such radio navigational aids as ILS, ADF, RDF, VHF, and fan marker beacons. Technical details are given on page 96 of the July 1953 issue of TELE-TECH & ELECTRONIC INDUSTRIES.

Phony TV Station Applicants

In several areas where the FCC has authorized new TV channels, a small number of opportunists have filed applications for construction permits without the slightest intention of ever building a station. These bad faith applications, intended solely as unethical business maneuvers, have been quickly dismissed by the Commission in those cases where motives became apparent. However, FCC moves cautiously in questionable cases, making sure that applications made in good faith are not summarily dismissed.

Crossing the fine line between unethical and illegal, some phony applicants are alleged to have offered to drop their applications in favor of a legitimate applicant—for a price—to eliminate risk of loss and lengthy litigation. Prime difficulty in proving this neat bit of extortion (if it exists) is the fact that payoff would probably disqualify legitimate applicant under rigid FCC regulations.

Recently, unsupported confidential reports have been circulated, stating that the FBI was checking relinquished applications to find out whether or not money had changed hands, and that Justice Department action would follow in those cases where findings were positive. To check on the truth or falsity of these statements, the editors of TELE-TECH & ELECTRONIC INDUSTRIES interviewed officials of both the Justice Department and the FBI.

Our findings are:

1. The Justice Department has no intention of prosecuting phony applicants according to present plans.
2. The FBI is not investigating the alleged irregularities.
3. An FBI official believes that even if such underhand activities were going on, it probably would not come under the Bureau's jurisdiction.

New FCC Procedure for TV

The FCC has instituted a new priority system for processing TV station applications. It supersedes the procedure in effect since July 1952, but does not affect current hearings. Old rules determined a city's priority according to whether it was served by one of the 108 stations on air at that time. Recognizing that some 100 additional stations have been placed in operation since the lifting of the freeze, the new rules determine priority according to two group classifications. Group A includes cities without any stations in operation; larger populations get higher listing. Group B consists of cities with stations; those with fewer stations get higher priority. When a Group B city gets a station, it drops down on the list. Cities will be processed alternately from Groups A and B. Clause on departure from established priorities gives FCC free hand to deal with exceptional cases: "The Commission may in the public interest and to prevent manifest injustice, process and designate for hearing applications without regard to the priorities."

MORE NEWS on page 17

As We Go To Press . . . *(Continued)*

"Tetrode" Transistors Go On Sale

Sylvania Electric Products, Inc., announces that a so-called "tetrode" transistor is now available, and that final tests are being made on a so-called "pentode" transistor, which is expected to become commercially available later this year.

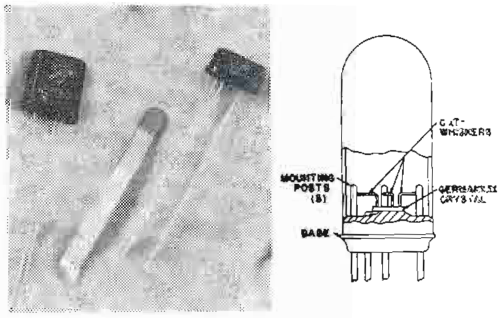
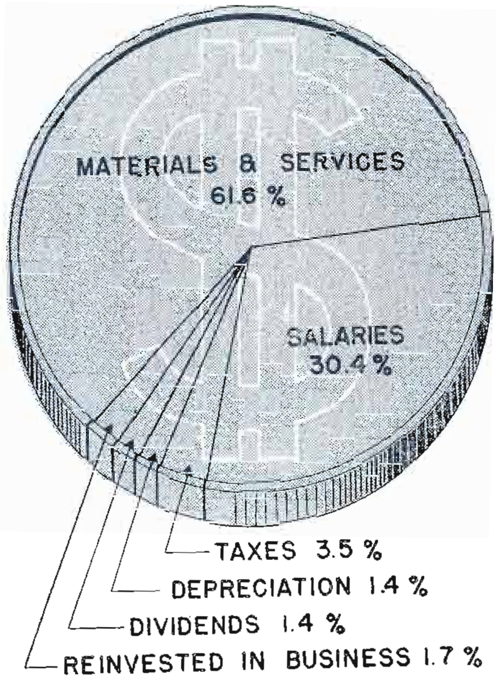


Photo shows junction triode transistor (l) and point contact type. New tetrode (sketch at right) can do the work of two triode units

Development of the tetrode and pentode types, according to James J. Sutherland, general manager of the Electronic Div., complements the company's work in triode transistors, which are now being produced. This point-contact tetrode, the 3N21, actually consists of two emitters, one collector and one base. It is designed to do the work of two triode transis tors, and should result in more simplified circuitry.

TV-Electronic Manufacturers' Income Dollar Where It Goes



COMING EVENTS

Sept. 1-3—International Sight and Sound Exposition, Palmer House, Chicago, Ill.

Sept. 1-4—AIEE, Pacific General Meeting, Hotel Vancouver, Vancouver, British Columbia.

Sept. 1-12—British 20th National Radio & Television Exhibition, Earlscourt, London, England.

Sept. 9-12—NEMA, Haddon Hall Hotel, Atlantic City, N.J.

Sept. 13-16—AICE (Quarterly Meeting) Fairmount and Mark Hopkins Hotels, San Francisco, Calif.

Sept. 14-16—NEDA Con. & Mfg. Conf., Chase Hotel, St. Louis, Mo.

Sept. 15-17—RTMA, Hotel Biltmore, New York, N.Y.

Sept. 21-25—ISA 8th National Instrument Exhibit, Sherman Hotel, Chicago, Ill.

Sept. 28-30—9th Annual National Electronic Conference, Hotel Sherman, Chicago, Ill.

Sept. 30-Oct. 1—Aircraft Electric Equipment Conference, AIEE, New Washington Hotel, Seattle, Wash.

Oct. 5-8—URSI-IRE, Joint Technical Meeting, National Research Council and Defense Research Board, Ottawa, Can.

Oct. 5-9—74th Convention of the SMPTE, Hotel Statler, New York, N.Y.

Oct. 6-8—Fractional Horsepower Motors Conference, AIEE, Fort Wayne, Ind.

Oct. 12-14—Symposium on Simulation and Computing Techniques, Naval Air Development Centre, Johnsville, Pa., and Univ. of Pennsylvania, Philadelphia, Pa.

Oct. 13-15—National Conference on Tube Techniques, Western Union Telegraph Co., 60 Hudson St., New York, N.Y.

Oct. 14-16—Machine Tool Conference, AIEE, Hotel Cleveland, Cleveland, Ohio.

Oct. 14-16—Recorder-Controller Section, SAMA, Mid-year Meeting, Seaview Country Club, Absecon, N.J.

Oct. 14-17—Audio Fair, Hotel New Yorker, New York, N.Y.

Oct. 19-21—RTCM Fall Assembly Meeting, Edgewater Beach Hotel, Chicago.

Oct. 19-23—41st National Safety Congress and Exposition, Conrad Hilton, Congress, Morrison and Hamilton Hotels, Chicago, Ill.

Oct. 19-23—National Metals Show, Cleveland Auditorium, Cleveland, O.

Oct. 20-22—8th Annual Industrial Packaging and Materials Handling Exposition, Mechanics Hall, Boston, Mass.

Oct. 26-28—RTMA, Radio Fall Meeting, King Edward Hotel, Toronto, Canada.

Oct. 30-31 — Semi-Annual Meeting, ASTE, Dayton Biltmore, Dayton, Ohio.

Nov. 4-6—17th Annual Time and Motion Study and Management Clinic, sponsored by IMS, Sheraton Hotel, Chicago, Ill.

Nov. 9-12—Conference on Radio Meteorology, Univ. of Texas, Austin, Tex.

Nov. 13-14—IRE, Annual Electronics Conference, Hotel President, Kansas City, Mo.

Nov. 17-19—RTMA, Palmer House, Chicago, Ill.

AICE: Amer. Inst. of Chemical Engineers
AIEE: Amer. Inst. of Electrical Engineers
ARRL: American Radio Relay League
ASTE: American Society of Tool Engineers
IRE: Institute of Radio Engineers
IMS: Industrial Management Society
ISA: Istrument Society of America
NEDA: National Electronic Distributors Assc.
NEMA: Nat'l Electrical Mfrs. Assoc.
RTCM: Radio Technical Commission for Marine Services
RTMA: Radio-TV Mfrs. Assc.
SAMA: Scientific Apparatus Makers Assoc.
SMPTE: Soc. of Motion Picture and TV Engineers
URSI: International Scientific Radio Union.

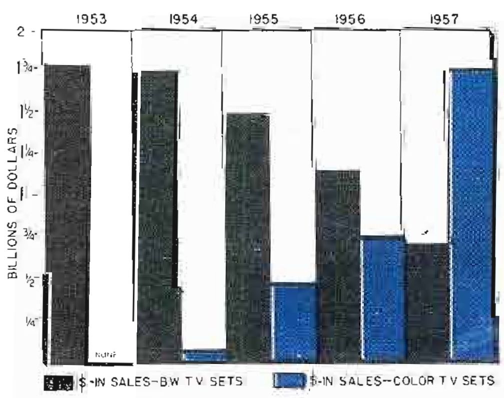
RTMA Changes Name to RETMA

Members of the Radio-Television Manufacturers Association have voted to change the Association's name to the Radio-Electronics-Television Manufacturers Association and approved a reorganization plan which will expand the Board of Directors and provide larger representation for new segments of the industry, especially in the advanced electronic field. The changes become effective immediately.

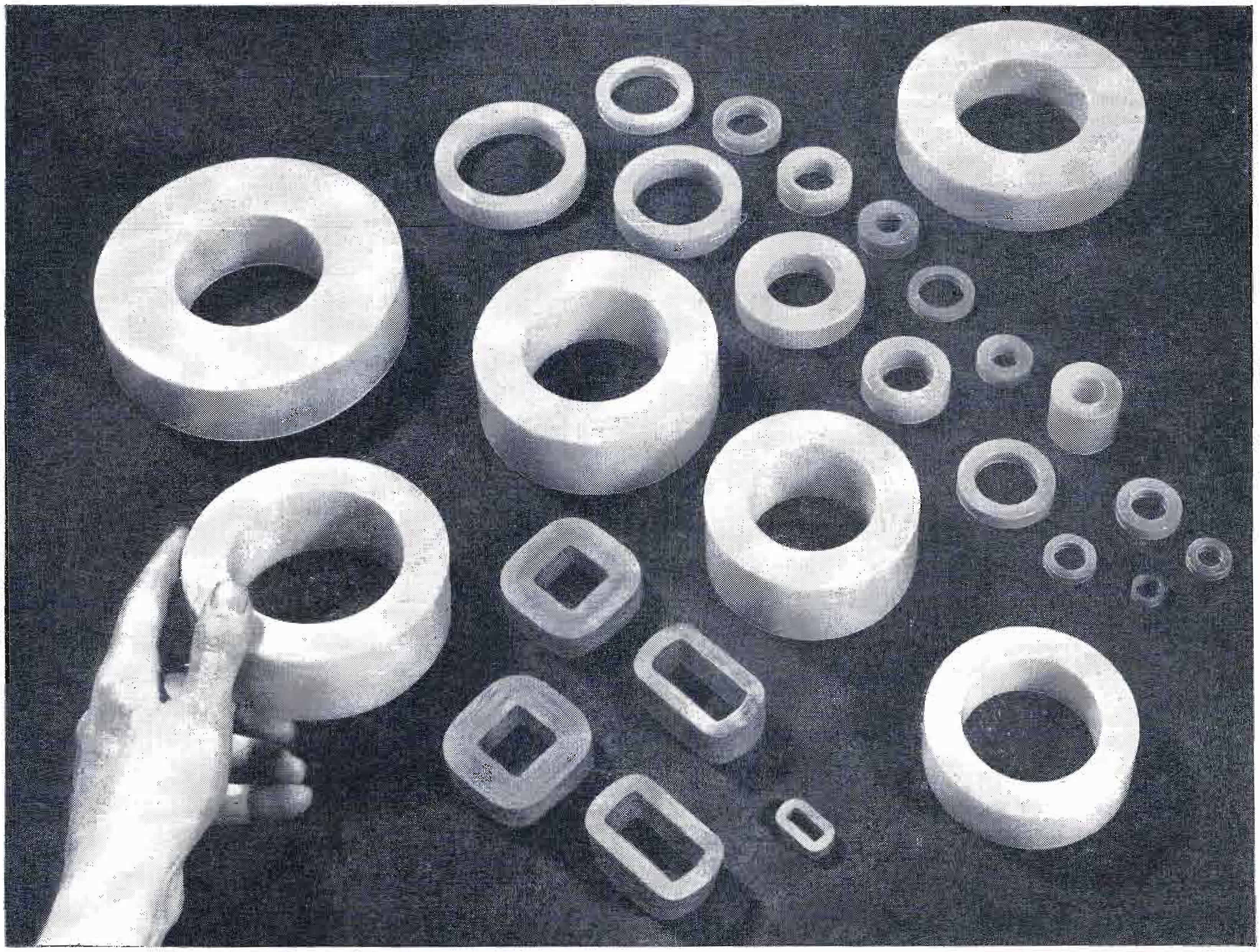
CBS to Broadcast NTSC Color

CBS Television is planning to feed NTSC color programs to its network around Sept. 15, 1953. In a letter to affiliates, President J. L. Van Volkenburg disclosed that sustaining programs will be utilized under experimental authorization by the FCC. When color standards are adopted, a regular schedule of network broadcasts will be made.

$ Value of Sales, 1953-1957 (Est.) Color and Black & White TV Sets



See TELE-TIPS on page 28



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Let us help with your problems of cores for Magnetic Amplifiers, Pulse Transformers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Peaking Strips, Reactors, etc.

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Why Hughes Diodes have set A NEW STANDARD OF RELIABILITY

Reliability in a germanium diode is determined principally by permanent freedom from the two major causes of diode failure—moisture penetration of the diode envelope, and electrical instability under extreme operating conditions.

HUGHES GERMANIUM DIODES are designed to prevent such failures through two exclusive features:

1. **Fusion Sealing**—The glass-to-metal seal, proved in billions of vacuum tubes, is incorporated to full advantage in diode manufacture by the Hughes-developed process of fusion sealing at high temperature. The result is a rigid *one-piece* glass envelope making moisture penetration impossible.

2. **100% Testing**—One hundred per cent testing insures the satisfactory operation of **HUGHES DIODES** under adverse conditions of moisture, temperature, vibration and severe shock. Hughes testing procedures *invite* instabilities to occur prior to shipment and assure rejection of every defective diode. *Each* **HUGHES DIODE** is humidity-cycled, temperature-cycled, JAN shock-tested, and electrically tested under vibration.

Reliability of **HUGHES DIODES** has been proved in airborne military electronic equipment for navigation, fire control and guided missiles. The same high standard required for these uses is your insurance against costly shutdowns, high maintenance expense and time losses.

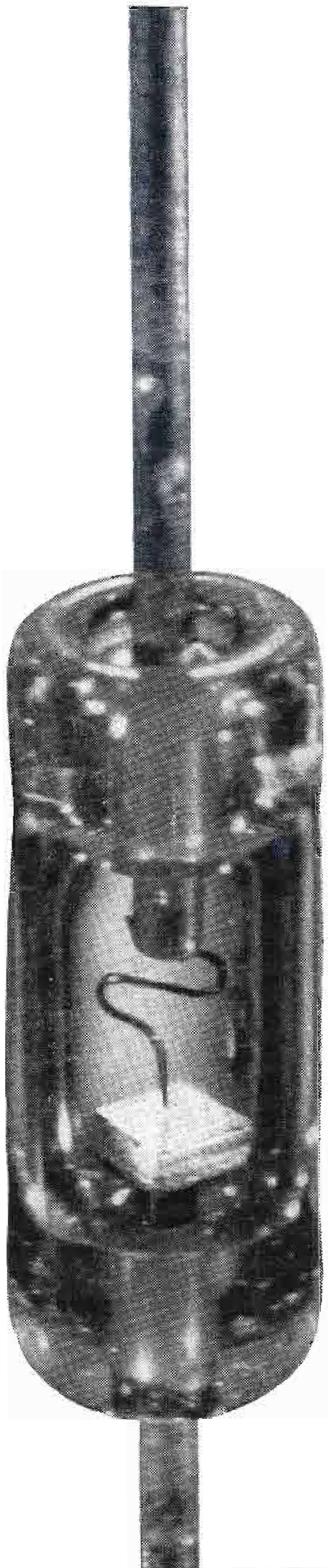
Specify **HUGHES DIODES** wherever reliability is essential.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

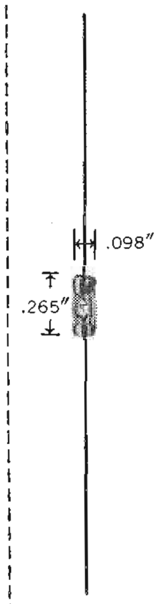
Description	RTMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)
High Peak	1N55B	190	150	5.0	0.500 @ −150 v
	1N68A	130	100	3.0	0.625 @ −100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v; 0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v; 0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v; 0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v; 0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v; 0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v; 0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v
	1N117	75	60	10.0	0.100 @ −50 v
	1N118	75	60	20.0	0.100 @ −50 v
General Purpose	1N90	75	60	5.0	0.800 @ −50 v
	1N95	75	60	10.0	0.800 @ −50 v
	1N96	75	60	20.0	0.800 @ −50 v
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v; 0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v; 0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.
**Formerly 1N69A. †Formerly 1N70A. ‡Formerly 1N81A.

In addition to RTMA *types,* HUGHES DIODES *are also supplied 100 per cent factory-tested to special customer specifications.*



Fusion sealed in glass *for electrical stability*



actual size

Semiconductor Sales Department

Hughes

AIRCRAFT COMPANY
CULVER CITY, CALIFORNIA

Chicago *New York City*

Address inquiries to Dept. T

TELE-TIPS

(Continued from page 28)

EYE ACHES—PRO AND CON: Contrary to the belief that 3-D movies cause eye strain and headaches, R. A. Sherman of Bausch and Lomb Optical Co. states that optometrists will recommend that people see stereoscopic pictures as often as once a day as part of the corrective procedure. The 12 to 15% of the public with visual disorders will be made more aware of the need for correction. Viewing 3-D movies is a beneficial exercise because it stimulates the use of the eyes in focusing and converging toward an object as it moves closer to the viewer. People with a lack of focusing flexibility often suppress the vision of one eye subconsciously.

TV STATIONS can operate successfully in small communities, is the opinion of Thad H. Brown, Jr., vice president of the NARTB. Taking an average of the six smallest-market stations operating last year, the minimum gross annual operating cost was found to be between $200,000 and $250,000. The norm for these stations was 24 full-time and 8 part-time employees. Indications are that a station may be operated for $150,000 if only film and/or network programs are used. An economic analysis shows that only those communities whose retail sales reach at least $37.5 to $50 million are a safe TV investment.

MICROWOOD is the name for new, economical, wall and ceiling covering for homes, offices, hotels, restaurants, theatres, institutions, etc. We believe it might have interesting possibilities for use on radio-TV cabinets too. Recently developed in Europe, "microwood" consists of a finely-shaven layer of wood laminated to a thin paper backing (0.005-in. thick). It is readily adaptable, of high tensile strength, and can be stamped, printed, painted, lacquered, varnished, waxed, oiled, punched, ground and polished. It is available in ten exotic African and European woods, ranging from light to dark shades, from David Feldmon & Associates, 525 Walnut Street, Cincinnati 2, Ohio.

(Continued on page 52)

Pick the Winner

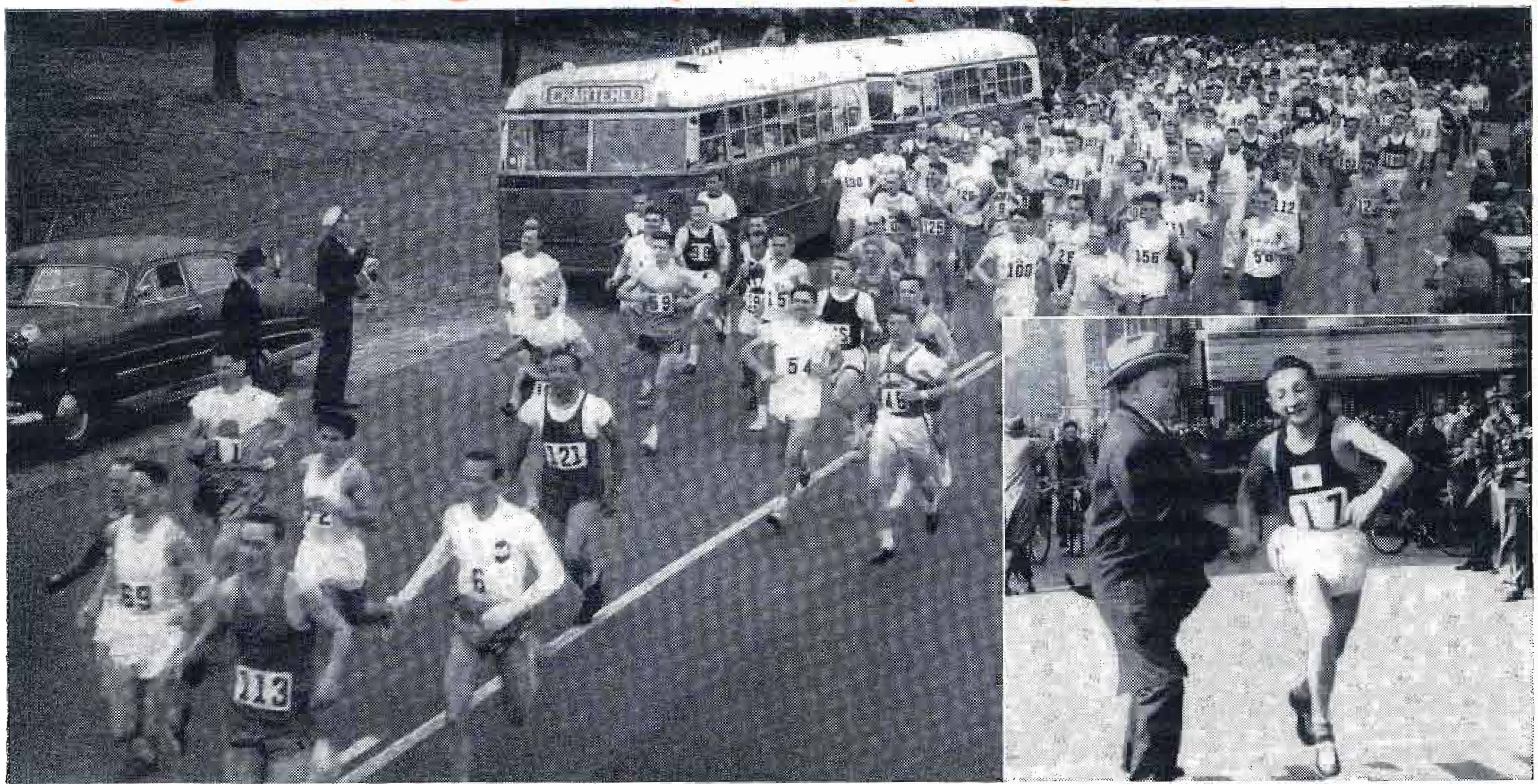
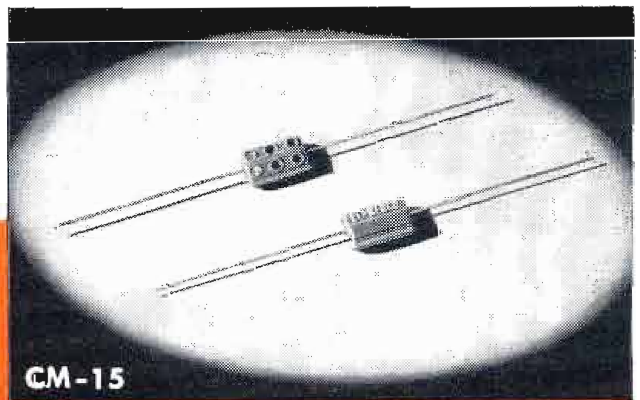


PHOTO · BOSTON HERALD

PHOTO · BOSTON POST

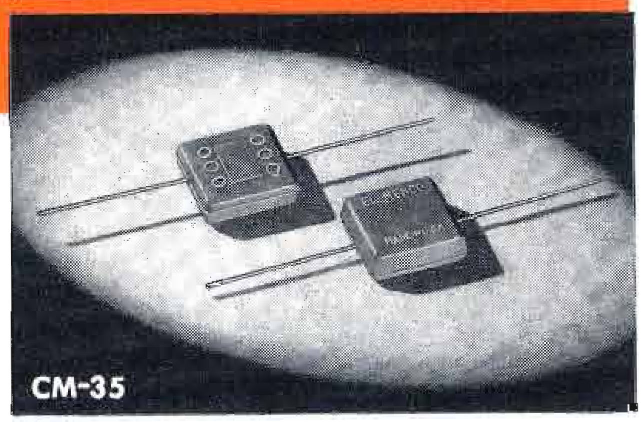
THEY ALL STARTED EQUAL . . . BUT ONLY ONE WON!

Yes, they all started equal in this year's Boston 26-mile Marathon. But only Keizo Yamada WON in the record time of 2 hours, 18 minutes and 51 seconds. Why? Because he had the capacity to run farther faster.



ALL CAPACITORS START EQUAL, TOO

. . . but El-Menco Capacitors always win because they're *factory-tested at more than double their working voltage*. You can know for sure that they have a wide margin of victory over the adverse conditions of any application.



So whether you pick the midget CM-15 (2-525 mmf. cap) or the mighty CM-35 (5 — 10,000 mmf. cap), you're sure of a winner . . . in any military or civilian service.

Jobbers and distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y. — Sole Agent for Jobbers and Distributors in U. S. and Canada.

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MOLDED MICA **El-Menco** MICA TRIMMER

CAPACITORS

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

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

TELE-TIPS

(*Continued from page* 50)

RADAR CAN KILL animals and injure humans, reports Cmndr. S. I. Brody of the Navy's Bureau of Aeronautics. Rabbits have been killed in 75 seconds with 3-kw radar waves, and with airborne systems as high as 1 megawatt going into operation, humans may suffer serious effects if proper precautions are not taken. The eye's sensitivity to radar, with consequent susceptibility to cataract formation, makes it a vital organ of extreme concern. Explosive effects are also noted. At 323 feet, photo flashbulbs were set off, and at 70 feet on explosion of aluminum chips in gasoline vapor was produced. One suggestion is that large metal screens be built around planes testing their radar sets on the ground.

FCC NIXES BC ST.-LT. CONTROL—Washington reports thumbs down on a request by New York City to turn its street lights off and on through a special radio signal from station WNYC. The FCC said the city's proposal would "seriously hamper" operation of the national system for radio "alerts" in time of enemy air attack. It said the proposal also would make the city's street lighting system vulnerable to "jamming" by saboteurs. The city's 152,000 street lights now are turned off and on through time switches. New York officials said this system made it almost impossible to turn lights on or off in an emergency without operating each switch individually. It proposed the new method of using a WNYC signal to activate electronic relay devices to control the lights. The city said this method would be more reliable and save a substantial amount of money. It would require WNYC to interrupt its broadcasts for seven-tenths of a second and increase its power momentarily.

RESEARCH PROTECTION—"No research director who is any good really directs any research. What he does is to protect the research men from the people who want to direct them and don't know anything about it."—C. E. K. Mees, Vice-president in charge of research, Eastman Kodak Co.

TELE-TECH

& ELECTRONIC INDUSTRIES—RADIO-TELEVISION

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

ENGINEER vs PHYSICIST

Competent Technical Design the Remedy for Decreasing Reliability of Military Electronic Equipment

There appears to me to be a great deal of loose talk and very little sound thinking about a problem now facing us:—The trend toward increasing complexity and decreasing reliability of electronic equipment for war.

We undertake a program of building reliable tubes—but don't do too much about the conditions under which they operate. We put equipment through very severe environmental tests in the laboratory—yet industry has so far been backward in following that equipment into the field, to see how it is actually used. We lose interest after the equipment leaves our factory and the government pays our bill.

To me, there are certain logical steps in the specification, development, design and production of a piece of military gear. The first of these is essential performance, around which the specification is written. What are the minimum functions that the equipment has to perform?

Essential Performance

Certainly no one believes that we should build electronic equipment or weapon systems of a lower performance than those possessed by our potential enemies. Certainly no one would agree that the airborne electronic equipment that was suitable for a 300 mph plane in World War II, is adequate in planes traveling at or above the speed of sound. Even in relatively simple areas such as front-line communication there has been a considerable mechanization of the foot-soldier's activities, with a substantial increase in firepower, which requires better coordination of effort through electronic communication.

If then, in order to achieve essential performance the equipment has to be made more complex, we must admit that fact—and proceed accordingly. But a word of caution, before we start the design—let's be sure the requirements are essential. A radio set to be used on open landing boats or a beachhead may have to be immersion-proof even if it complicates the design and increases the cost by 100%. But is this true of such a set for use at corps headquarters? Is the present demand for air transportability for everything justified if it means magnesium castings, skinned-down transformers, and a special 400-cycle power supply, all of which may double or triple the cost?

Complexity vs. Reliability

If increased complexity is necessary, it does not necessarily follow that the equipment has to be less reliable. Reliability is the ability to function continuously without trouble. We have a great many instances in our commercial experience where extremely complex equipment operates with a high degree of reliability. But it is designed with reliability as a primary objective. This requires a sound program of *engineering the product,* a study of the operating conditions and the type of maintenance to be expected, extended field trials in which the designer participates. The establishment of conservative operating margins, etc.

In my opinion, most of our troubles with lack of reliability stems from our need for more engineering to balance the current overdose of applied physics!

Where Physics Is a Must

Now, I don't want my remarks to be interpreted as a slap at the physicist whether he be in a college, government, or industrial laboratory. He is a very necessary part of this alliance. In order to meet the grade of performance required of this equipment, the frontiers of our technology have to be pushed back—not only in tubes, circuits and components but in materials and basic design philosophy. Applied Physics here is a must.

However, after the physicist has been able to show that these requirements can be met by certain circuits and combinations of components, instead of rushing into production—as we are very apt to do because the need is great—time *must* be taken to engineer this equipment by people who are skilled in design and development for use.

If we can do it for home radio, TV, and other appliances, then we certainly ought to be able to do it in the military field where human lives depend on it.

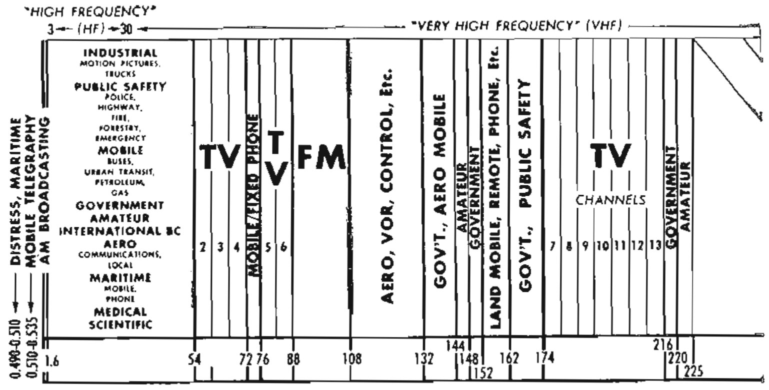
Take Time for Adequate Design

While we still have a breathing spell, let's stop telescoping our schedules, let's stop jumping from the research department into production.

In the development, design and production of a new piece of equipment, let's give as much time to design as to development. Let's give adequate opportunity for the product engineer to accomplish his end, even to the following of the equipment into the field to review its installation and maintenance. Then perhaps this rash of troubles with unreliable equipment will disappear. Then we may be able to return the term "haywire" to its agricultural origins and obtain for the radio engineer the professional standing and recognition now enjoyed by the applied physicist.

A guest editorial by Frederick R. Lack, vice-president Western Electric Co., past-president Radio Mfrs. Assn., Chairman Joint Electronics Equipment Committee, Munitions Board, and past president Armed Forces Communications Association. These comments are excerpts from Mr. Lack's recent address before the AFCA.

RADARSCOPE



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

TRANSISTORS

DEFINITIONS as applied to transistor types are likely to become confusing to many in the months ahead. While the terms "tetrode" and "pentode" carry significant meanings (the effects on space charge by the addition of electrodes) when referring to vacuum tubes, these same meanings may not necessarily be intended when discussing transistors. In the November, 1952, issue of TELE-TECH and ELECTRONIC INDUSTRIES (page 38) we describe the tetrode development of Bell Telephone Labs. wherein the addition of the fourth element enables high-gain operation at frequencies ten fold higher than for triodes. In this issue we report Sylvania's tetrode, wherein the fourth electrode is an additional emitter and this, in turn makes the transistor unit function more as a twin triode. Their pentode transistor, scheduled for production soon, will have three emitters and thus will also have greater versatility as a multi-circuit unit.

FAR HORIZONS

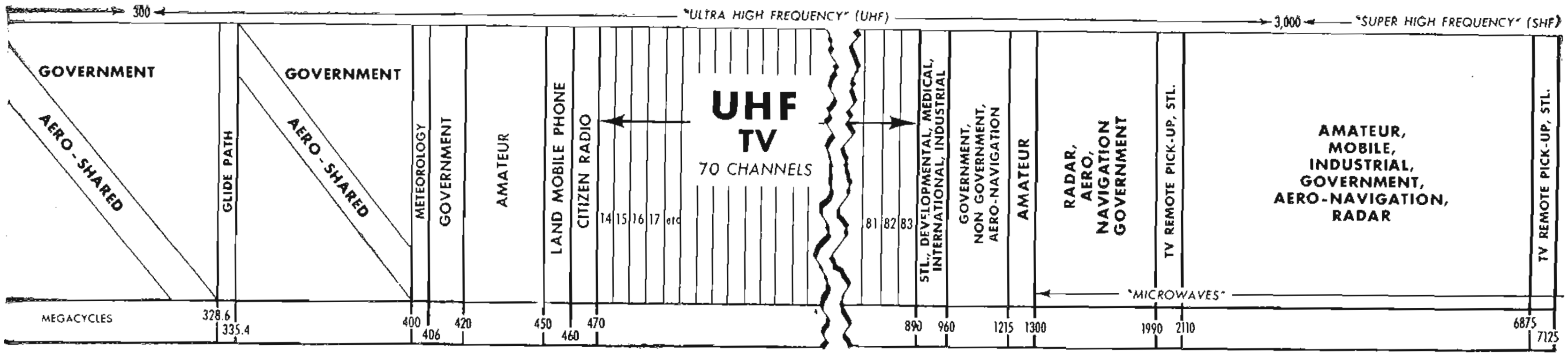
UNIFIED FIELD THEORY—Undoubtedly every radio man has remarked, at some time or other, on the surprising parallelism in the operation of gravitation, electromagnetism, light, radio, and electrostatic attraction—all five are transmitted across open space and all five obey the same inverse-square law. This significant similarity led to Dr. Einstein's long search for a unified field theory, following his 1905 conclusion that matter and energy are inter-convertible (1 gram of matter equals 25,000,000 kw-hr). Now comes Dr. V. Hlavaty of Indiana to show that instead of two parallel entities, gravitation and electromagnetism, as we have sensed them, gravitation is merely a manifestation of electromagnetic phenomena, so that the ultimate "Ursache" after all is *electromagnetsism*—the same electromagnetic waves of which radio and TV are made! Which being true, electromagnetic (i.e. radio) engineers may conceivably someday be neutralizing (or amplifying) gravity, and delivering milk or fuel-oil to remote places along with TV! Absurd as this now seems, certainly the atom bomb, a 1953 reality, was based on no less tenuous (or solid) a foundation in Einstein's supposedly fantastic equations of 1905!

INTERNATIONAL

DOUBLE-TRACK TV FILM is proposed by Jack Gould of N. Y. Times, as result of German suggestion for multi-language use—an invaluable tip to manufacturers for noncommercial educational TV stations in the United States—who are anxious to have their films shown in many countries. This film would have two sound tracks. One track would carry the authentic sound background, such as cheers at a sports contest, applause for a speaker or the crackle of a spectacular fire. The second track would carry the commentary. A native announcer fluent in languages would listen to the second track on earphones and translate as the film progressed. This would enable each country to report an event in its own distinctive way, free from the taint of outside propaganda.

EXPORT

RTMA LOOKS ABROAD—W. M. Adams, chairman of the RTMA Export Committee, has addressed the Association's board of directors on the growing importance of the exporting of electronic equipment and components and urged the Association to make an investigation of requirements of the industry. Following Mr. Adams' talk, the Board authorized President Plamondon to appoint an ad hoc committee to work with a subcommittee of the Export Committee in developing a program designed to promote foreign sales of American-made equipment and components and to give greater recognition to the export phases of radio, television and electronics production of member-companies.



COLOR TV

COLOR TRANSMISSION—GE engineers expect the growth of color television to proceed in three definite steps. The first will be the production of color programs in large cities by network origination stations, and the rebroadcast of these programs by local stations around the nation. The second step will be the production of slide and film color programs by local stations, and third, the production of live-talent color programs by local stations. Equipment which can be added to an existing station to provide the best possible rebroadcast of network color programs will cost less than $20,000, and will be available in six months.

To permit a local station to originate slide and film color programs, an additional $68,500 worth of special projection equipment must be added. To originate live talent shows from its own studios, an existing station must add color studio cameras and switching equipment, at a cost of at least $70,000.

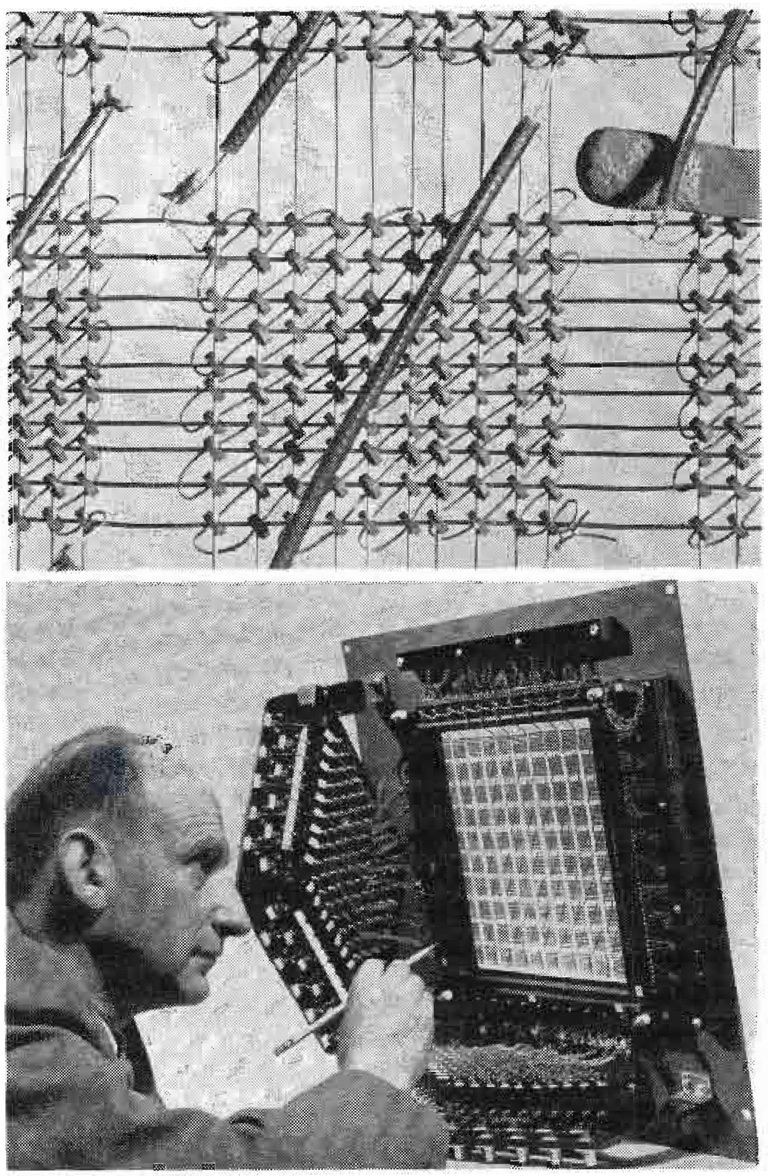
EMPLOYMENT

STARTING SALARIES of young engineers still continue to rise. Illinois Tech figures for 1953 show nearly $400 per month for architectural graduates (5 years), with mechanical engineers at $377. Next come the electrical engineers with $371; industrial engineers, $370; mathematics majors, $368; and civil engineers, $367. Slightly below the class average of $362 were the physics graduates who started work at an average monthly salary of $360. Then came the chemistry majors, with $356; chemical engineers, $352; fire protection and safety engineers, $342; business and economics graduates, $327; and metallurgical engineers, $317. Graduates with masters' degrees commanded correspondingly higher salaries than those with bachelors' degrees. Mechanical engineering masters averaged $490 a month, while masters in electrical engineering started at $437, and chemical engineering at $415.

COMPUTERS

NEW HIGH-SPEED MAGNETIC MEMORY developed by Dr. Jan A. Rajchman, an RCA physicist, stores 10,000 items of information. The system is highly reliable, and promises to be relatively inexpensive, as memories for computers go. It can memorize or recall a bit of information in a few millionths of a second. The heart of the memory is a matrix of a hundred closely spaced wires at right angles to which run a hundred more wires. At each of the 10,000 wire intersections is a magnetic core, surrounding one vertical and one horizontal wire. The "0" cores, 1/15 in. thick, are made of a special ferromagnetic spinel. This ceramic-like material is easily molded on automatic stamping machines.

In operation, a current flowing through two intersecting wires causes the core to switch its polarity to negative or positive, thereby storing one bit of information. Current in one wire alone is not enough to trip the polarity. To read out, the core to be interrogated is subjected to pulses along its two intersecting wires. If the core is tripped into opposite polarity, its reversal creates a signal in a wire that runs through the center of all 10,000 cores. If it is not tripped, no signal appears in the common wire. Conceivably, 100 such grids may be connected together so that 1,000,000 items of information could be stored.



Dr. Rajchman examines high-speed, large-capacity memory which he developed at RCA's David Sarnoff Research Center. Enlarged view at top shows size of magnetic cores compared to head of a paper match. Core memorizes signal of horizontal and vertical wires passing through its center. Common wire threading through all cores is read-out. Insulated wires (dark diagonals) link the common read-out wire of one group of cores to another

Applying Pulse Magnetrons to

Design errors underlying current reliability difficulties traced to understanding of absolute ratings. Switching, life, mismatch and physical environment are also evaluated

By CHARLES V. LITTON, Chairman of the Board and *PAUL W. CRAPUCHETTES, Dir. of Engineering, Vacuum Tube Dept.*
Litton Industries, San Carlos, Calif.

PART ONE OF TWO PARTS

EXPERIENCE of past years indicates that an undue percentage of electronic equipment has been plagued by a general lack of reliability. A detailed study of the problems encountered in efforts to make equipment containing pulse magnetrons reliable will illustrate the general problem and direction of solution.

For the most part, what few satisfactory solutions have been made to specific trouble spots have come about by what one might call "political" rather than scientific means. By this is meant simply that by compromise at the conference table, both magnetron and circuit engineers have made alterations in their respective products which have resulted in an increased compatibility, but which have alleviated rather than eliminated many of the difficulties involved.

It is necessary to appreciate the fact that a performance specification designed to test a magnetron to establish its general quality *does not* at the same time define a set of working conditions under which apparatus incorporating the magnetron may be expected to give satisfactory life and performance.

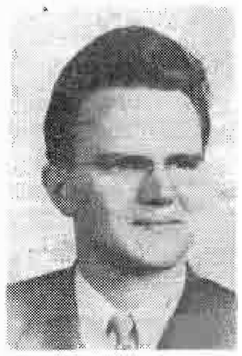
Much more important than the realization of this limitation is, however, the absolute avoidance of the trap that has been laid for application engineers, which not only spells out future trouble for the magnetron, but for most other types of electronic devices as well. Briefly, this trap lies in the unquestioning assumption that if a specification defines a tube, then a tube will define the specification, and that demonstrable performance with a tube establishes the adequacy of circuit design. No one fallacy has contributed more to equipment non-reliability than this one.

Figs. 1 and 2 are photos of a 4J52 magnetron and its component parts, except for magnet and fittings.

As a result of initial development, a specification will exist for a particular magnetron which is representative of what can be done at that time. Fig. 3 shows a distribution curve of the product with quantity as ordinate and "quality" as abscissae, and the location of the original specification is plotted as a vertical line. These initial locations represent economic compromise at a date and assume that some equipment design had been satisfactorily demonstrated with tubes of this quality.

Following the sometimes erroneous platitude that the proof of the pudding is in the eating, it is often assumed that the equipment design responsibility ceases upon the dem-

Litton



Crapuchettes

onstrated performance of the equipment aggregate—and this is the trap. This "satisfactory" performance indicates only that a specific and selected sample of tubes that in reality do not have any type designation whatever, have worked in an equipment. The tests in no way demonstrate that a specific tube *type* is functional until such time as statistical quantities of marginal spec tubes have been run in the equipment, and even these demonstrate no margin of safety for the operation.

As improvements appear in time and several manufacturers enter the field, the situation such as Fig. 4 results. If manufacturer of magnetrons C had been chosen as the supplier, then it is obvious that no marginal tubes are even available from this source. Unless all sources are tried, and minimal spec tubes from the manufacturer with the lowest margin of spec are used, no evaluation of a tube type in an equipment will have been made, and in any event, any procurement of tubes must be made against a specification which protects the performance of equipment using tubes at or slightly below this specification.

There is the inherent requirement at administrative level that magnetron test specification continually be raised to crowd the lowest quality performer. In the case of the armed services, somewhere in their own administrative echelon there lies the necessity to so monitor a situation that they exercise control over:

1. The test specification for magnetrons which will guarantee adequate supply of suitable product.
2. The selection and supply for equipment acceptance and design test of magnetrons which are marginal with respect to the specification in 1.
3. The contractual requirement that circuitry be so devised as to accommodate the above tubes.

Such a philosophy will permit great freedom in the accommodation to varying situations all the way from sample lots to large procurements without compromise on the necessary and essential final requirement of compatibility between equipment and magnetrons.

The limitations on magnetron operation might be divided into four general headings:

1. Ability to accept changing input, duty, pulse length, and rate of rise (i.e. switching).
2. Life under a given set of conditions in which each must be separately evaluated, though with a

Radar Equipment

full knowledge of the interdependence of various performance characteristics.

3. Ability to accept "how much mismatch" of the load in phase and standing wave ratio.

4. Physical, electrical and mechanical environmental considerations.

Switching

In this section we shall discuss what happens in the magnetron as a result of changing the input peak current, repetition rate, rate of rise and fall of voltage, pulse length, and duty, i.e., switching. The transient effects of switching, amenable to circuit analysis, are not covered here.

One of the primary limitations on pulse tube operation is maximum operable pulse length, even if average input power is scheduled down in accordance with tube specifications. This is, at least in part, due to the loss of emission of oxide coated cathodes when a long pulse is applied. In general, for very short pulse lengths, the instantaneous emission of an oxide cathode is approximately 100 times greater than normal emission capability. But for longer pulses, following this instantaneous peak there is a fairly rapid decay in the pulse current. This may be attributed to two factors, namely: (1) the near exhaustion of free barium by local heating at the surface by the long pulse at fairly high duty (i.e. short recovery time) limits the peak current obtainable. (2) The fact that when a very sharp pulse of voltage is applied to an oxide emitter, the emitted current consists of a capacitive displacement component within the coating as well as the conduction component, and thus the result is an initial peak in the current pulse followed by a rapid decay. Hence addition of these two effects can only mean that the longer the pulse the greater the likelihood of moding or missing due to loss of emission. Moding or missing in this case would appear toward the trailing edge of the pulse due to failure of the magnetron to draw high current with a consequent increase in voltage to the point where the next higher mode might appear.

Specific attention should also be given to the filament schedule under unusual operating conditions. A characteristic of magnetrons that some of the input power from the high voltage source is dissipated in the cathode by "back-heating." Depending on the tube design and the application this may or may not be important. The specifications on many tubes, however, include a formula by which the power to the heater is to be reduced as Pi, the average plate power input is increased. It is the intent of this formula that the cathode temperature shall be held approximately constant, under different conditions of operation. This intent must be remembered if the tube is to be used under extreme conditions. If, for example, the average input power is obtained at a very low pulse repetition rate and with correspondingly long pulses, or if pulsing is not regular and excessively long intervals (in terms of milliseconds) may occur between pulses, then the intermittent nature of the back heating may cause excessive variation of the cathode temperature. This may cause erratic operation, particularly at the start of the pulse. This phenomenon can sometimes be corrected by increasing the filament power accordingly but, since this will lead to an excessively high cathode temperature at either end of the pulse or during intervals of frequent pulsing, the correction may reduce life. Under such unusual operating conditions, therefore, special attention should be given to the filament schedule. Any change in this schedule should be studied in terms not only of its immediate effect on operating stability, but also of its effect on life.

Observable Limitation

This leads to an observable limitation sometimes noted in switching pulse length of a pulsed magnetron. It is particularly noticeable after switching from long to short pulse length that arcing, moding and misfiring takes place for several minutes. This might be explained in terms of the foregoing paragraphs, i.e., on long pulse lengths it is not at all uncommon for a magnetron to lose emission, particularly in localized areas where backheating is most severe. Until such time as more free barium can be deposited in these localized areas on the surface, erratic operation might be expected, particularly at the start of the pulse. Probability of moding and misfiring is enhanced by the fact that switching from long to short pulse also switches from lower to higher rates of rise of voltage. The cure for this is probably quite complex but certainly improved control of cathode temperature is a desirable target, aging is a temporary expedient, and reduction of rate of rise of voltage is a uniform solution.

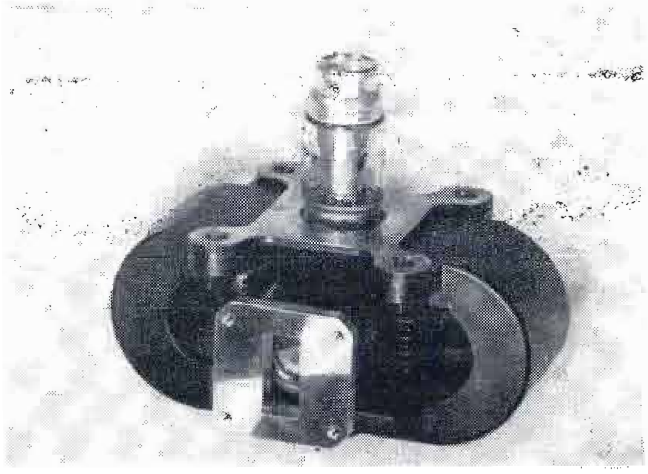


Fig. 1: Photograph of 4J52 magnetron

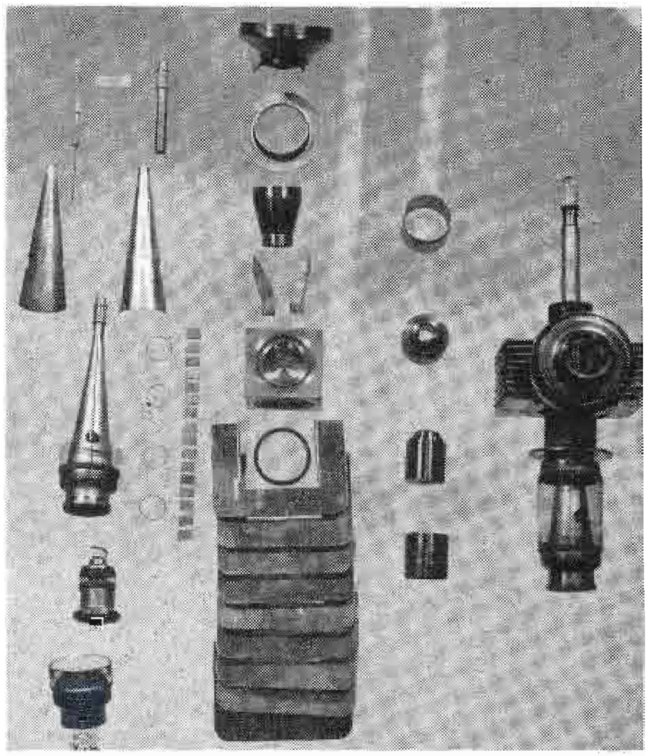
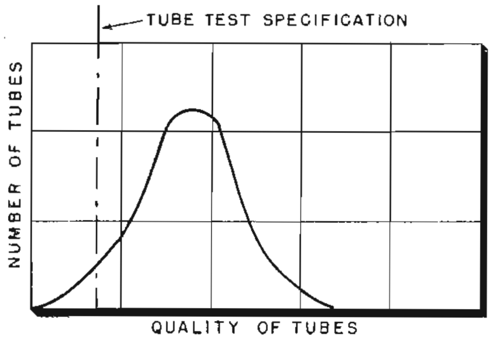


Fig. 2: Component parts of 4J52 magnetron. Magnet and fittings are not included in photo

Another explanation also exists to account for the switching phenomena. We are actively engaged in checking for final operation rather than checking out any theory. If such a theory of operation existed it might read about as follows:

(1) A film of emissive material (barium and barium oxide) is deposited on the end hats during operation of the magnetron. This may be checked by removing the cathode of several magnetrons which exhibit the above characteristics.

(2) We then postulate that during operation this film must reach some equilibrium state for the pulse length used (for how else could the tube "clean up" after a short aging at this pulse length?). And, further, that the equilibrium for one pulse length



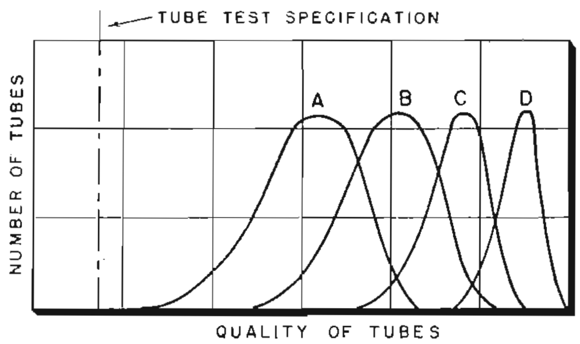


Fig. 3: (l) Initial quantity-quality distribution curve. Vertical line is original specification. Fig. 4 (r) With improvements in time, no marginal tubes are available

JAN-4J52
THIS SHEET of TEST LIMITS is a PART of SPECIFICATION JAN-1A

Description: Magnetron, fixed tuned, pulse type, with permanent magnet

Ratings:	Ef	i_b	pi	Pi	tk	Du	tp	Anode T
Absolute	V	a	kw	w	sec		μs	°C
Maximum:	12.6+10%	30	450	450	—	.002	1.2	150
Maximum:	12.6+10%	20	300	300	—	.002	0.5	150
Minimum:	12.6+10%	—	—	—	240			

Pulsing Service: Note 2 **Cathode: Oxide and coated unipotential

Notes: (a) Shall not be operated at maximum peak input power pressure less than 60 cm. Hg.

(b) Shall not be operated longer than 6μs. in any 100 μs interval.

Page 1 of 5 pages Date JAN-4J52

Fig. 5: 4J52 spec sheet lists magnetron's absolute ratings, which must be carefully applied

is different from that at other pulse lengths at their consistent value of i_b. These we feel are reasonable assumptions.

(3) Let us now assume some level of operation, and switch to a longer pulse length and properly schedule i_b (the argument holds equally well for switching from long to short pulse lengths) and find that the end hats seek some new level of equilibrium.

(a) The end hats are hot, have an emissive coating and are consequently emitters in the truest sense of the word. The end hats are axially spaced closer to the vanes than the cathode. From starting theory, then, we would logically expect oscillations to start at a lower voltage and at a different frequency (several megacycles at most) from normal operation.

(b) Current is then drawn by this "end space magnetron," but it must be emission limited, so it reaches some point early in the pulse where the voltage starts to rise. At this point a choice of three courses is available to the magnetron:

(1) The voltage can continue to rise until arcing occurs.

(2) The voltage can continue to rise until operation occurs in a higher order mode.

(3) The voltage can rise to normal π mode operation with indications of noisy spectrum as the magnetron starts anew. This is due to the confusion of the electrons with co-existing oscillation patterns in the interaction space.

This theory adequately explains the effects, and it only remains to prove the causes by their elimination. This is currently under way in a search for new materials with no emission for use as end hats.

The foregoing discussion on cathode limitations easily explains why duty should be scheduled down as pulse length is increased. That is, recovery time for cathode emission must be increased for long pulse operation. It further explains why peak plate current must be decreased as pulse length is increased. Emission just is not as available for excessively high current on long pulses as on short pulses.

At this point perhaps the case sounds bad for the magnetron. This however is not true, for at no time have we put numerical limits on what the magnetron can stand. This is reasonable for it must vary from type to type, manufacturer to manufacturer, and even from tube to tube. What we have outlined so far shows only that certain limitations do exist but not that all of them co-exist in a given tube or equipment.

All limitations discussed thus far have been on operation at maximum level but the magnetron has at least one limitation to the systems engineer at low level operation. Simply stated, at low peak values of plate current pushing is far greater than at high peak values of plate current, where pushing is generally defined as the frequency change which occurs during dynamic changes in plate current over a 6 db range.

Thus we find somewhat of a dilemma. You cannot operate all magnetrons at or beyond the specification limits and expect adequate service, nor can you "baby" them along by operating at extremely low levels. Where then can you operate them? There is a broad range of values (approx. 6db) in which they will give several hundred hours of faithful service, and it is in this realm that test specifications and operating specifications must be adjusted.

Corrective Actions

Other limitations requiring action by persons other than the magnetron manufacturers are:

(1) The preparation of an adequate duty schedule in co-ordination with all tube and equipment manufacturers, such that no specification tube need fail in the field.

(2) The preparation of dual specifications—one for the tube manufacturer and one for the system engineer, such that an adequate safety margin on items such as the rate of rise of voltage will be maintained in all systems at all duties and thus re-aging can be avoided.

In designing a system for use with a particular magnetron, care must be taken to insure operation of the magnetron within its allowable limits as delineated on the tube specification sheet.

The "absolute ratings," except in a few cases specifically noted to the contrary, are not intended to be applied simultaneously. Instead they represent maximum or minimum allowable values of the various parameters taken individually. As a specific example, let's take a look at the JAN 4J52 tube specification sheet. The top of page 1 appears as in Fig. 5 and represents the tube's "absolute ratings."

The first line of maximum ratings should be interpreted as follows:

(*Continued on page* 100)

Final NTSC Color TV Standards

Specification for compatible signal utilizes color burst on back porch of horizontal sync. Industry support paves way for early approval by FCC

ON July 23, 1953, the National Television System Committee filed a petition with the FCC for the adoption of transmission standards for color TV. The following is the NTSC specification for the color picture signal.

A. General Specifications

The color picture signal shall correspond to a luminance (brightness) component transmitted as amplitude modulation of the picture carrier and a simultaneous pair of chrominance (coloring) components transmitted as the amplitude modulation sidebands of a pair of suppressed subcarriers in quadrature having the common frequency relative to the picture carrier of +3.579545 MC ±0.0003% with a maximum rate of change not to exceed 1/10 CPS/sec.

B. Delay Specification

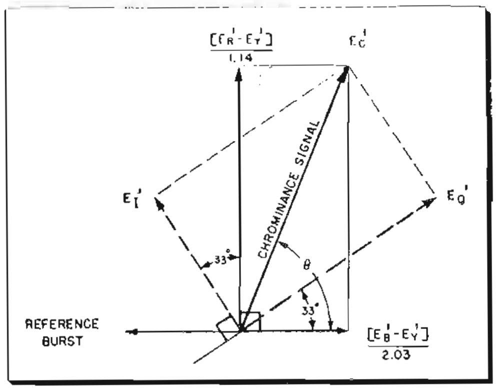
A sine wave, introduced at those terminals of the transmitter which are normally fed the color picture signal, shall produce a radiated signal having an envelope delay, relative to 0.1 MC, of zero micro-seconds up to a frequency of 3.0 MC; and then linearly decreasing to 4.2 MC so as to be equal to −0.17 μsecs at 3.58 MC. The tolerance on the envelope delay shall be ±0.05 μsecs at 3.58 MC. The tolerance shall increase linearly to ±0.1 μsec, down to 2.1 MC, and remain at ±0.1 μsec down to 0.2 MC. The tolerance shall also increase to ±0.1 μsec at 4.2 MC.

C. The Luminance Component

1. An increase in initial light intensity shall correspond to a decrease in the amplitude of the carrier envelope (negative modulation).

2. The blanking level shall be at (75 ± 2.5) % of the peak ampliture of the carrier envelope. The reference white (luminance) level shall be (12.5 ± 2.5) % of the peak carrier emplitude. The reference black level shall be separated from the blanking level by the setup interval, which shall be (7.5 ± 2.5) % of the

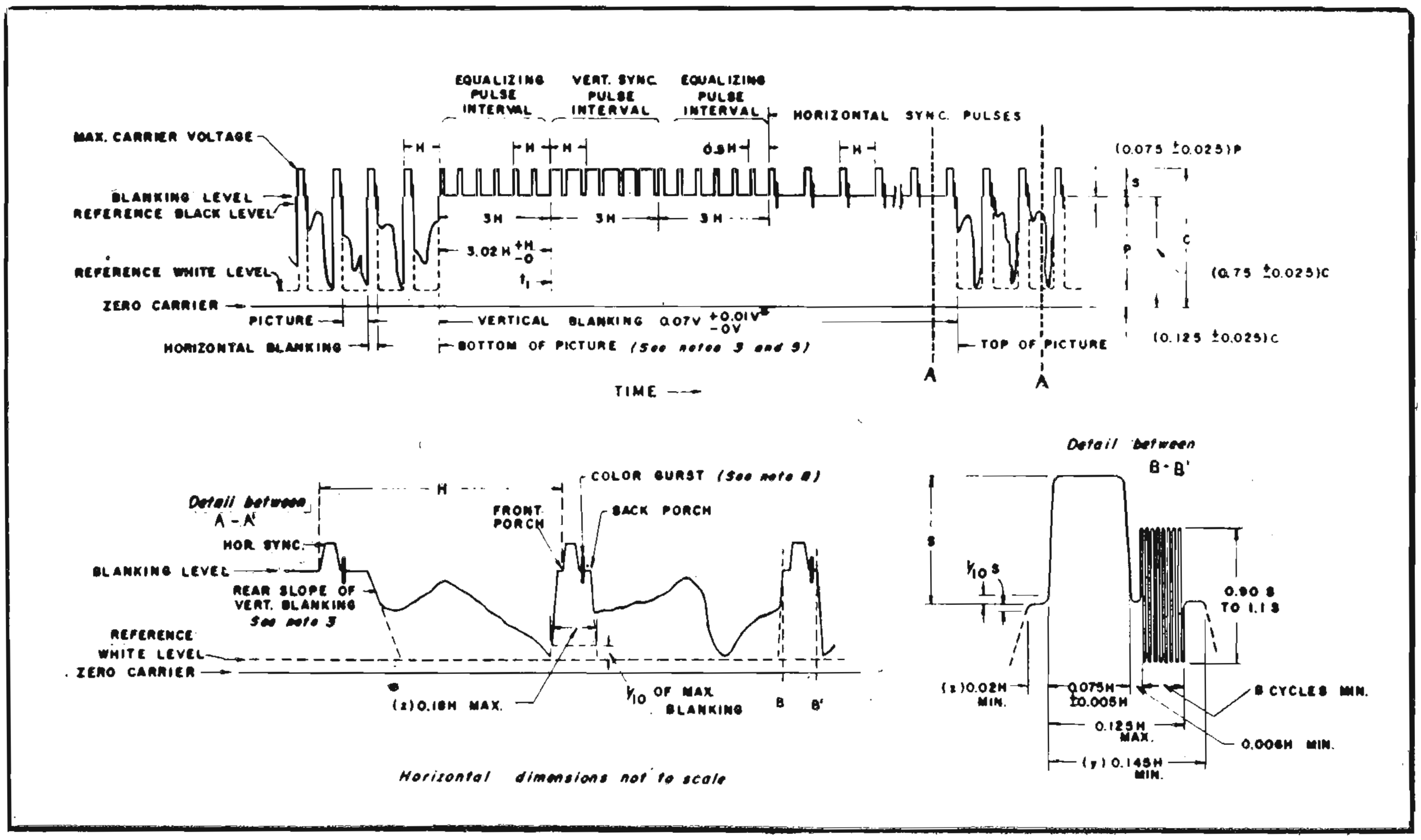
(*Continued on page* 102)



Phase relations of color signal. Burst corresponds to AM of a continuous sine wave

NTSC color TV signal employs 8-cycle color burst on back porch of horizontal sync pulse. Waveform is essentially same as standard black-and-white

NOTES
1. H=Time from start of one line to start of next line.
2. V=Time from start of one field to start of next field.
3. Leading and trailing edges of vertical blanking should be complete in less than 0.1 H.
4. Leading and trailing slopes of horizontal blanking must be steep enough to preserve minimum and maximum values of (x+y) and (z) under all conditions of picture content.
*5. Dimensions marked with asterisk indicate that tolerances given are permitted only for long time variations and not for successive cycles.
6. Equalizing pulse area shall be between 0.45 and 0.5 of area of a horizontal sync. pulse.
7. Color burst follows each horizontal pulse, but is omitted following the equalizing pulses and during the broad vertical pulses.
8. Color bursts to be omitted during monochrome transmissions.
9. The burst frequency shall be 3.579545 mc. The tolerance on the frequency shall be ±0.0003% with a maximum rate of change of frequency not to exceed 1/10 cycle per second per second.
10. The horizontal scanning frequency shall be $\frac{2}{455}$ times the burst frequency.
11. The dimensions specified for the burst determine the times of starting and stopping the burst, but not its phase. The color burst consists of amplitude modulation of a continuous sine wave.
12. Dimension "P" represents the peak excursion of the luminance signal from blanking level, but does not include the chrominance signal. Dimension "S" is the sync. amplitude above blanking level. Dimension "C" is the peak carrier amplitude.



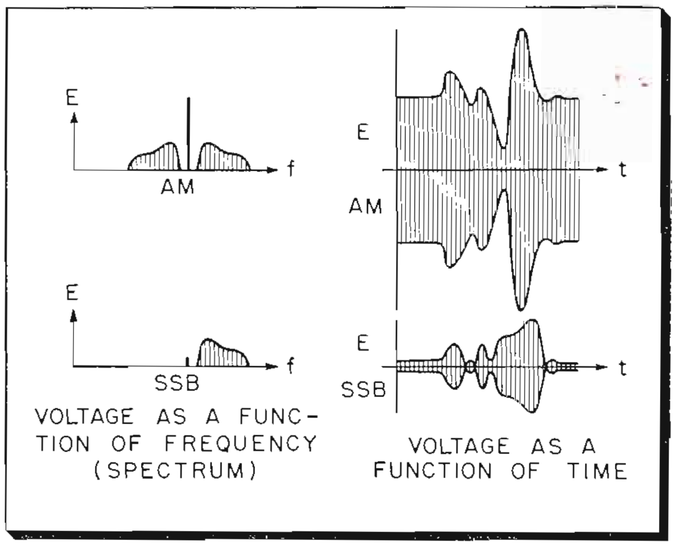


Fig. 1: AM and SSB signals in terms of spectra and modulation

Performance of AM

Comparative evaluation shows SSB is well suited for long range paths and is less susceptible to fading than conventional AM

By JOHN F. HONEY
Stanford Research Institute, Stanford, Calif.

THERE is no single magic number which can be used to indicate the relative merit of amplitude modulation (AM) and single sideband (SSB) communication systems. The comparative value of these two systems depends to a very great extent on the conditions of use and on equipment limitations imposed by any given service. The SSB system is well suited for long range communications in the LF, MF, and HF frequency ranges because of its spectrum and power economy and because it is less susceptible to the effects of selective fading and interference than conventional AM.

Fig. 1 illustrates AM and SSB signals in terms of their familiar frequency spectra and modulation envelopes. The principal advantages of the SSB system arise from the elimination of the high-energy AM carrier signal, which contributes nothing to the intelligence handling capability of the system, and from a further reduction in sideband power permitted by the improved performance of the SSB system under unfavorable propagation conditions.

Fig. 2 illustrates the basic elements of a typical SSB transmitter. The speech signal is first converted up to a low intermediate frequency by the balanced modulator. The desired sideband of this conversion is selected by the SSB filter. The SSB signal is then raised to the desired radio frequency by further frequency conversions and is amplified to the desired power level by means of a conventional linear power amplifier.

The basic SSB receiver shown in Fig. 3 appears very similar to the transmitter, and the various operations are simply the inverse of those just outlined for the transmitter. The received SSB signal is heterodyned down to the low i-f, passed through the SSB filter, and moved to audio frequency by means of a linear translational demodulator. Considerable advantage of the similarity of the transmitter and receiver may be realized in the design of a combined equipment or "transceiver."

Demodulation Carrier

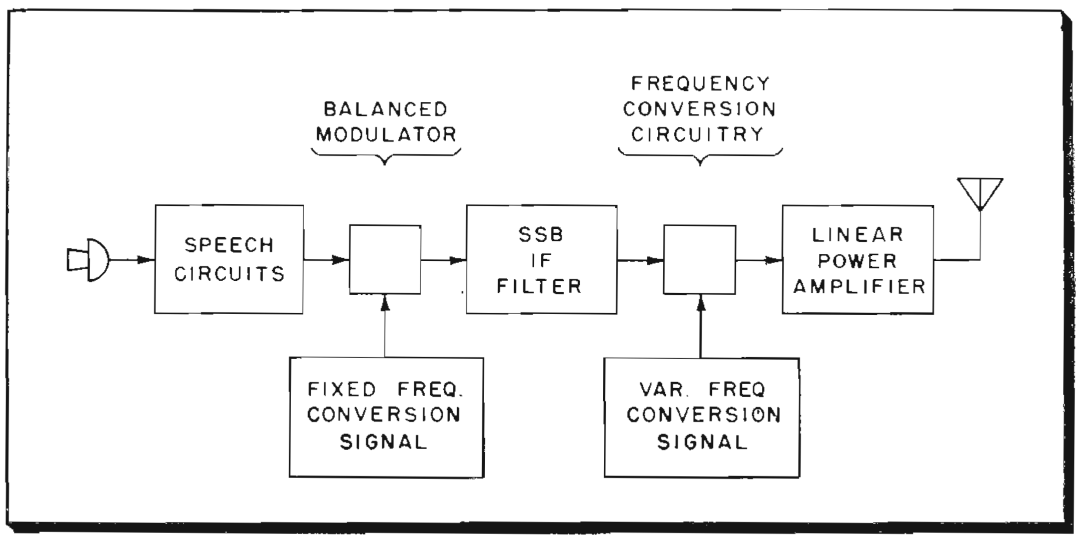
It is necessary that the demodulating carrier be held within 20 to 50 CPS of the carrier frequency of the received signal after translation. This requires either excellent frequency control of the transmitter and receiver (1 to 5 ppm) or rather elaborate AFC provisions in the receiver in order to achieve automatic "push-to-talk" operation. The additional complexity of these circuits is not normally required in the AM system.

These factors will be discussed in more detail after we have compared the relative performance of the AM and SSB systems and the equipment limitation factors.

System Performance Comparison

Imagine that a SSB communications link is set up beside an AM link and that the two systems are operated identically in the presence of noise and under theoretically ideal propagation conditions. It will be found that the two systems will perform identically (the same S/N at the output of the two receivers) if the total sideband power output of the two transmitters is the same. If the output of the SSB receiver may be said to contain one unit of signal power, the output of the AM receiver will contain two units of signal power because of the coherent addition of the two AM sidebands in the receiver detector. If the output of the SSB receiver contains one unit of noise power, the output of the AM receiver will contain two units of noise power because of incoherent addition of the noise voltages accepted in each of the two sidebands received. Thus, the signal-to-noise ratios at the output of the two receivers are the same.

Fig. 2: SSB transmitter converts speech to i-f, selects sideband, and raises signal to desired r-f



and Single-Sideband Communications

The AM signal is quite susceptible to degradation by multipath transmission or selective fading effects. If the carrier is shifted in phase with respect to the rest of the signal spectrum, audio output is reduced. If the carrier is reduced in amplitude with respect to the rest of the signal, audio output is reduced and severe distortion products are generated. The SSB system is not subject to degradation by variations in suppressed carrier phase, and AFC circuits may be designed to minimize the effects of severe suppressed carrier fading.

Extensive tests have been made in the laboratory and over short and long distance transmission paths in an attempt to evaluate the importance of the relative susceptibility of the two systems to selective fading conditions. In these tests, AM transmission was used, and a single receiver was modified to provide simultaneous AM and SSB demodulation of the received signal. Tape recordings were made of standard word-list transmissions, and the tapes were then evaluated by a six-man articulation scoring team. All told, about 270 50-word lists were recorded and evaluated. The results of these tests indicate that, for good propagation conditions, the two systems will perform identically if the power output of the single sideband transmitter is the same as that found in one of the two sidebands in the output of the AM transmitter. Some of the tests were made under extremely bad fading conditions and, though the difference in performance between the two systems was much more striking, it was not possible to obtain an accurate evaluation.

With the two parallel systems operating without noise or selective fading, but in the presence of narrowband man-made interference, the narrower bandwidth of the SSB system results in an improved probability that the desired channel will *not* contain destructively strong interference. The difference in resulting system performance may be compensated by increasing the power of the AM transmitter. A statistical study has been made of the distribution of signals on the air versus signal strength, and in this case the results of the analysis indicates that the probabilities of successful communication will be the same if the power output of the single sideband transmitter is equal to one-half the power in one of the two sidebands in the output of the AM transmitter.

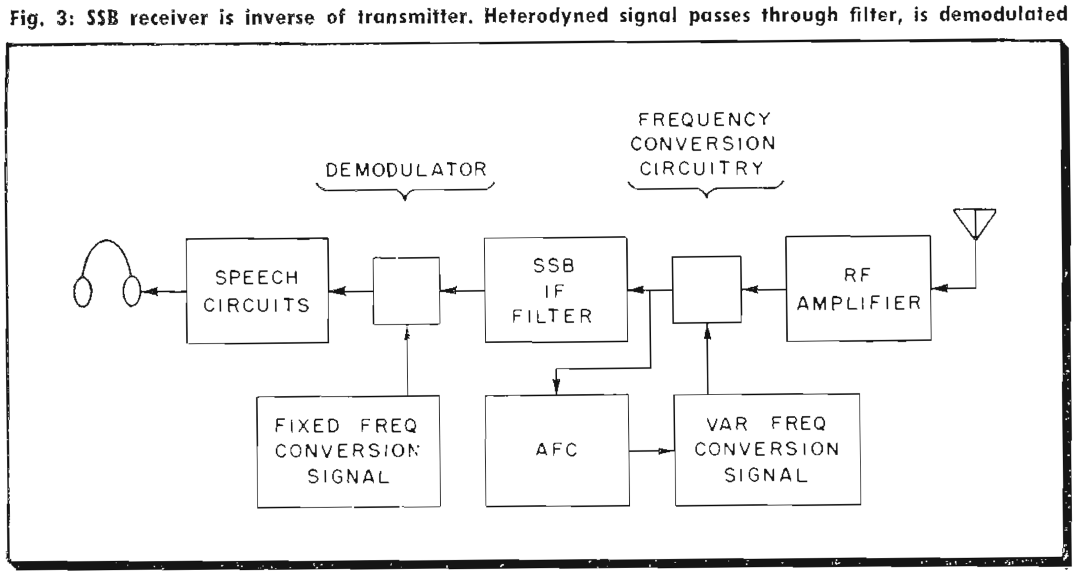
Transmitter Comparison

It has been shown that the combined effects of noise and moderate selective fading and interference conditions can be responsible for an improvement of from 0 to 9 db in the performance of the SSB link over an AM link when the transmitters have the same total sideband power output. The greater improvements are generally found under maximum range conditions, and maximum range is a prime factor in the determination of required transmitter power in any communications link. It might be stated that the SSB system is in effect much more durable under adverse conditions than is the AM system.

In order to be able to compare the weight, size, and other characteristics of the transmitters in identically-performing AM and SSB communications systems, we must know something of the actual noise, interference and fading conditions which would prevail in any specific service. Lacking specific information of this kind, we can at least set up a conservative example and assume that only 3 of the possible 9 db advantage will be realized on the average contact. Under this condition, the SSB transmitter will be required to develop the same power output as that in one of the two sidebands in the output of an AM transmitter providing equivalent performance.

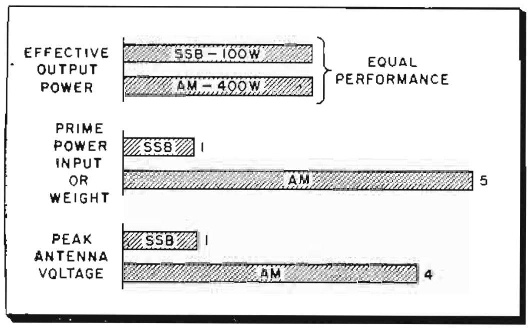
Fig. 4 illustrates the case of equivalent performance for the AM and SSB systems in terms of prime power input, total equipment weight and peak antenna voltage developed. Efficiencies in the case of the AM transmitter are calculated for the usual high-level plate-modulated Class-C power stage. It is assumed that a 70% average modulation index is achieved by the use of appropriate speech processing techniques in both systems. The AM transmitter power output stages, including the modulator, actually draw about seven times the high-voltage power required by the SSB power amplifier. However, since the SSB transmitter is characterized by slightly more low-level circuitry than the AM transmitter, a power ratio of five to one appears more reasonable for practical power levels. The AM transmitter is rated according to carrier power output, and the SSB transmitter is rated according to power output obtained for 100% single tone modulation. Note that the 400-watt AM transmitter develops 100 watts in each of its two sidebands for 100% single tone modulation—the same power in each sideband as that developed by the SSB transmitter. It has been found that the relative weights for this general type of equipment follows rather closely the relative prime power requirement.

Fig. 3: SSB receiver is inverse of transmitter. Heterodyned signal passes through filter, is demodulated



Performance Comparison

The information shown in Fig. 4 can be reinterpreted for the various limiting conditions which may exist in different services. Fig. 5 illustrates the relative advantage of AM and SSB communications equipment when the weights of the two equipments are held the same. The SSB equipment delivers performance which is the same as or better



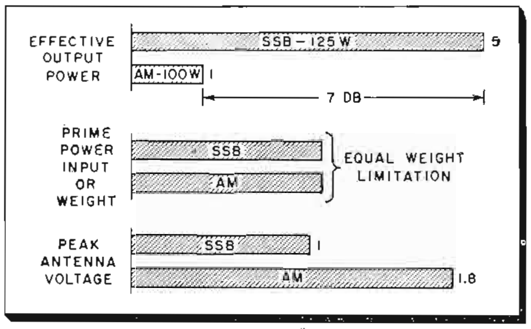


Fig. 4: (l) Equivalent performance for AM and SSB in terms of power input, weight and peak antenna voltage. Fig. 5: (r) SSB advantages for equal equipment weights

than an AM equipment having five times the transmitter power output that is permitted by the weight and power requirement limitation. The peak antenna voltage developed by the SSB transmitter is a little over half that for the AM system, thereby permitting a further weight saving in the antenna coupler and wing or tail-cap insulating sections.

However, the peak antenna voltage may be the principal limiting factor on the performance of the communications system. The antenna voltage limitation becomes important in services where high power is needed and operation at high altitudes with electrically small antennas is desired. Fig. 6 illustrates the relative advantage of AM and SSB systems when performance is limited by a given maximum antenna voltage. Under these conditions, the use of the SSB system permits the use of higher power equipment that will deliver 16 times the effective power of the largest permissible AM transmitter.

Thus, it can be seen that the advantages to be realized by the use of the SSB communications system for long-range high-frequency communications depends on both the propagation conditions normally experienced in a given service and on the equipment power, weight or voltage limitations which may apply in any given service. The greatest advantage of SSB communications is generally realized under the most difficult communications conditions.

Fig. 7 illustrates how the advantage of the single sideband system for the various limiting conditions may vary with propagation conditions over a long range path. "Ideal" conditions are taken to mean communications limited by the presence

(Continued on page 147)

Radio "Trafficasting" Aids Highway Control

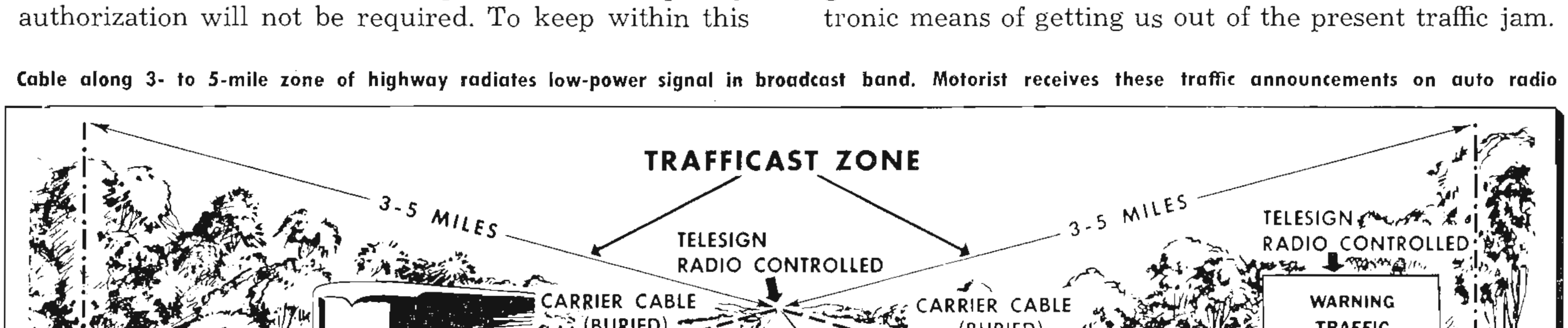
Highway Communications systems have become vital elements in the structure of modern traffic management. On high-speed routes such as the New Jersey and Pennsylvania Turnpikes, VHF and microwaves have teamed up to provide instantaneous contact between police cars, service vehicles, and central control points. This is a big step forward in highway engineers' attempts to expedite traffic on our overburdened roads, but a most important consideration has been overlooked—*traffic information is not being directed sufficiently at the individual motorist.* An occasional briefly-worded sign is not adequate.

For this reason, a system which enables the driver to receive traffic announcements over his auto radio would appear to offer a promising solution. A system of this type, developed by Touradio, Inc., utilizes a carrier cable buried along both sides of the road.. A low-power radio transmitter, operating in the standard broadcast band on a frequency not assigned to a regular station in the area, feeds "trafficasts" to the cable, which in turn radiates the signals to passing vehicles. Since these signals are of low power and confined to the highway right-of-way, it is expected that special FCC frequency authorization will not be required. To keep within this low-power rule, each trafficast zone is limited to about five miles, although zones may be adjacent to one another. Therefore, a person driving 60 mph would receive five minutes of continuous pre-recorded bulletins or spot announcements describing road conditions, civil defense measures and similar information in each zone. Highway signs would call attention to the frequency which the driver should tune in. This system, now under consideration by leading highway agencies, has received enthusiastic endorsement from motorists, according to polls taken by the Port of New York Authority. It has been employed successfully as a traffic management tool for over a year and a half in New York's Lincoln Tunnel.

Other applications include a radio-controlled "telesign," which would cause various neon messages to be illuminated according to road conditions. Also, two-way broadcasts to service vehicles would be possible with a minimum of equipment. Furthermore, TV surveillance at key points could be monitored at a central station, and the resulting information sent by radio to motorists.

We're hoping that highway officials will move with greater than usual speed to utilize this scientific electronic means of getting us out of the present traffic jam.

Cable along 3- to 5-mile zone of highway radiates low-power signal in broadcast band. Motorist receives these traffic announcements on auto radio



Page from an Engineer's Notebook

No. 22 — Microwave Response Law Corrector

By *LAWRENCE J. PERENIC*
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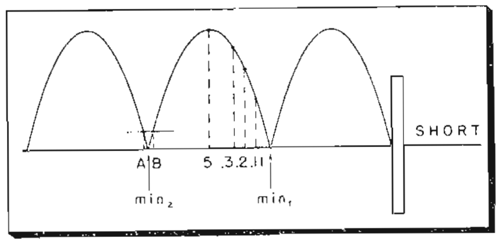
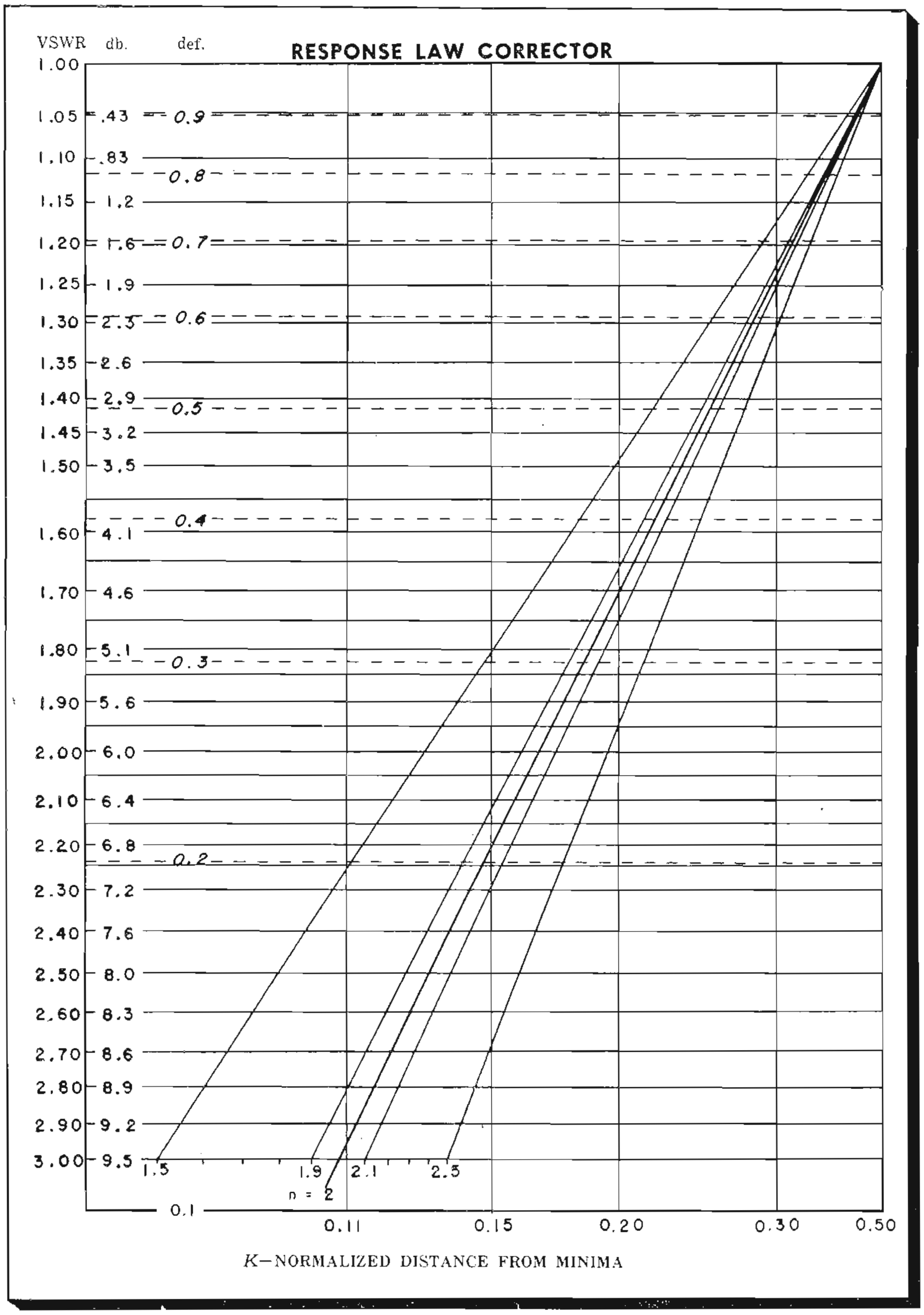
IT frequently becomes desirable, in taking measurements of voltage standing-wave-ratio, to be able to calibrate the measuring system. If, further, this can be accomplished rapidly and without recourse to secondary standards, one is able to maintain a consistently high degree of accuracy over a continuous spectrum with relatively standard equipment.

The accompanying Response Law Corrector is based upon a knowledge of the spatial field distribution in a waveguide, or other uniform transmission line, under short-circuited conditions. One of the most useful features of this method, aside from its simplicity, is that it does not depend upon the accuracy of any calibrated attenuators or amplifiers. It is an absolute method and, therefore, one which is to be preferred.

Results are obtained with a minimum of computation and quickly disclose the behavior of the slotted section, detecting element (bolometer, barreter, or crystal), standing-wave amplifier and indicating meter, taken together as a system. By plotting four especially-selected points, it is possible to determine, graphically, not only the response law of the system, but also the corrected VSWR if the response is other than square law. This last feature will be found of inestimable value to those who employ crystals as detecting elements.



Various values of K to obtain X_p from short



To Obtain Response Law

1. Terminate slotted section in a short.
2. Measure min_1 and min_2 distances by bracketing: min (bracketing) $= (A+B)/2$, where A and B are distances from short where meter deflection is same on both sides of minimum.
3. Determine probe positions (distances from short), X_p, according to following table:

K	$(min_2 - min_1)$	+	min_1	=	X_p	deflection linear meter
0.50	(. . . − . . .)	+	. . .	=	. . . cm	1.00
0.30	(. . . − . . .)	+	. . .	=	. . . cm	. . .
0.20	(. . . − . . .)	+	. . .	=	. . . cm	. . .
0.15	(. . . − . . .)	+	. . .	=	. . . cm	. . .
0.11	(. . . − . . .)	+	. . .	=	. . . cm	. . .

4. Set linear meter deflection to full scale with probe at that X_p where $K=0.50$.
5. Observe and plot linear meter deflection (or VSWR) versus K for four remaining values of X_p.
6. Read response law as slope of line passing through plotted points. (For square law response, slope $= 2$.)

To Correct VSWR Readings to Square Law

1. Project observed VSWR horizontally to intersect with response law determined above.
2. At intersection with response law, project vertically to $n=2$.
3. From intersection with $n=2$, project horizontally to left and read corrected VSWR on chart.

Measuring Air-Density for Aircraft

By HENRY F. COLVIN, III
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Kollsman Instrument Corp.
80-08 45th Ave., Elmhurst 73, N. Y.

IN aerial gunnery, knowledge of the density of the air through which the guns must fire is of prime importance in securing accurate results. The relative air density system engineered by Kollsman is designed to provide these data for use in gunnery computers.

The density of the air is usually expressed as a fraction of the density of air under standard conditions. In most computers, these conditions are taken to be the NACA standard temperature of 15°C and absolute pressure of 29.92 in. Hg.

The weight density, hereafter called simply the density, of air, which is assumed to be a perfect gas, is given by

$$\rho = p/RT \qquad (1)$$

where ρ = Density of air in lb/ft.^{3}
p = Static pressure lb/ft.^{2}
T = Air Temperature °K.
R = Gas Constant

At standard conditions of temperature and pressure, the standard density becomes

$$\rho_o = p_o/RT_o \qquad (2)$$

where ρ_0 = Standard density
p_0 = Standard pressure
T_0 = Standard temperature

The relative air density (RAD) is defined as

$$D = \rho/\rho_o \qquad (3)$$

Combining Eqs. (2) and (3):

$$D = (p/T)\,(T_o/p_o) \qquad (4)$$

From Eq. (4) it can be seen that the relative air density is dependent on the ambient pressure and temperature, and on the standard air temperature and pressure.

With standard conditions established as 15°C and 29.92 in. Hg. the equation for RAD becomes

$$D = \frac{p}{T} \times \frac{273.2+15}{29.92} = 9.632\,\frac{p}{T} \qquad (5)$$

Instrumentation

From Eq. (5), it is evident that to compute the relative air density both air pressure and the temperature must be measured.

The air pressure may be measured by a pressure sensitive mechanism connected to the same source of static pressure as the altimeter, or to a similar source.

The air temperature may be measured by means of a temperature sensitive probe which projects into the airstream, or by a bulb which is installed flush with the skin of the plane. However, neither the pressure nor the temperature so measured will necessarily be that of the free undisturbed air. Errors will be caused by the disturbance of the air flow, by the passage of the airplane and even of the probes through the air.

The nature of the static pressure position error is well known, and not much is done about it other than to find a location for the static pressure source which is subject to the least possible error. The best location for the altimeter static source will also be the best for the RAD system.

The errors of the measured temperature are of greater significance, however, and a correction must be made. The measured temperature is higher than the true air temperature. The increase is caused both by adiabatic compression and skin friction. In practice, these effects are lumped and a factor, K, is determined experimentally. "K" expresses the combined heating effect as a fraction of the theoretical adiabatic compression temperature rise. The theoretical temperature rise is equal to

$$V^2_T/2gJC_p$$

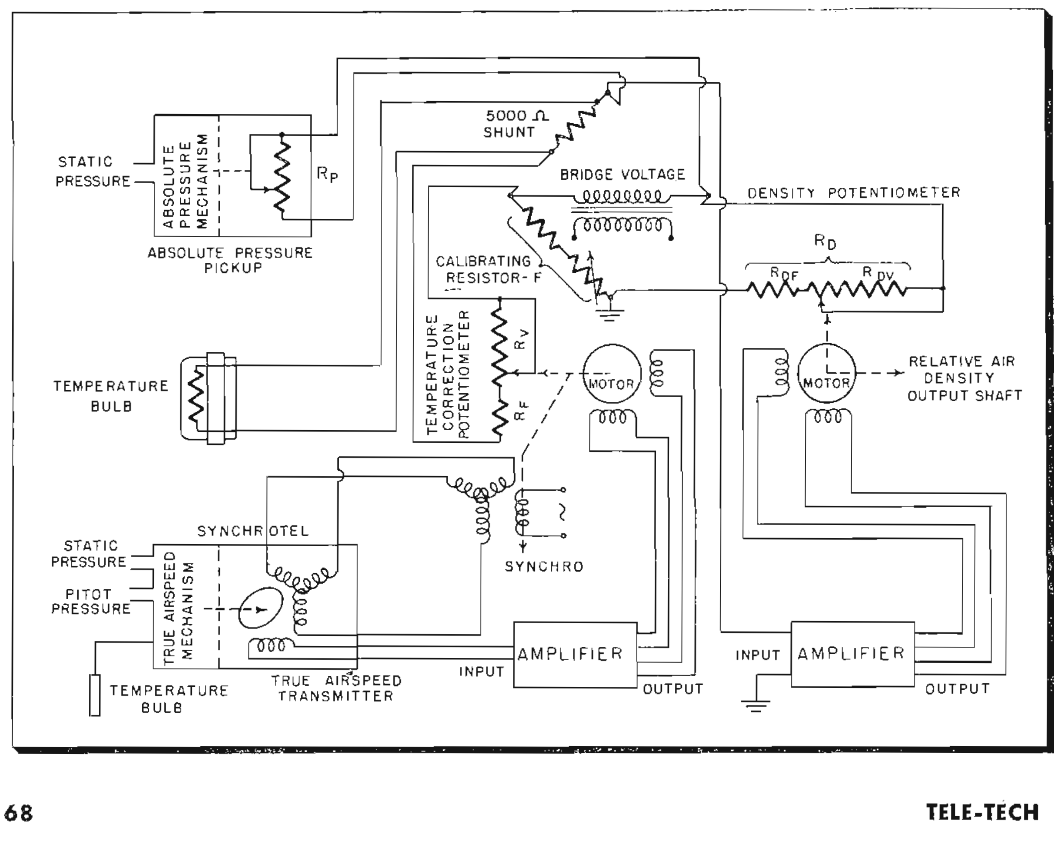
and the actual temperature rise is expressed by

$$\Delta T = T' - T = KV^2_T/2g\,JC_p \quad (6$$

where ΔT = Temperature error °C.
T = Measured air temperature °K.
K = Fraction of theoretical temperature rise realized.
g = Acceleration due to gravity = 32.17 ft./sec.^{2}
J = Mechanical equivalent of heat = 778.26 BTU/ft. lb.
C_p = Specific heat of air at constant pressure = 0.240 BTU/lb./deg. F. = 0.432 BTU/lb./°C.
V_T = True airspeed ft./sec.

From Eq. (6) it can be seen that a measurement of true air speed is required in order to make this correction. In this system, it is measured by a True Airspeed Transmitter which detects the pitot pressure, static pressure and air temperature, and moves a Synchrotel (a low-friction synchro made by Kollsman) to an angular position proportional to true air speed.

Fig. 1: Circuit for computing relative air density. Output shaft rotation is function of RAD



Computation of RAD

The system for the computation of RAD is shown schematically in Fig. 1. The computation of Eq. (5) is performed electrically, and the output is a shaft, the rotation of which is a function of relative air density. In most applications, the shaft motion is proportional to RAD.

For the computation of RAD, the pressure is measured by a diaphragm mechanism which moves a variable resistor so that the resistance between terminals is directly propor-

Gunnery Computers

Temperature, measured by variable resistance bulb, is combined with pressure information to compute relative air density. Special low-friction synchro employed to translate RAD information into shaft rotation

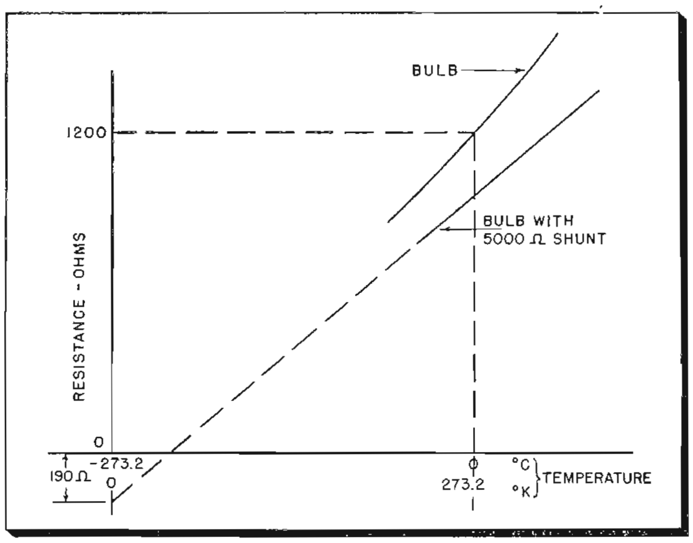


Fig. 2: Resistance-temperature characteristics of bulb

tional to the static pressure. That is

$$R_p = Ap \qquad (7)$$

where R_p = Resistance of the pressure transmitter.
A = Constant of proportionality.

The temperature is measured by a variable resistance bulb which is connected into an electrical network, the total resistance of which must be made proportional to the absolute true air temperature.

The temperature bulb used (Fig. 3) resistance-temperature relationship shown in Fig. 2. The temperature scale represents the measured temperature T′.

When a resistance of 5,000 ohms, with a very small temperature coefficient, is connected in parallel with the temperature bulb, the resistance of the combination is related to temperature as shown in Fig. 2. This curve may be represented very closely by the equation

$$R = 4.24T' - 190 \qquad (8)$$

where R = Resistance of shunted temperature bulb (ohms).

When true airspeed is expressed in knots, Eq. (6) becomes

$$\triangle T = 1.3186K\,(V_T/100)^2 \qquad (9)$$

and

$$T' = T + \triangle T = T + 1.3186K\,(V_T/100)^2 \qquad (10)$$

where V_T = True air speed (knots).

The factor K has been found to vary between about 0.6 and 0.9. A few temperature probes have been designed with the object of making K = 1, thus measuring the full adiabatic temperature rise. One probe, the vortex thermometer, is reported to measure the true temperature directly, as a result of which K equals zero.

With the probes currently in use, however, a correction is made to the measured temperature. On the basis of Air Force tests, in the Kollsman system the factor K is assumed to have the value 0.8. Then, combining Eqs. (8) and (10).

$$R = 4.24T + 4.472\,(V_T/100)^2 - 190 \qquad (11)$$

If a resistance equal to

$$190 - 4.473\,(V_T/100)^2$$

be added in series with the shunted temperature probe, the resulting total resistance of the temperature circuit would be

$$R_T = 4.24\,T \qquad (12)$$

where R = Total resistance of temperature circuit (ohms).

This satisfies the requirement that the resistance of the temperature circuit be proportional to the absolute true temperature.

The added series resistance will be greatest at the lowest value of true airspeed to be measured, and least at the highest. The least value may be provided by means of a fixed resistor.

$$R_F = 190 - 4.473\,(V_{T\,max}/100)^2 \qquad (13)$$

where R_F = Value of the fixed resistor (ohms).

Variable Resistor

The remainder of the required series resistance may be provided by means of a variable resistor, the resistance of which is a function of true airspeed.

$$R_V = 4.473\,(V_{T\,max}{}^2 - V_T{}^2)\,10^{-4} \qquad (14)$$

where R_V = Resistance of variable resistor at any point (ohms).

In the Kollsman RAD system, the nonlinear variable resistor, known as the temperature correction potentiometer, is positioned by means of a closed loop servomechanism which includes the true airspeed transmitter. The output of this servo, a shaft rotation linear with true air speed, is usually required as another input in the gunnery computer.

The Synchrotel is connected into a conventional synchro type servomechanism, in which the error signal is amplified and used to drive a motor so as to position the potentiometer when the servo system is balanced. As the Synchrotel moves, the motor causes the potentiometer to move also, and so to introduce the proper resistance into the temperature circuit.

The pressure transmitter and the temperature circuit are connected as two legs of a Wheatstone bridge circuit. Of the other two legs, one is a variable resistance proportional to RAD and the other an adjustable fixed resistance.

The condition for balance of the bridge circuit is given by

$$R_D = F\,(R_p/R_T) \qquad (15)$$

where R_D = Resistance of Density circuit (ohms)
F = Resistance of calibrating resistor (ohms)
R_p = Resistance of pressure transmitter (ohms)
R_T = Resistance of temperature circuit (ohms)

Substituting Eqs. (7) and (12) into (15)

$$R_D = (FA/4.24)\,(p/T) \qquad (16)$$

Substituting from Eq. (5)

$$R_D = \frac{FA}{40.84}\,D \qquad (17)$$

The unbalance voltage from the bridge is amplified and supplied to the two-phase induction motor which drives the density potentiometer so as to balance the bridge.

Eq. (17) shows that when the bridge is balanced, the resistance of the density leg is proportional to RAD. If the potentiometer is linear, the shaft rotation will be proportional to D. If some other function of density is required, a suitable nonlinear potentiometer can be designed.

In the design of a specific RAD system on the general line of the one described, a number of decisions must be made. Some of the decisions are

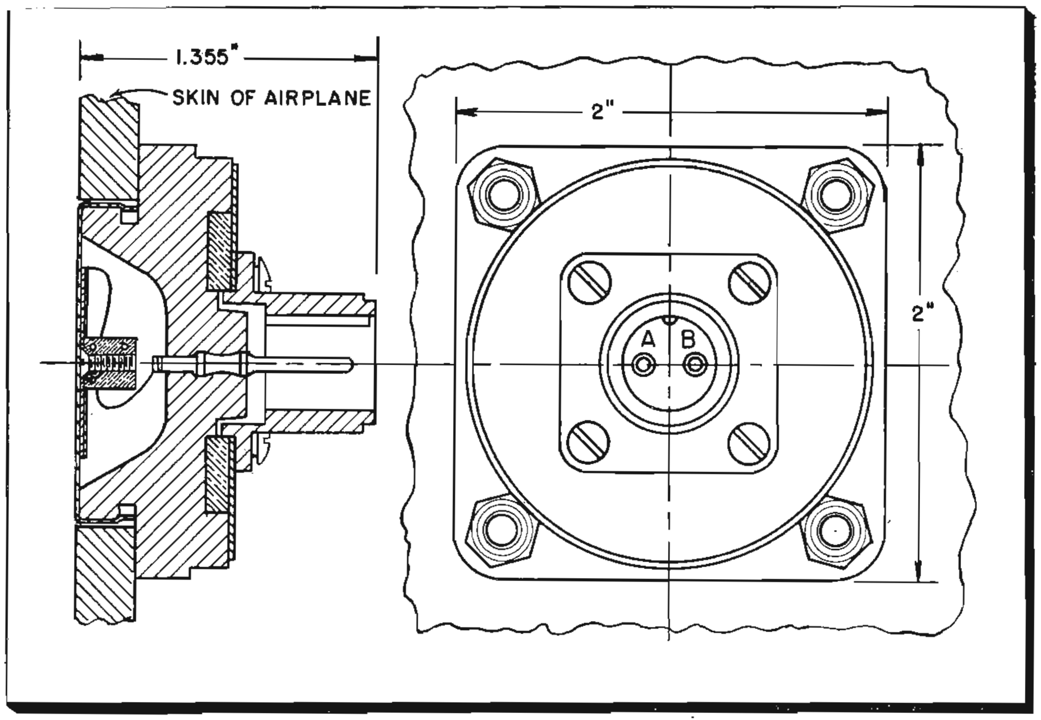


Fig. 3: Flush mounting construction of free air temperature bulb for aircraft

dictated by the available components, and others follow as an inevitable consequence of prévious decisions.

The temperature bulb used in Kollsman RAD systems is illustrated in the drawing in Fig. 3. This bulb has a resistance at 0°C of 1200 ±1 ohms. The temperature sensitive winding is of nickel alloy wire having the proper curve of resistance vs. temperature. The resistance is the highest that can be built into a bulb this size with this wire. Nickel alloy wire is used because it has close to the highest temperature coefficient of resistance of available wire material.

Temperature Circuit

The rest of the temperature circuit must be designed so that the total resistance will be

$$190 = 4.473\,(V_T/100)^2$$

The range of true air speed to which the system will be subjected must be determined. It will be noted that the limiting true air speed which can be handled by a system based on this design is that which reduces the added resistance to zero, or

$$V_{TL} = \sqrt{190/4.473} \times 100$$
$$V_{TL} = 651 \text{ knots}$$

where V_{TL} = Limiting true air speed (knots)

If the maximum true air speed is less than 650 knots, the required series resistance can be broken down into a fixed resistor and a variable resistor (the temperature correction potentiometer).

As described in the preceding section, the value of the fixed resistor will be

$$R_F = 190 - 4.473\,(V_{T\,max}/100)^2 \quad (13)$$

and the resistance of the temperature correction potentiometer will be

$$R_V = 4.473\,(V_{T\,max}^2 - V_T^2) \times 10^{-4} \quad (14)$$

The total resistance of the potentiometer will then be

$$R_{V\,max} - 4.473\,(V_{T\,max}^2 - V_{T\,min}^2) \times 10^{-4} \quad (18)$$

A nonlinear potentiometer, the rotation of which is proportional to changes in true air speed, must be designed. That is

$$\theta = \frac{V_{T\,max} - V_T}{V_{T\,max} - V_{T\,min}}\,\theta_{max} \quad (19)$$

where θ = Angular position of the potentiometer (deg.)

θ_{max} = Total angle of the potentiometer (deg.)

This may be more conveniently written

$$\theta = B\,(V_{T\,max} - V_T) \quad (20)$$

where B = The "rate" of the potentiometer

$$= \frac{\theta}{V_{T\,max} - V_{T\,min}} \quad (21)$$

By substituting (20) in (14)

$$R_V = 4.473\left(\frac{2V_{T\,max}\,\theta}{B} - \frac{\theta^2}{B^2}\right) \times 10^{-4} \quad (22)$$

When the proper values for B, V_{Tmax}, and V_{Tmin} are substituted into equation (22), the resulting equation will express the relationship between resistance and rotation of the temperature correction potentiometer.

The total angular rotation of the true airspeed transmitter and of the temperature correction potentiometer must be considered together.

If the rotation of the potentiometer is restricted from turning indefinitely in either direction, then the total angle of the Synchrotel in the true airspeed transmitter must be less than 180°. A practical maximum is 175°. In this case, the rotation of the potentiometer may have any total angle, within its design limitation, as there is no chance of the system getting out of step as a result of a complete revolution of the follow-up system. The follow-up synchro will, of course, have the same angular motion as the Synchrotel.

Potentiometer Rotation

If the potentiometer is free to rotate continuously in both directions, it is essential that the potentiometer go through an integral number of revolutions for one revolution of the Synchrotel. Then, if the follow-up synchro goes through a complete revolution, and comes to balance, the potentiometer will also return to the correct position.

For best accuracy and resolution in both the potentiometer and the Synchrotel, the total angle should be as large as possible. The angle will generally be limited by the design of the potentiometer. The maximum angle of non-linear potentiometer in most cases is between 300° and 320°. The total angle of the true airspeed transmitter for the air speed range may be specified within wide limits. If, however, it is necessary to select a standard true airspeed Synchrotel ratio, then the potentiometer must be designed to fit.

An important consideration in the design of a nonlinear potentiometer is the ratio of the greatest to the least value of the resistance-rotation slope. The greatest value which can be accommodated without a change of wire size in many potentiometer designs is four to one. In the square-law potentiometer, such as the temperature correction potentiometer, the ratio of greatest to least slope is the same as the ratio of the greatest to the least value of the function which is to be squared, in this case the true air speed. If the range in true air speed can be confined to a four-to-one change, the potentiometer design will be simplified, although of course greater changes can be accommodated if necessary. The rest of the temperature-correction servo may be designed along the lines of conventional servo practice.

(*Continued on page* 140)

G Curves & Impedance Amplifiers

Increasing number of engineers employing this new circuit technique. How to account for load impedance variations in transformer-coupled systems

By
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THE design of impedance and transformer coupled amplifiers, with few modifications, follows the patterns similar to those described for triode and pentode resistance coupled amplifiers. The differences result primarily from the variation of amplifier load impedance with frequency and from the fact that the static and the dynamic load impedances always differ in impedance type amplifiers. Good practice calls for loading an impedance or transformer coupled amplifier with a fixed loading resistance across the impedance of transformer output when uniformity of amplification and/or minimal phase characteristics are important considerations.

Rating of audio interstage transformers on the basis of turns ratio and the primary inductance as a function of primary static current would probably simplify the design of transformer coupled amplifiers. The user could then establish his amplifier frequency response and amplification characteristics by selection of a transformer having adequate primary inductance and use of the proper loading resistance on the secondary. Use of pentode amplifier tubes is entirely satisfactory when the proper secondary loading is provided. A pentode design example is included to indicate the design details.

The design of triode type impedance and transformer coupled amplifiers is patterned after the design of triode resistance coupled amplifiers. The only difference between impedance coupled and transformer coupled amplifier design is the need to consider the transformer turns ratio in the determination of the primary and secondary impedances. The impedance ratio is the square of the turns ratio.

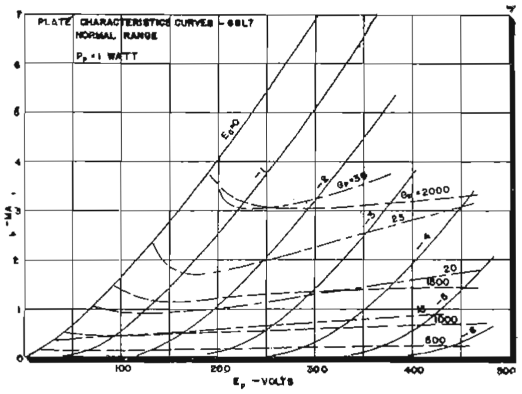


Fig. 1: Plate characteristic curves for 6SL7

In an impedance coupled triode amplifier, the static load line slope is determined by the coil dc resistance. The static load line is normally nearly vertical with impedance and transformer coupled amplifiers. The dynamic load line is determined by the phasor admittance of the paralleled coil reactance and the load resistance (or the transformed value of load resistance with a transformer.) As long as the inductive susceptance is small compared to the load conductance, good phase and amplitude characteristics may be expected.

Assume that an impedance coupled amplifier is to be built using a 6SL7 tube triode section. A supply voltage of 250 v. is available. The signal input voltage is a peak of ±2 v. The loading resistor is 100,000 ohms. The problem is to find the amplifier design and its characteristics.

PREVIOUS ARTICLES describing the conductance curve technique may be found in the following issues of TELE-TECH & ELECTRONIC INDUSTRIES: Feb., May, July, 1953; Nov., 1950; July, August, 1949.

The vertical static load line is drawn at 250 v. on the characteristics curves in Fig. 1. Then the dynamic load line having a slope corresponding to 100,000 ohms is drawn through the intersection of the −2 v. bias contour and the vertical 250 v. plate voltage line. Reading the transconductances and plate conductances at zero bias, −2 and −4 v. bias, and substituting in

$$VA = -G_M R_L / (1 + G_P R_L) \quad (1)$$

gives the voltage amplification values as 48.5, 48.5, and 46.3 respectively. From these data, the distortion does

(Continued on page 142)

TABLE I: TRANSCONDUCTANCES AT CHOSEN BIAS VALUES

E_{c2}	0	−4	−8	−12	−16	−20	−24	−28	−32
150	5300	4350	3400	2400	1200	200			
175	5700	4700	3900	3000	2000	900			
200	5900	5100	4300	3500	2600	1600	500		
225	6200	5500	4700	4000	3050	2200	1200	800	300
250	6500	5800	5000	4400	3600	2700	1800	1300	600

TABLE II: TRANSCONDUCTANCE SUMS AT SPECIFIED BIAS EXCURSIONS

E_{c2}	Mean Bias	0	4	8	12	16	20	Minimum E_p
150	12	4800	4400	4550	5300			90
175	14	5000	5000	4800	4900	5700		105
200	16	5200	5100	4800	5200	5900		120
225	18	5200	5200	5500	5800	6200		135
250	20	5400	5400	5700	5600	5900	6500	150

TABLE III: IMPEDANCE AND OUTPUT

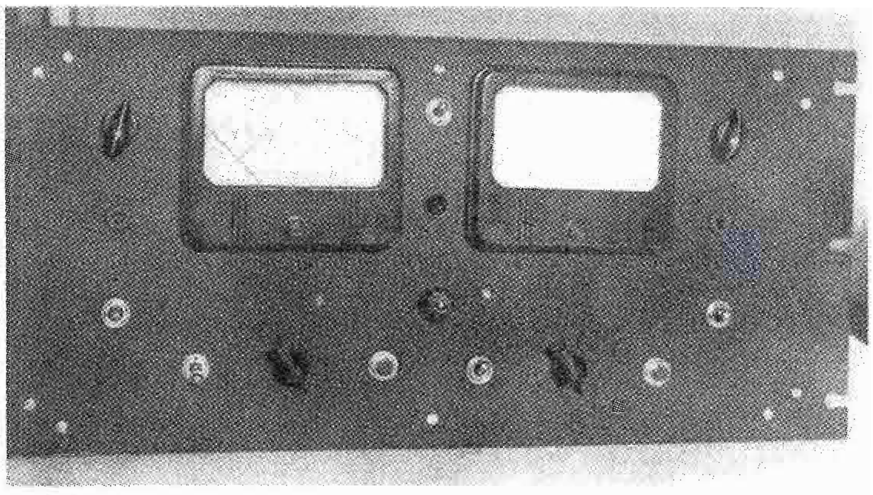
E_{c2}	Plate Voltage Change	Current Change	Impedance	Power Sum
150	160 volts	40.8 ma.	3900	3.2 + 0.2 = 3.4
175	145	51.0	2850	3.7 + 0.2 = 3.9
200	130	61.5	2100	4.0 + 0.2 = 4.2
225	115	68.0	1700	3.9 + 0.2 = 4.1
250	100	80.0	1250	4.0 + 0.2 = 4.2

TABLE IV: BIAS EXCURSION TRANSCONDUCTANCE SUM

E_{c2}	Mean Bias	0	2	4	6	8	10	12	14	16	18
75	−10	10200	10000	10600	11400	12600	13700				
100	−12	12000	12400	12700	13200	14000	16000	18000			
125	−18	10000	10300	10500	11100	11700	12300	13900	15600	17200	18800
125	−24	6000	(18800 uncorrected at 24 volts)								

Operating Remote

What every broadcaster and equipment manufacturer should know about designing and running remote transmitter systems. How to comply with FCC regulations. Telemetering circuits for both telephone lines and r-f links



Remote control transmitter for AM and FM stations

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

WITH recent FCC decisions pertaining to operator requirements and remote control operations, many stations are investigating the possibilities of remote control operation with the attendant economical and physical advantages.

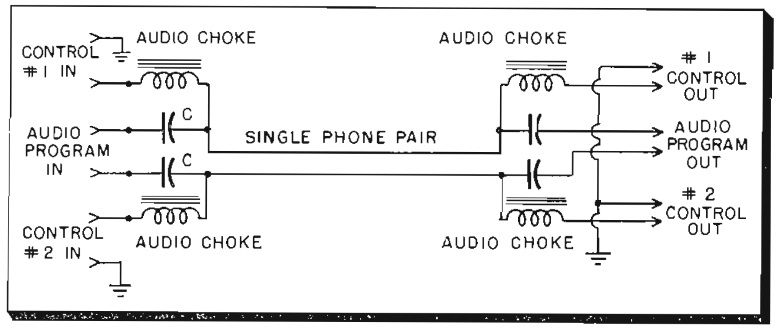
Depending upon whether the station transmitter is fed audio via telephone lines or ST link, the problem resolves itself primarily into two categories, the one wherein the control and telemetering must be effected over the present link facilities and broadcast carrier, (either AM or FM), or via simpler dc or ac control signals fed either over separate lines or the station audio telephone lines.

Telephone Line Control

One limitation that may restrict a fully flexible remote control over telephone lines of course will be the inability of a company to supply a sufficient number of lines between studio and transmitter, or the financial outlay involved in the rental of a large number of separate phone pairs. Therefore, efficiency is demanded insofar as possible, in the use of these. Fig. 1 shows how a single pair can be used to transmit the station's audio program, and two sets of control signals. In this particular application, the "control signals" must be dc to avoid crosstalk with the audio on the line.

Fig. 2 indicates a method of accomplishing four functions on a single pair, operating each line of the pair against ground. This system is called the differential voltage system and its operation is based upon the ability of the selenium rectifiers to discriminate against a positive or

Fig. 1: (l) Single pair carries program plus two controls. Fig. 2: (r) Polarity differential system accomplishes four functions on single pair



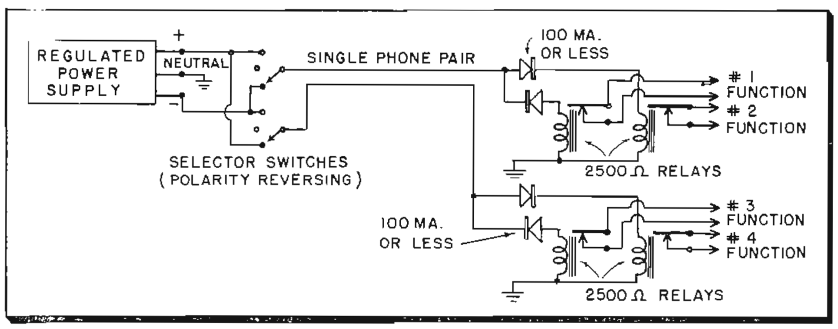
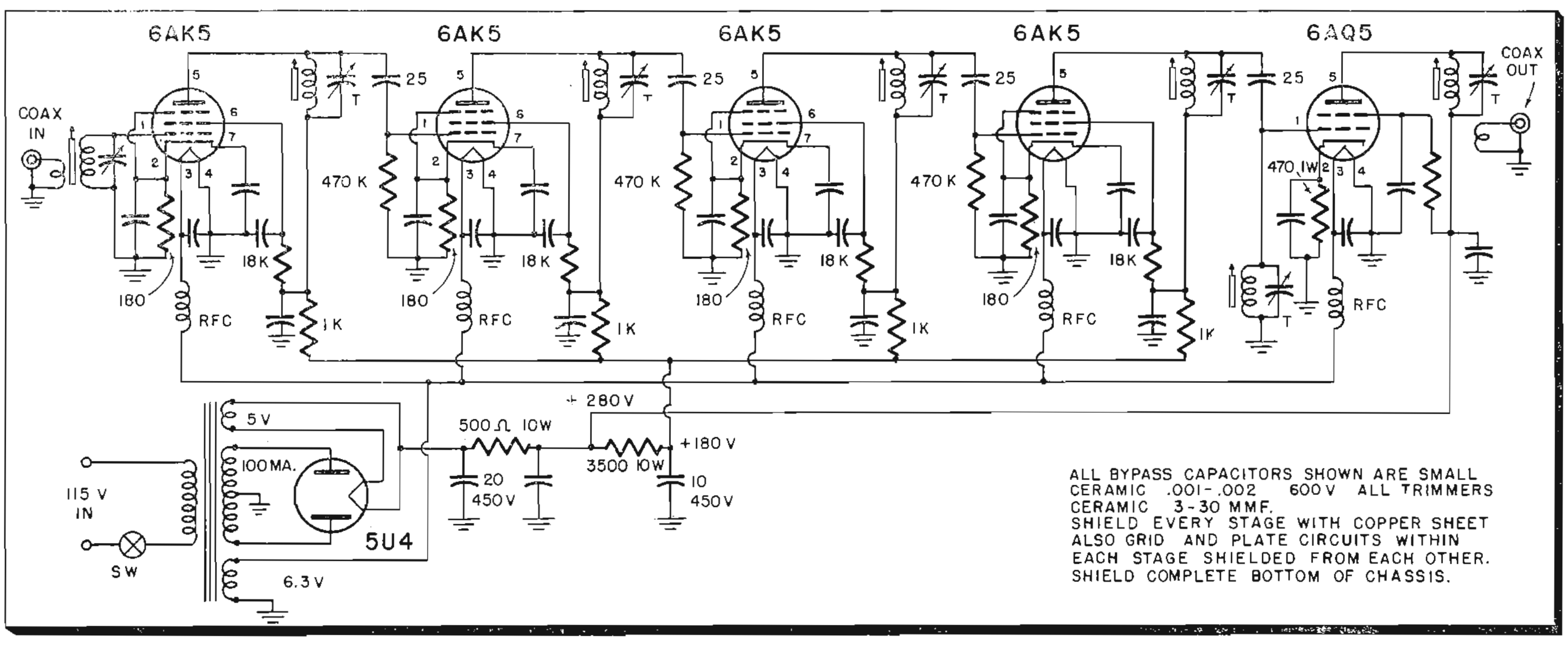


Fig. 3: Five-stage FM booster with power amplifier output stage. At WRFL it is driven by a two-bay five element yagi antenna



Control Broadcast Stations

negative voltage, and allow only the relay desired to operate, in effect making an ordinary "plate" type of relay a polarized relay. The voltage source should be a regulated dc supply which supplies both a dc negative and dc positive voltage against ground. Care should be exercised when the 115 volt supply is connected to get the ground side of the line on the chassis ground.

A "differential" relay may be used in the Fig. 2 application as well as two separate units. This "differential" relay can be used to control the direction of rotation of a control motor, which may be used to raise or lower the transmitter power output through adjustment of a coupling control or variable resistance power adjustment as is used in some transmitters. This type of motor can also be used to tune any variable capacitor in the transmitter. The FCC requires that control be maintained over the power radiated by the transmitter, thus at least one motor is usually needed per transmitter.

Most stations install the frequency and modulation monitors at the studios or control point, using a booster amplifier to build up the low value r-f picked up on an efficient antenna, to the value necessary to drive the particular type of monitor used.

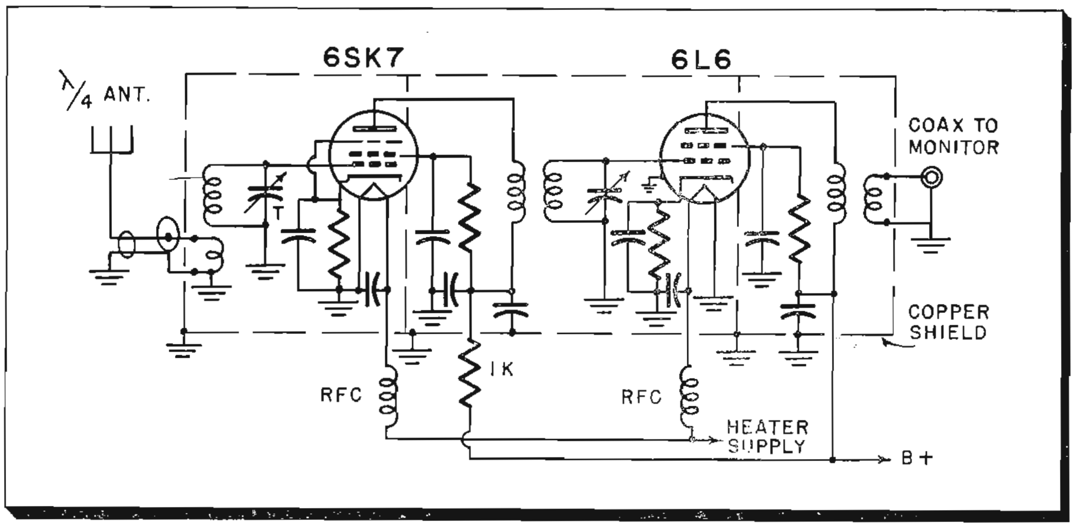


Fig. 4: AM booster, similar to unit at WARK, employs quarter-wave skywire

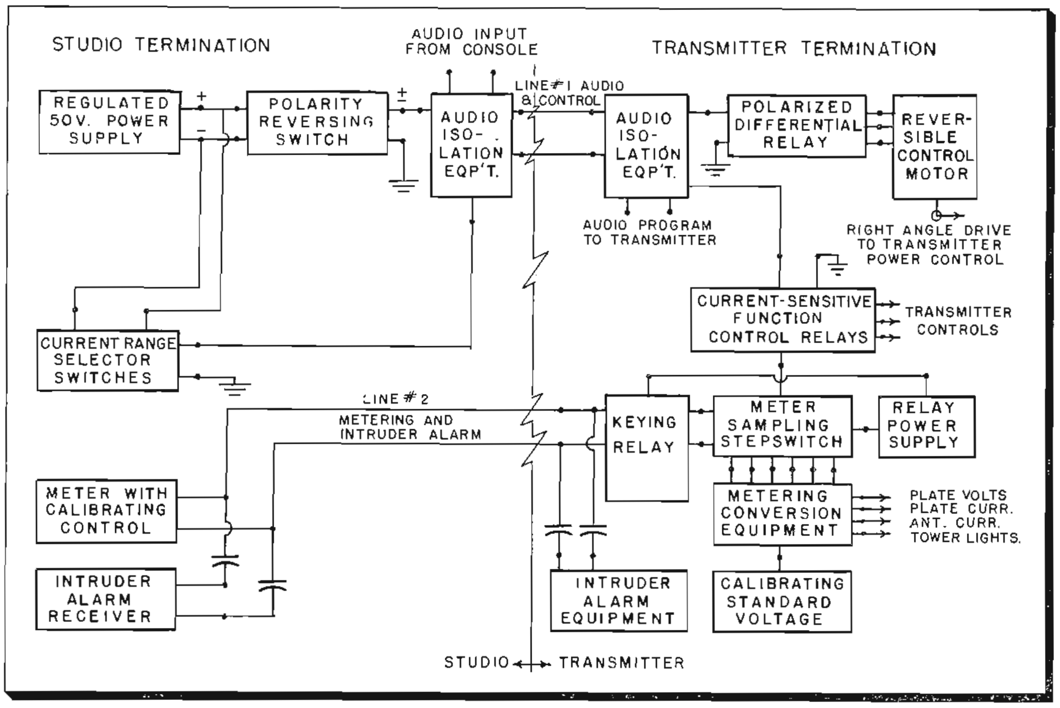


Fig. 5: WRHI uses polarity differential system for remote control operation of power control motor, and current differential system for transmitter controls and stepswitch

FM Booster

Through careful isolation of all stages and ordinary VHF precautions, a five-stage FM booster with power amplifier output stage was constructed that operates perfectly, and has given satisfactory service for two years. This particular amplifier is diagrammed in Fig. 3. It is driven by a two-bay five-element yagi antenna cut to the station's frequency.

For picking up AM signals, a quarter-wave skywire situated away from strong local inteference sources will most often suffice in locations where the studios and transmitter are not far apart. Station WARK in Hagerstown, Md., uses such an antenna, with an amplifier similar to Fig. 4. The antenna supplies a measured two volts of r-f, which the booster builds up to the necessary power for driving the monitor.

Earlier in the article we described the use of the polarity differential system for remote control functions (Fig. 2). WARK uses the current differential system. This depends for its operation upon a series of relays tied across the line or between one side of the line and ground. Each relay is adjusted to close at a different current drain. This can be accomplished by either the rear spring adjustment or other tension adjustment on the relay, or by using different values of limiting resistors in series with the relay. As in most dc applications of this nature, a 2500 ohm "plate" type relay is used. These can usually be adjusted to close at 5, 10, 15, 20 ma and up. The first relay can be used to control the primary power on the transmitter, the second can control the high voltage, the third to operate the control motor forward and the fourth to operate it in reverse. The third relay could also be used to pulse a stepswitch to select meter samples for telemetering.

WRHI, Rock Hill, S.C., uses the polarity differential system for operation of the power control motor, and the current differential system for the operation of the transmitter controls and stepswitch meter sampling relay as diagrammed in Fig. 5. Here the only meter readings that need be taken are the plate volts on the final amplifier, plate current of the final amplifier, antenna current and number of tower lights burning. Means for deriving samples of all these readings in terms of voltages are shown in Fig. 6. These voltages are selected in order by a simple rotary type stepswitch easily obtainable. This switch has six positions, and is merely an electrically operated rotary selector switch. The first position is left open for the "off"

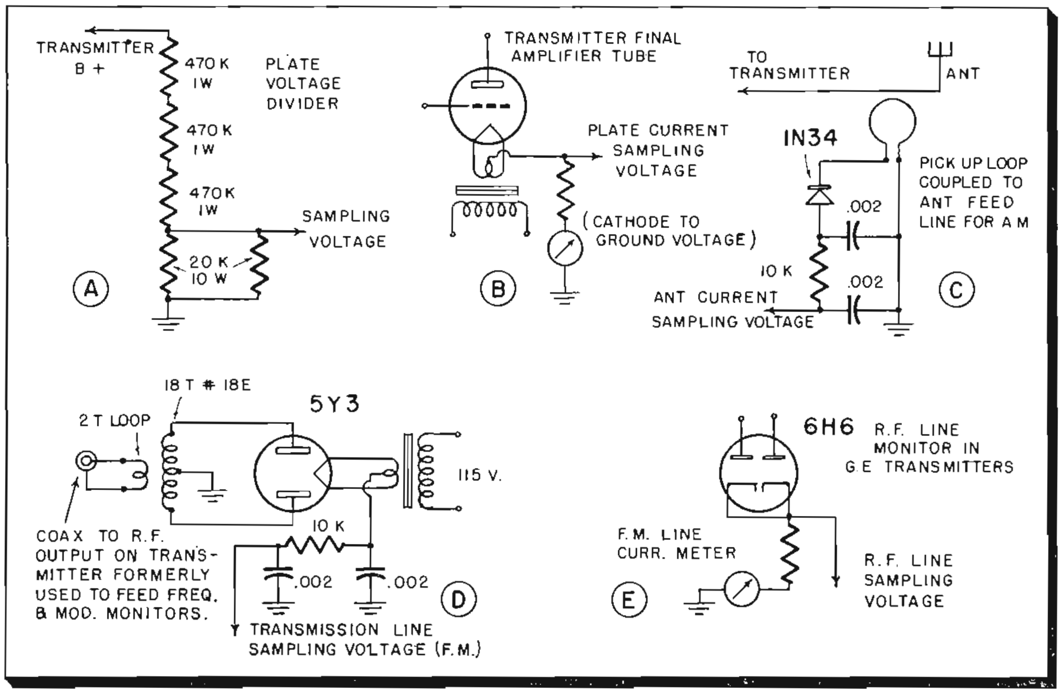


Fig. 6: Voltages derived from various meter sampling methods are selected by a rotary stepswitch

position. The second position is connected to a 6 volt "hotshot" type of battery as a calibrating voltage.

A Richmond, Va., station uses an audio tone control system. This is quite similar to a system described for use with an STL in TELE-TECH & ELECTRONIC INDUSTRIES, Aug. and Sept. 1951. Different audio tones are transmitted over a separate telephone line, each tone operating a specific function at the transmitter. Here the surplus Hammarlund "Fleet Control" equipment was used, with a separate tuned circuit at the receiving end of the line to control a relay tube.

Dial and Stepswitch

Many remote control stations are using a system involving a dial and stepswitch method of selecting functions. WTSV and KEAR are in this category using a ten position stepswitch, such as that from the above mentioned surplus equipment. Fig. 7 is a simplified diagram of such an arrangement. Here the function to be operated is dialed, then a voltage is introduced through the stepswitch contacts to a circuit which effects control through a relay. In the same manner, meter samplings are introduced back into a line. Control is maintained in such an installation by a holding current in the line which keeps a relay closed, controlling the primary circuit in the transmitter. In case of a line failure, the relay drops out, shutting down the transmitter.

When a station decides to go remote control, the chief engineer or station manager should make application to the FCC on form 301-A, which is a single page form requesting modification of a broadcasting station authorization to remote control. Use a separate form for each station should there be both AM and FM transmitters. The form must be prepared in triplicate and filed with the FCC in Washington. Most applicants are also filing a somewhat simplified diagram and specifications of their remote control equipment.

The rules for remote control do not specify the exact equipment to be installed, or the circuits to be controlled. However, section 3.66(3) for standard broadcast stations and section 3.274(3) for FM broadcast stations state: "Control and monitoring equipment shall be installed so as to allow the licensed operator either at the remote control point or at the transmitter, to perform all of the functions in a manner required by the Commission's Rules and Standards." Type approval of the particular equipment involved is not at present contemplated. The Commission does not have available for distribution copies of the amended rules and regulations. These were printed in the Feb. 4, 1953 issue of the Federal Register, copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

Prior to January 26, the date when the FCC adopted the amended rules, special temporary authorizations for remote control had been granted to 26 FM and 4 standard broadcast stations, according to the FCC. No other special temporary authorizations had been granted between this date and March 10.

STL or Carrier Systems

When lines are unavailable or impractical, the station may be fed either by an STL link or from another station. Some stations have proposed using very low frequency audio signals for such control, with tuned reeds responding at the receiving end. Such a system was built by a communications equipment manufacturer, but as far as the author can determine, such a system has not been practically employed by a broadcast station. The other end of the audio spectrum is better suited for remote control.

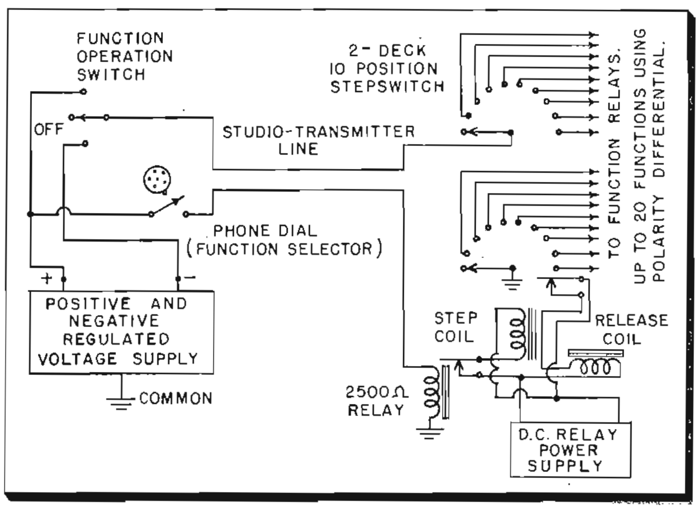
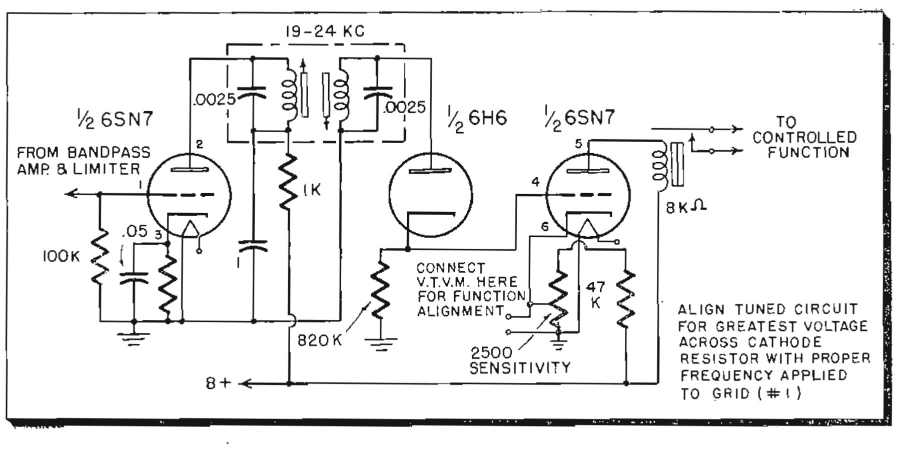


Fig. 7: (l) Remote control used by WTSV and KEAR uses dial and stepswitch
Fig. 8: (r) Selective circuits used for remote control at station WVBT



This includes, generally, frequencies between 17 and 40 KC introduced into the program carrier at low modulation percentages to prevent intermodulation distortion. Such a system can be designed to be as simple as possible to comply with FCC regulations, or quite complex, affording any number of automatic protective devices such as resets, etc., and even returning weather information at the transmitter location, along with meter readings. This information is especially desirable in locations where icing conditions are an important factor to the transmitter's operation.

The original WRFL (FM) remote control installation was described in TELE-TECH & ELECTRONIC INDUSTRIES in the Aug. and Sept. 1951 issues. Since this time, weather equipment salvaged from a surplus Radiosonde outfit has been installed to detect icing conditions. A ten-position stepswitch was substituted for the original six position one so that sufficient readings could be accommodated.

Since this WRFL system has been described previously, more emphasis will be placed on the air system used at the Rural Radio Network in New York State, whereby one FM station is used to supply programs and controls another FM transmitter. Here, the engineers developed a system that has been reported nearly foolproof and has been operating very satisfactorily now for many months.

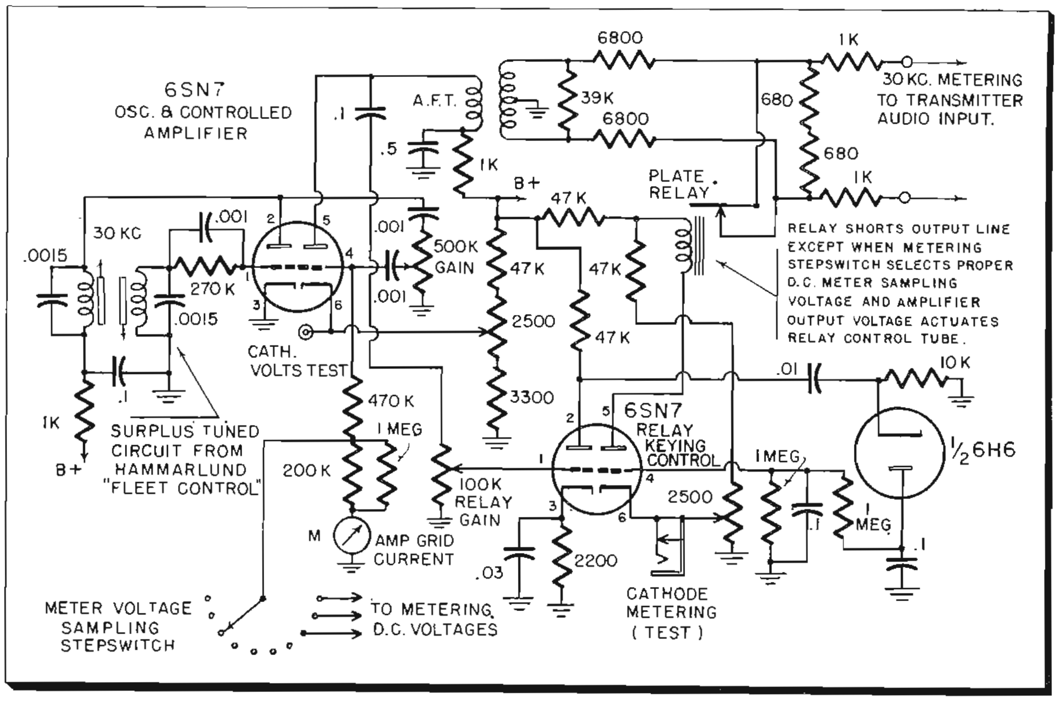


Fig. 9: WVBT telemetering oscillator and control system employing tuned circuits

Control Signals

Fundamentally, control signals are introduced into the controlling transmitter audio system. These modulate the FM transmitter at 10% or less, and range in frequency from 17 to about 28 KC. Tuned circuits such as the one shown in Fig. 8 are used to select the signals and make them operate separate functions, such as turning the transmitter on and off, tuning the final tank circuit, load the transmitter, select receivers for program changes, and select meter sampling voltages for the telemetering device. This applies a 30 KC tone to the controlled transmitter carrier, which varies in amplitude according to the meter sampling voltages applied to it, which in turn is separated from the audio at the controlling point, and made to operate a meter to indicate percentage modulation of the FM carrier by the tone, which in turn is interpreted as meter readings which have been selected by the system.

The telemetering device used at WVBT for changing the dc meter sampling voltages to super-audible modulation levels is shown in Fig. 9. Note that a "calibrating" voltage is applied in the first position of the stepswitch. This is used to adjust the meter at the control point, which, in effect, adjusts for any changes that may have occurred in the whole metering system since the last set of readings were taken.

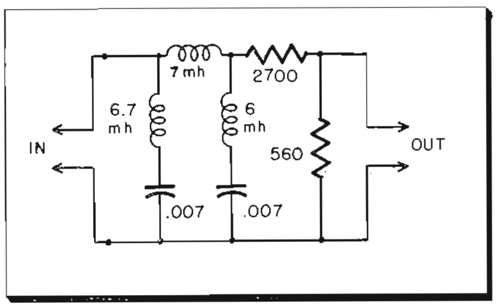


Fig. 10: Low-pass filter separates prevents control tones from being transmitted on air

Since the control tones are transmitted by the controlling station along with the program information, it becomes desirable to keep these control tones from being transmitted also by the second transmitter. Therefore, a low-pass filter is used as shown in Fig. 10. And, conversely, to prevent any possibility of audio tones or harmonics falsely operating any of the remote controlled operations, a high-pass filter is used between the receiver and the selective circuits. This filter is incorporated with a clever limiting amplifier acting as an automatic volume control for the control tones in the circuit in Fig. 11.

WVBT uses the stepswitch method of remote control, rather than the simpler single-relay-per-tone system employed at WRFL. The WRFL engineers felt that the system would be more foolproof and easier to maintain if the stepswitches were limited to the metering selector only. As a matter of fact the first system developed for use at this station used a stepswitch to select a function, then a second pulse of the control signal operated this function. This system was discarded because of the lack of flexibility and simplicity. However, at WVBT a great number of functions were needed, such as overload resets, auxiliary power supply starting, switching for several receivers, etc. This demanded the use of the stepswitch system, which through careful design has proven itself in flexibility and reliability. Another word in defense of the use of the stepswitch as a function selector seems to lie in the fact that most of the earlier remote control systems and at least one of the commercial systems being marketed today use at least one 10-position stepswitch in addition to the meter sampling selector, and most of these mechanisms are the surplus stepswitch from the previously mentioned "Fleet Control" or a similar device. There are 5 or 6 types now readily available on the surplus market, operating at from 6 to 48 volts dc. This of course means that the use of one or more of these demands a dc power supply. A rotary breaker dial, similar to a modified telephone dial is also needed. This is modified to "make" instead of "break" on every impulse.

Since the WVBT transmitter is operated by signals appearing on the carrier of another station, and its programs are derived by switch-

(*Continued on page* 98)

Incentive Pay Plan

Highly successful "K" profit-sharing system, according to company production and sales.

IT is to be assumed that a well-balanced and well-trained man placed in attractive, efficient surroundings will produce good results if working under competent direction and with the knowledge that *he and his work are appreciated.* It is this latter phrase that presents the real problem for management.

Mr. Greenewalt, the President of DuPont, recently said, "If we had perfected the practice of Christianity, material incentive would be unnecessary since we would then be content to work for the good of man because of the spiritual reward that service would bring. Unfortunately, we have not reached that millenium, and incentive is essential to drive us forward."

There are few who do not understand financial incentive; some are even blinded by it. The average research worker is not over-happy with his direct monthly payment. It is also quite hard to tie together directly accomplishment and pay.

Development Credit

One of our really brilliant men has made relatively few direct contributions in the way of equipment, yet his basic knowledge has contributed in a large measure to many pieces of equipment developed by others. It is easy to reward this man, but how about the man developing the equipment which might even have failed without the suggestions of the former? The equipment man nearly always feels that he is largely entitled to the credit and that the advice he received was incidental. Let us even suppose that financial reward could be achieved to the satisfaction of all. The problem would still be far from solved because it would only be an acknowledgement that the work, not necessarily the man, had been appreciated. The nearest we have been able to come to the solution of this problem is to make the individual a real part of the company and to make his pay dependent both on his own success and on the success of the company. No individual who has become an established member of the development staff, (which usually means about three years after he joins the company), knows in advance what his annual pay will amount to, any more than does the sole proprietor of a small business. Approximately fifteen percent of all employees are on this monthly-salary pay-incentive system. For the research and development group, this figure is approximately 75 percent.

The monthly-salary incentive system is known as the K system, because K is the variable monthly multiplying factor. Employees on this system have an established monthly rate that is fully competitive industry-wise. This rate is then multiplied by a factor known as K. The system has been in effect for nearly 20 years, during which time

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Cambridge 39, Mass.

its annual average monthly variation has been from 0.864 to 1.50. All development personnel on the K system work a standard week on development problems regardless of the value of K or the hours that the plant is working. They receive no overtime pay.

A table of K is published with increments of .05. This table is for K values expressed in terms of the average of new orders, shipments, and factory turn-in. A K of unity is placed at substantially the break-even point; the figures for the previous month determine the value of K for the following month. The value for K for any given month is announced on the second or third working day of the month to which it applies. A chart of the weekly figures affecting K is kept during the month so that there is always a fair indication of what the next value of K will be. It is also interesting to observe the efforts of supervisors to boost K when a low value is indicated. Experience has shown that the system has worked very well. For 1950, K averaged 1.26; thus a $500-a-month man would have received an average monthly pay of $630 in addition to any profit-sharing or bonus payments.

Carryover Factors

Because of the expansion beginning with 1951, K has been at the maximum figure of 1.50 since that time. Government salary controls have made it difficult to make more than modest salary increases in basic salaries during this period.

Orders received may have wide swings because of the receipt in any one month of a large order, such as a large contract. If K were near the maximum of 1.50, the value of this new order as far as "Orders Received" is concerned would be largely lost. Similar conditions could also arise in the case of exceptional shipments. To correct this, any excess over the top of the 1.50 bracket is carried over for future use. Any carry-over remaining over twelve months is dropped.

The K figure for any month is announced through the publication of a short memorandum to all on the K system. This memo includes the amount of orders received, shipments, orders-on-hand, production, and comments pertaining to these figures. In addition, there is a summary of the discussions and actions taken by the management committee at their weekly meetings during the previous month.

Semi-annual Bonus

To stimulate individual or group effort, there has been in effect for many years a semi-annual bonus plan. Under this plan each person in the entire organization is individually rated and these ratings, expressed in points on a previously established rating table, are coordinated by a single committee known as the Personnel Committee. In addition to the rating points, there are assigned multiplying factors which take into account basic pay rates and position responsibility.

for Engineers

in effect for nearly 20 years, shapes salaries Bonus and welfare measures described

After ratings have been completed, the amount allocated to the bonus is divided by the total points, and each individual receives his proportional share. This system may seem quite complicated, but in actual practice and after many years of experience, its application has become relatively simple. The most difficult task for the Personnel Committee is calibrating the enthusiasm of the individual raters.

The amount allocated to these bonuses is hard to define because it is dependent on the expression, "whenever earnings permit." In 1938 when we were barely breaking even, we actually paid a small bonus when we wanted to be certain that we retained our personnel and because there had been a small amount of short time for factory employees. About 4% on the investment would be a general definition of whether or not a bonus would be paid. In 1947 this bonus totaled 5.7% of billings and equalled two or three months' pay for research men.

Profit-Sharing Trust

Starting early in the war, a profit-sharing trust was established. This trust provides that earnings, net after all other incentive plans, shall be divided equally between stockholders and employees after 6% has been earned on the audited net worth of the Company. This payment is not taxed to the employee as long as it remains in escrow for emergencies or increased retirement pay. Research employees who have been with us during the participation period of this plan have already nearly two year's base pay to their credit.

For the most part, those on monthly salary receive, whenever earnings permit, a bonus known as the December Stock Bonus. This is an amount to permit employees to buy into the company. As this stock bonus goes to only fifteen percent of the total employees, individual amounts tend to run high. While it is not mandatory that stock be purchased, there are exceedingly few cases when this is not done. In fact, our problem has been to limit the purchase to the amount of the bonus less income tax, it being our intent that the employee should in effect get the stock free.

Stock Purchase Plan

This stock purchase has far more than financial value. It truly makes the holder a part of the company. Not less than three stockholders' meetings are held each year, at which subjects of wide range are discussed, extending from financial and development problems to off-street parking. Never yet have actual votes been counted, but very frequently a show of hands is taken to guide the Directors in their actions. Every attempt has been made to operate the company as a partnership rather than as a corporation. Freedom of discussion between research men and management on all company problems is encouraged, but regular assignment problems are kept in established channels. It is this genuine feeling of "taking part" which has done much to provide that type of reward so necessary to secure what we feel to be personal recognition.

It will thus be seen that the general key of our administrative policy for development and allied personnel is, first, to set up a compensation system where a real salary incentive is possible. Our definition of this is one which permits a two-to-one variation in pay. The second is the establishment of a type of ownership which actually makes the individual feel that he, personally, is a part of the company. Mere financial ownership will seldom accomplish this. It is further the belief of the present management that managerial honesty toward the employee is fundamental in the system. Mere lip service is doomed to failure.

Health Protection Aids

As it has often been said, man does not live by bread alone, so does General Radio recognize that the incentives usually found in industry to keep employees satisfied should also be applied to its organization.

One of the most important of these is the health program. First of all, there is the free first aid and medical service. Of course, adequate first aid and emergency sickness facilities are provided through registered nurses and regular and emergency doctor connections. The so-called Blue Cross and Blue Shield benefits up to ten dollars per day and ancillary items are paid for by the company. If the employee desires these benefits extended to his entire family, one half of that cost is paid by the company.

Eyes are of great importance to any employee. Ophthalmological service and glasses are provided free to employees and at reduced rates to family members. If hospital service in the field is necessary, the same benefits as for any other type of hospital service apply.

The company is able to draw from a trust fund, established in part by a former officer for additional medical aid. This fund has been of inestimable help in the case of long illnesses of family members with polio, cancer, etc. One of the great worries of an injured or ill employee is loss of salary. This is quite serious in addition to medical costs. The company has a plan for com-

(*Continued on page* 116)

Engineer and Employee Benefits
Instituted by a Forward-Looking Electronic Manufacturer

A Summary of General Radio's Long-Time Welfare Plans

- Monthly-salary incentive plan (K system) for developmental staff
- Semi-annual bonus plan for all employees
- Profit-sharing trust between employees and stockholders
- December stock bonus to permit selected employees to buy into company
- Free first-aid and medical service; also Blue Cross hospitalization payments
- Ophthalmological services and eye-glasses free to employees (also family benefits)
- Trust fund for additional medical aid in long illnesses
- Life insurance provided up to twice annual base pay (maximum policy, $20,000)
- Pension plan, company contributing 3 times amount paid by employee
- Two cafeterias sell at cost of food. Overhead and salaries company-paid
- Employees' Credit Union maintained, company paying overhead
- Winter and Summer parties, dramatic club, bowling, hockey, baseball, glee club, etc. with company aid

Automatic Production Machine for

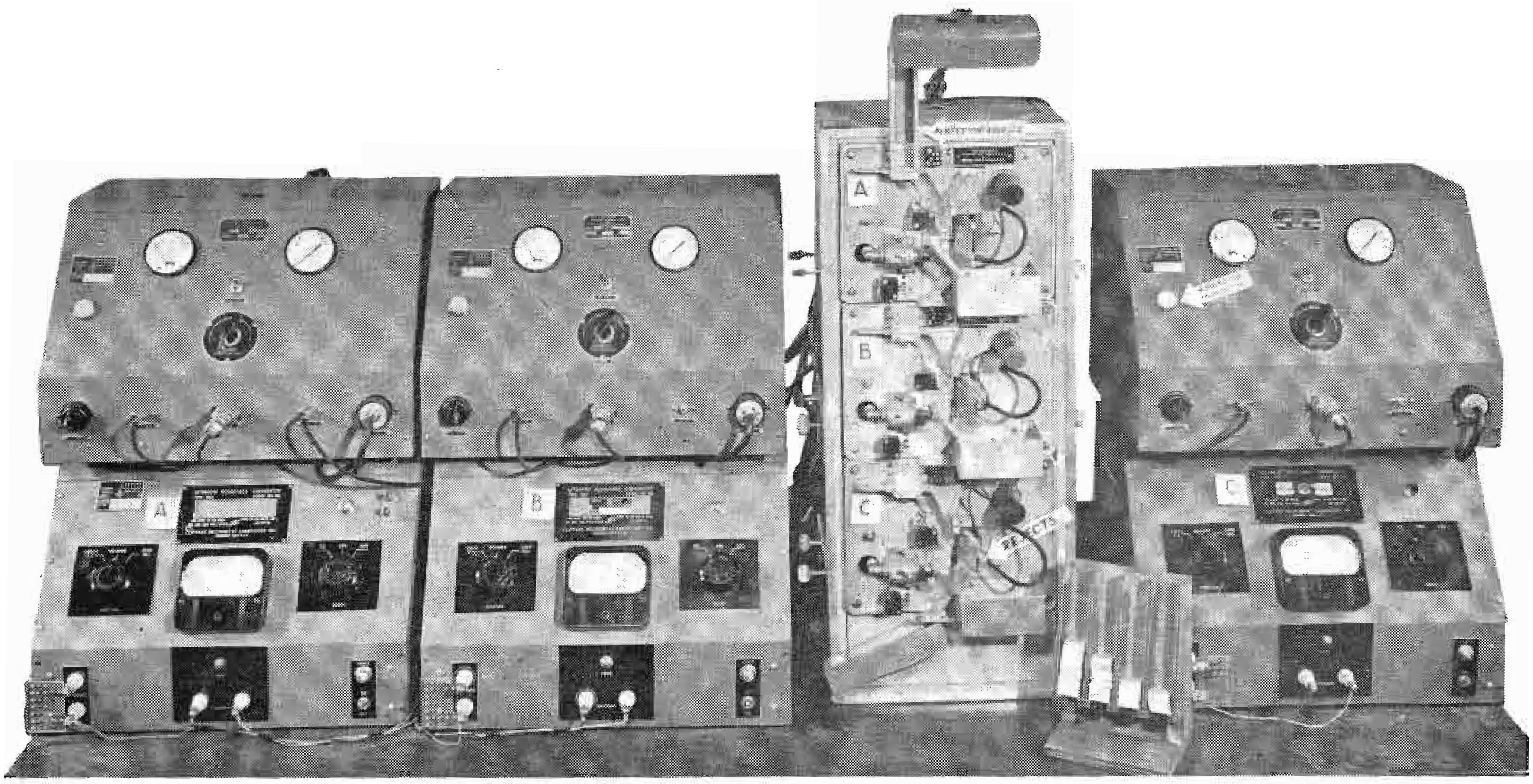

Fig. 1: Three-station Autobrader (vertical unit) for printed circuit production flanked by abrasive units (top) and resistance limit bridges

By *JACK BAYHA*,
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THE present state of development of the resistor printing portions of the printed circuit technique still leaves much to be desired in its ability to reproduce close tolerance resistive units on a mass production basis. Tolerances in the order of ± 5% or less are a common design parameter in electronic circuitry. Most printing systems for resistor manufacture are not compatible with the relatively close tolerances required.

Numerous techniques for resistor "tailoring" are used. Most rely on the removal of resistor material by erasure, abrasion etc., thus raising the value of resistance of units deliberately printed at lower than desired value. Control over the amount of resistor material removed is often achieved by limit bridges and similar devices. In general, all techniques require the pre-selection of resistor units to ascertain suitability for abrasion, subsequent abrasion to desired point of resistance, and reinspection for value. Most of these methods require handling operations as intermediate steps.

The design objective of the "Autobrader" development was to render all operations, except the loading of a supply chute and removal of completed work, fully automatic. This basic design approach eliminates any and all points of operator error, and yields a high rate of production coupled with an accurate work output. Furthermore, it eliminates the considerable number of rejects which are an inevitable result of human handling of the assembly.

Cascade Operation

The "Autobrader" operates in cascade fashion, any number of like stations being stacked one over the other, each station doing one specific resistor and delivering it completely abraded and inspected to the next station, which does the same for a different resistor on the same plate, in turn feeding the next station, etc.

Each unit performs many operations, the length of operation contingent on the quality of the resistors supplied to it by the printing machines. As a plate containing printed resistors passes through the unit, it is inspected, abraded if necessary, and passed or rejected, as dictated by its value. If abraded, it is reinspected for value, and once again passed or rejected. All of these operations except abrasion, whose time is based on initial value, take place in approximately one second. For resistors not lower than 60% below tolerance, abrasion takes less than 8 seconds, for better tolerance printings, the time goes down to one or two seconds. For economic reasons, an adjustable abrasion time limit is allowed, resistors taking longer than allotted time to reach value are automatically ejected from the machine if desired. It is interesting to note that this feature eliminates "hairline" resistors (resistors abraded till only a fine line remains), an obviously unstable element due to delicacy of structure. The "Autobrader" proper is designed to work with existing commercial equipment and supplies and interprets controlling information derived from the resistor unit being worked on. It applies the complete feedback principle, its product fully controlling its actions.

Station Equipment

Each station is equipped with a modified S. S. White Industrial "Airbrasive" unit. This unit supplies a fine stream of abrasive material (aluminum oxide) under pressure to the surface of the resistor, as directed by the controlling unit of the station. Each station is equipped

Close-Tolerance Printed Resistors

"Autobrader" employs electronic and pneumatic circuitry to abrade printed resistors to specified values. Three-station unit operates on 15 different resistors

with a Clippard Resistance Comparison Bridge, utilizing a sensitive relay in its output stage. These elements in combination with a controlling and handling unit make up a complete working "Autobrader" station.

Fig. 1 shows a complete three-station "Autobrader" unit used for the production of printed circuit units.

Fig. 2: Single Autobrader station. In operation abrasive outlet connects to nozzle on gate

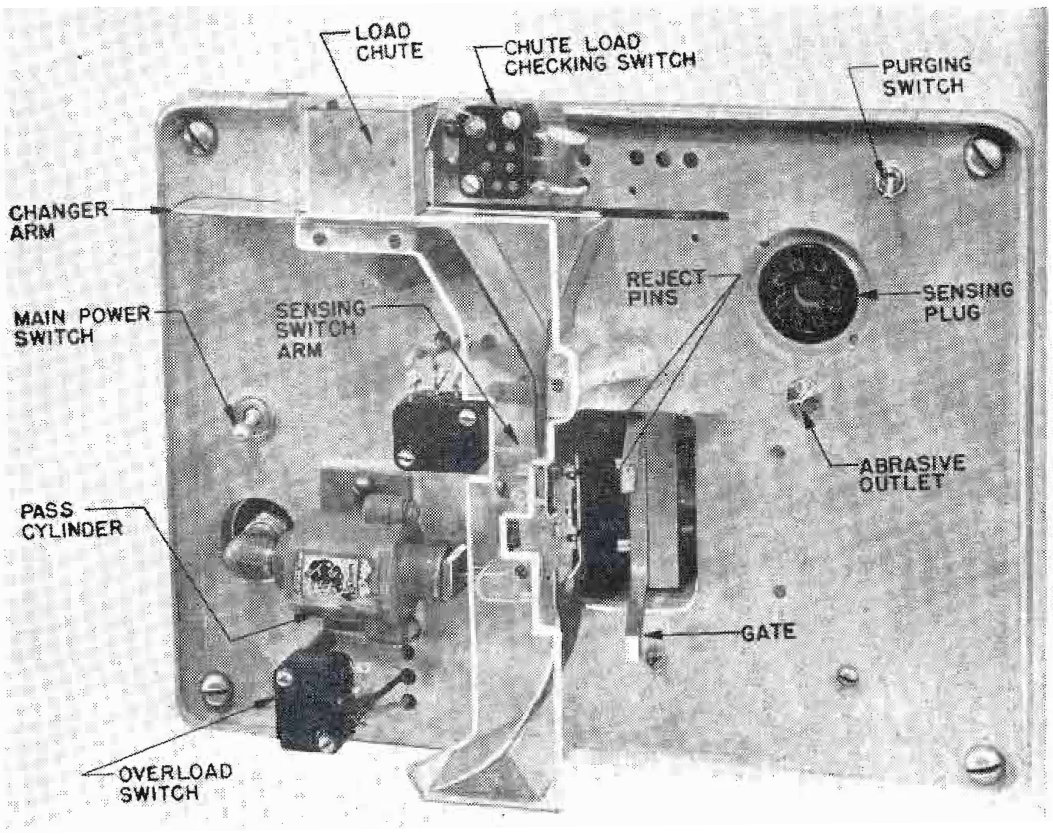
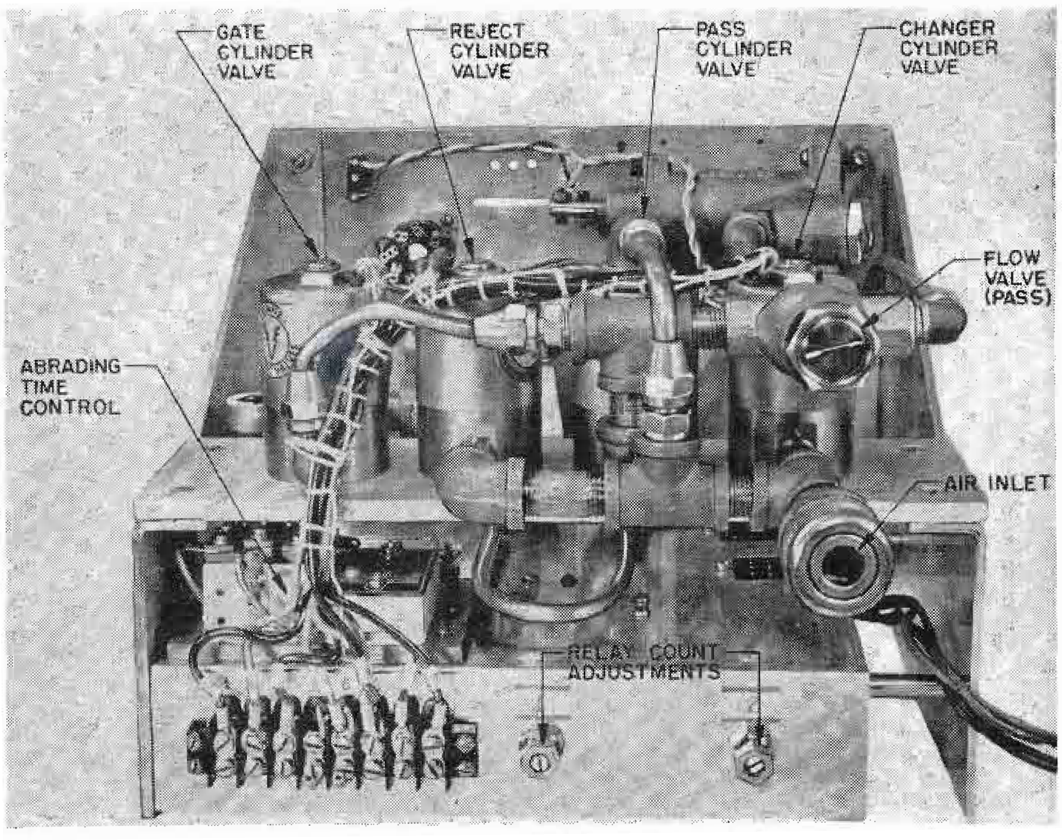


Fig. 3: Rear view of single station, showing cylinders, valves and air inlet



The "Autobrader" units are flanked on each side by the three S. S. White Corp. Industrial Airbrasive units and the three Clippard Automatic Resistance Comparators. The only modifications made in these units are the addition of more "triggering" relays in the Clippard units, and a modification of the Airbrasive control circuit.

Load Chute

Fig. 2 shows a full front view of a single "Autobrader station. The load chute carries the supply of plates, either inserted by an operator or received from a previous station. The chute load checking switch is used to prevent the machine from "changing" the last plate in its hopper. This switch avoids electrical circuitry complications resulting from allowing the last plate to fall. Its action is merely to close the station down temporarily until at least two plates are present in the loading chute.

The purging switch is used when it is desired to empty the station of all plates for any reason, and acts merely as a bypass of the chute load checking switch.

The changer arm is actuated by a cylinder, best seen in the rear view photos, Fig. 3 and 4. It strips the bottom plate from the stack and causes it to drop through the chute to come to rest on the pins of the pass cylinder as shown in Fig. 2. They are shown here in relaxed or pass position. The sensing switch is closed by the presence of a plate in the work position and causes the gate which carries an abrasive gun and contact plate to close upon the work. The sensing plug acts as a disconnect between the gun and contact assembly, which also houses in its male plug the standard resistors used for that particular resistor. This arrangement prevents incorrect standards from being used with any gun assembly.

Overload Prevention

A finger from the overload switch extends into the loading chute of the following station and closes down this station, should the following station become overloaded. This prevents any jamming in the chutes due to a pile-up of work caused by long abrasion times in the following station. The chute load checking

AUTOMATIC PRODUCTION MACHINE (Continued)

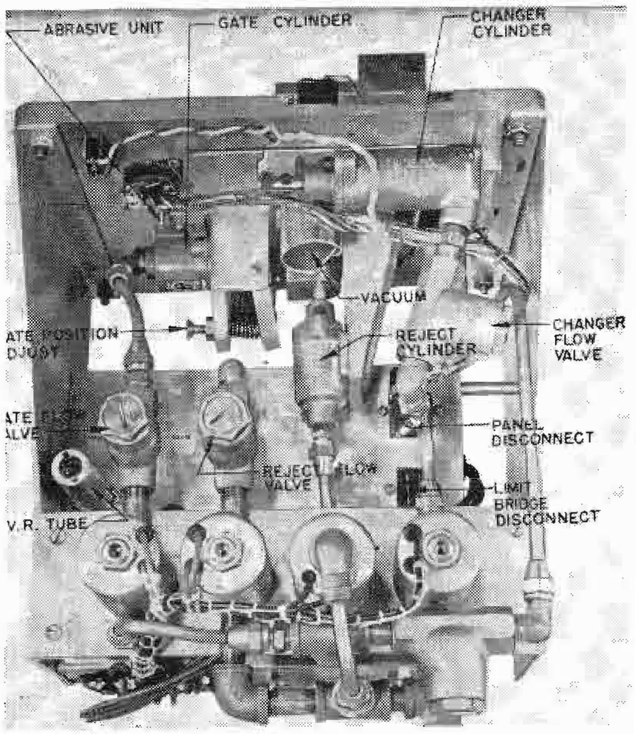


Fig. 4: Top view of station shows gate and changer cylinders mounted behind front panel

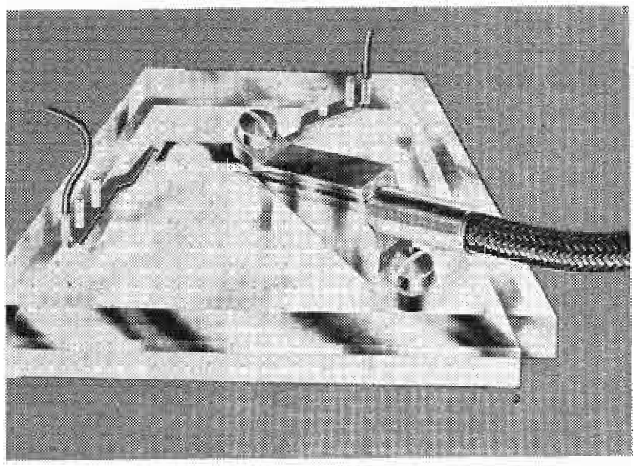


Fig. 5: Gate swings abrasive nozzle into position to direct stream at resistor plate

switch and the overload switch coupled with the load chute allow for maximum operating speeds, dependent on average production rate, rather than delaying production for occasional single slow abrading units. Any tendency of one station to delay production is compensated for by the operator by increasing abrasive flow setting, resulting in faster abrasion. Excessive abrasive flow may cause occasional over-abrasion which is readily detected by the operator by the occurrence of a reject cycle following abrasion.

Load Chute

The initial station is equipped with an oversize load chute, into which plates with resistors ready for abrasion are loaded, in stacked manner. Plates are removed by the changer arm from the bottom of the stack as directed by the work position. Absence of a plate in the work position causes the changer arm to operate and deliver a plate to the work position.

The presence of a plate in the work position is detected by a sensitive switch and causes the gate to move into position. This gate carries the abrasive nozzle and electrical contacts into position ready for work. See Fig. 5. As the contacts come into position, the value of the resistor printed on the work piece is compared to the standard which is a part of this nozzle and contact assembly. If the value of the subject resistor is above that of the first standard, which is set at the low end of the tolerance bracket, an automatic switching circuit switches in a second standard, set at the top of the tolerance bracket. If the resistor is below this second standard, it is obviously within tolerance, (having been above the first standard) and the pins which act as a stop in the chute system are withdrawn, and the gate recedes simultaneously, dropping the plate into the next station's load chute, thus passing on a satisfactory piece.

Should the resistor be above the second standard, it also causes the gate to recede, and reject pins at the back of the chute now move forward, pushing the plate out of the chute and into the reject box affixed to the station.

Raising Resistor Value

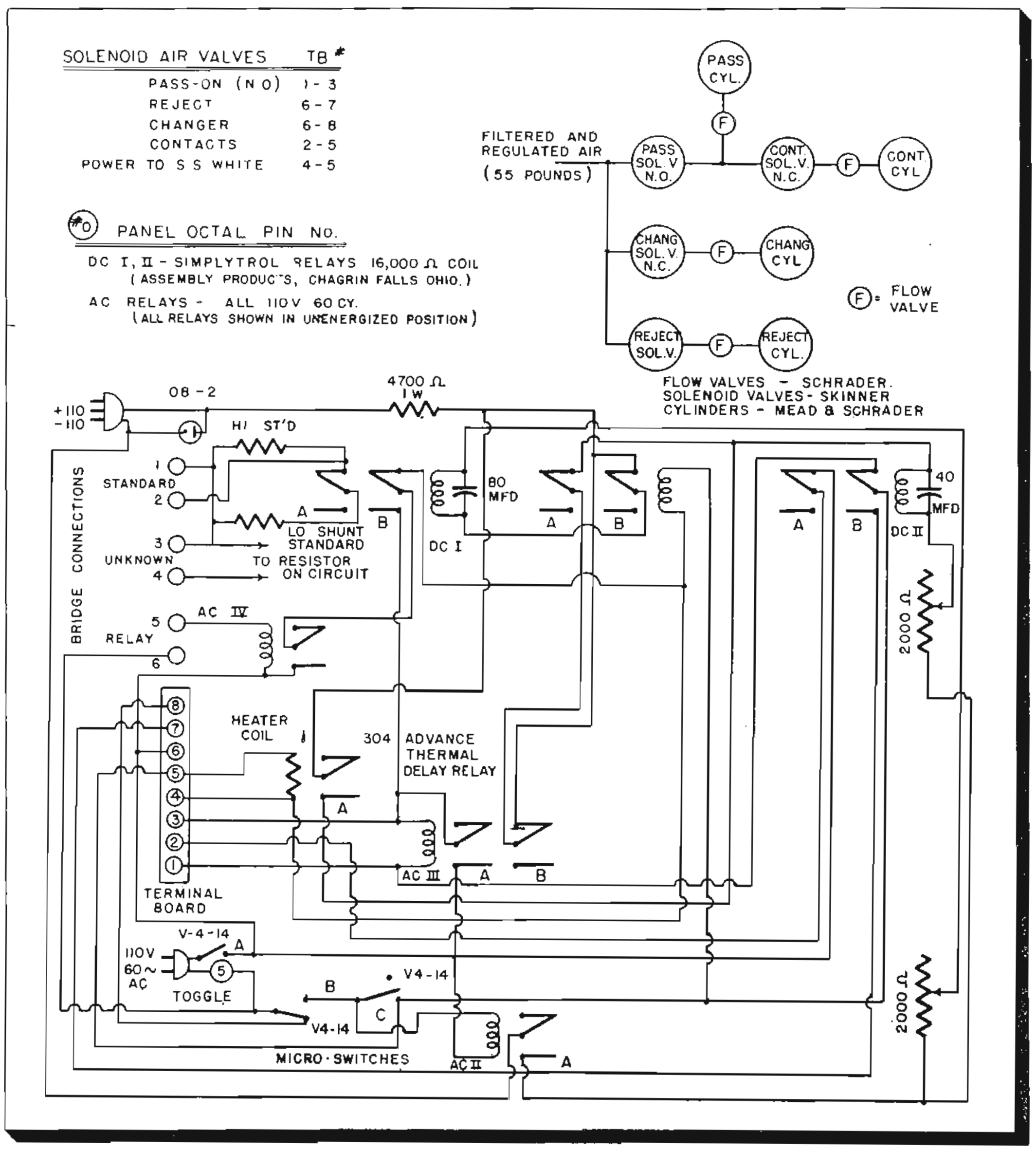
If the value of the resistor is below the first standard, the S. S. White Airbrasive unit is signaled to deliver abrasive. This abrasive cuts away the surface of the resistor and, thus, raises its value. See Figs. 5 and 7. When it reaches correct value, the abrasive stream is cut off automatically by the limit bridge. This reaching of correct value causes the resistor standard switching circuit to change to the second or high limit standard. If the work resistor is below this standard, the unit is passed. If its value is over this second standard because of over-abrasion, the unit is rejected. See Fig. 8.

Design Aspects

The "Autobrader," while performing a very complex function, utilizes relatively simple elements. It is timed mechanically by utilizing air

(*Continued on page* 153)

Fig. 6: Schematic diagram of Autobrader circuit. Pneumatic schematic shown at top



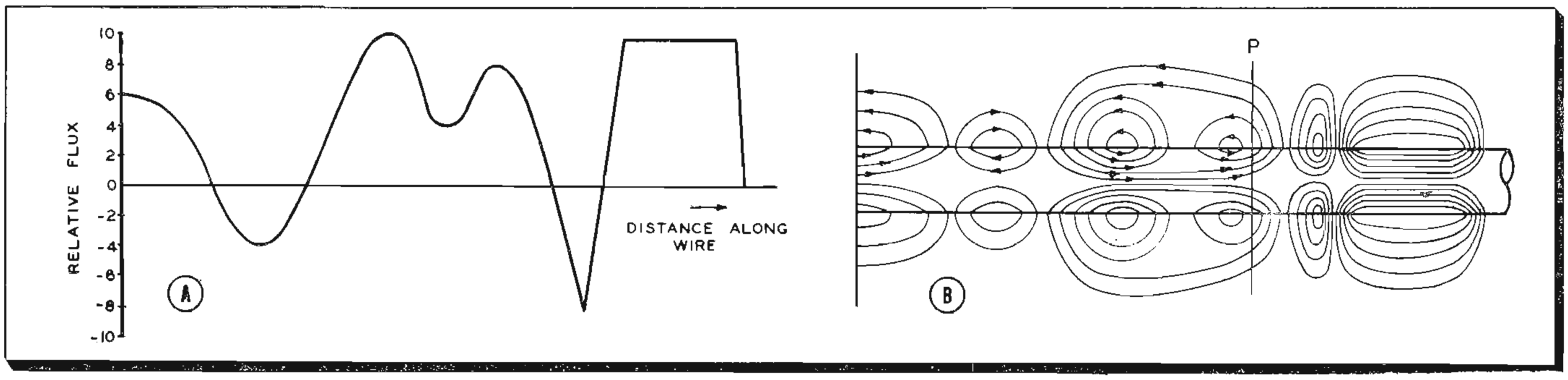


Fig. 1: (a) Arbitrary waveshape along magnetic wire. (b) Corresponding magnetic flux distribution pattern of recording wire

Magnetic Recording

Development of new tapes and equipment, such as "microhead," pave way for recordings of high fidelity and increased economy. High-frequency bias described

By
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SOUND recording can be thought of as a long time-delay element, that we put into a circuit, but it differs from other delay elements in several ways:

1. The delay is measured in hours or days, rather than fractions of a second.
2. The delay is usually longer than the entire program.
3. Time delay can be controlled after the event.
4. The sound can be repeated.

The most common recorded pattern is a mechanical phonograph groove with lateral or vertical dimensions that vary from an average position according to the original acoustic waves. A second widely used record is an optical strip with a visual pattern which transmits light in accordance with the original acoustic waves. The third method, which has grown most rapidly in recent years, is a magnetic pattern on a wire, tape or other magnetizable material.

Each system has advantages. In the field of home entertainment, especially for short popular records, the phonograph disc is unsurpassed. For theater projection, optical sound on film is most convenient. Popularity of magnetic recording is based on several unique features:

1. *Fidelity*—no vibrating mechanical parts are required either in recording or playback.
2. *Reliability*—no critical adjustments as in a cutter stylus or a recording galvanometer; immediate monitoring.
3. *Economy*—low initial cost;

Fig. 2: Magnetic tape pattern made visible by iron particles

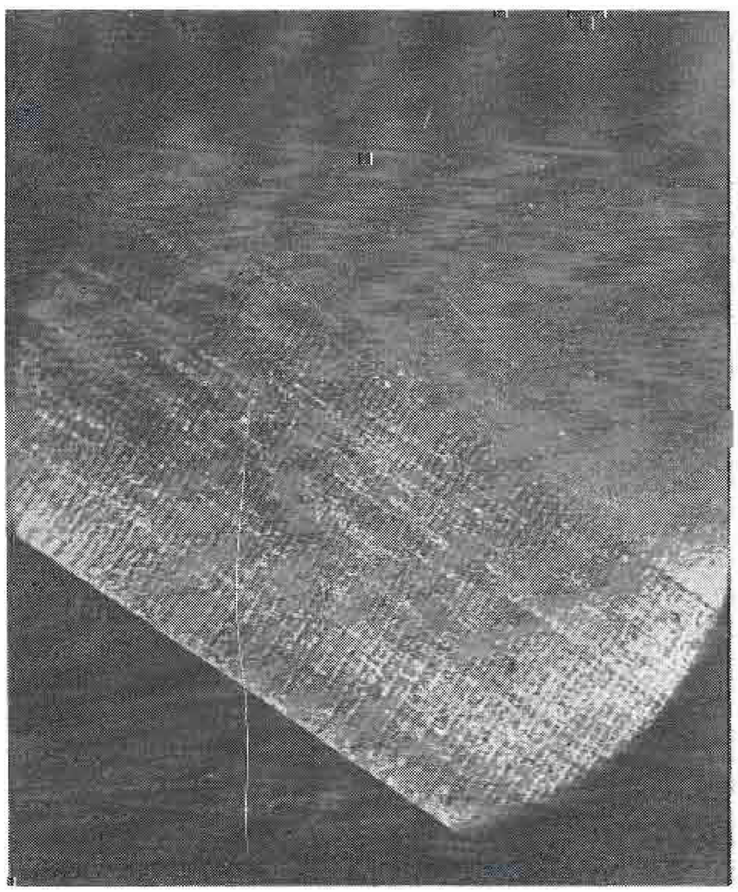


Fig. 3: (a) Coated paper tape and (b) solid metal magnetic tape. (c) Stainless alloy wire and (d) brass core with magnetic coating

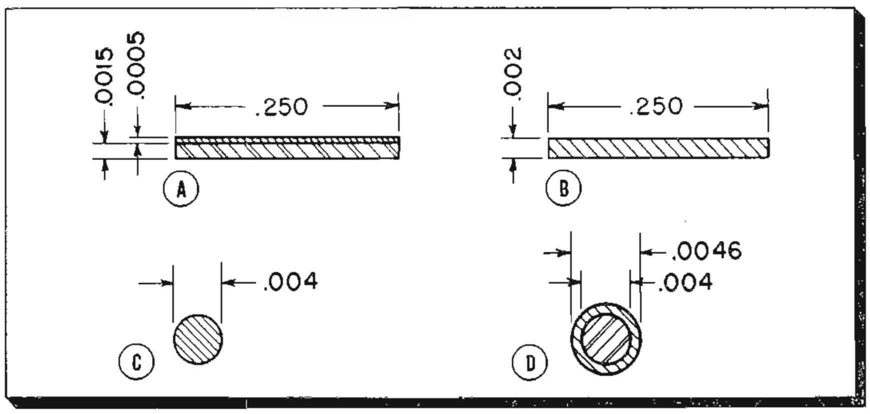
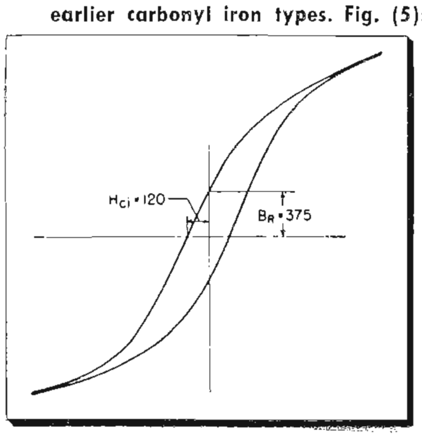
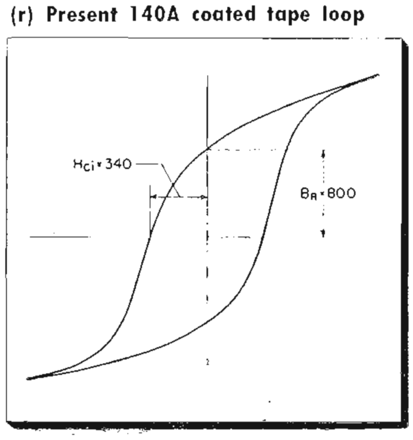


Fig. 4: (1) Hysteresis loop of iron oxide tape is improvement over earlier carbonyl iron types. Fig. (5): (r) Present 140A coated tape loop





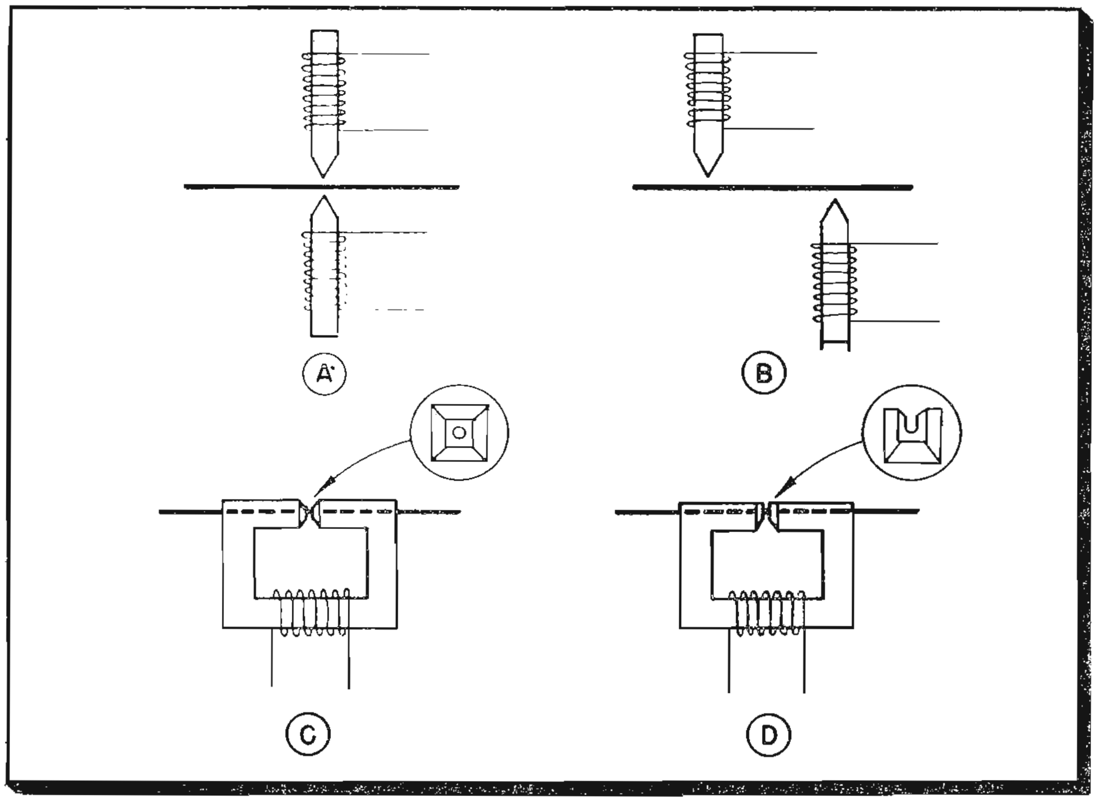


Fig. 6: Recording heads. (a) Opposed heads; (b) Staggered; (c) hole-and-gap; (d) slot-and-gap

erasibility; ease of editing.

Not only may magnets in the form of bipolar horseshoe or bar shapes be made, but magnets with multiple poles are possible. Further, the degree of magnetization may be continuously variable, according to any desired function within limits of recording resolution. Fig. 1 is an arbitrary waveshape, and the corresponding magnetic flux pattern. The flux surrounding a magnetic record can be made visible by settling fine iron particles on its surface. This was done to a half-width tape recording in Fig. 2. (Irregularities of the recording gap show up so well that crime detection laboratories could prove that a record was made on a certain recorder.)

Magnetic records have been made in the form of round wires, flat wires, threads, tapes, films, discs, belts, cylinders, and flat sheets. Any or all of these can be solid, plated, coated, or impregnated with the active material, so we have a sizeable number of combinations to choose from. Some tape and wire forms are shown in Fig. 3.

Most magnetic recording wire is a stainless steel alloy of about 18% chromium, 9% nickel, and 73% iron. It is interesting that this alloy is from the class of "non-magnetic stainless steels." Though non-magnetic as it comes in ingot form, the alloy takes on the desired magnetic properties after a series of carefully controlled heating and cold-working treatments. Recording wire is available on standard spools about 2¾ in. in diameter by ⅝ in. high, containing up to an hour (7200 ft.) of 0.0036 or 0.004 in. wire.

Most magnetic tape is a thin coating of active material on a plastic film base. The tan or brown coating is an iron oxide of formula Fe_2O_3, with magnetic properties including a coercive force of about 275, and a residual magnetization of about 800. The oxide is a fine powder, with particles about 0.00004 in. or smaller in size, uniformly dispersed in a binder which adheres to the film base. Black coatings for tape are generally iron oxides of formula Fe_3O_4, with a coercive force of about 350, and with the same physical characteristics as the brown oxide. Recently a "high output" tape has become available. It has practically double the magnetic energy of ordinary brown tape, but is otherwise interchangeable with it.

A standard tape package contains 600 or 1200 ft. of ¼-in. wide by 0.002 in. thick tape, on a 5 or 7 in. plastic reel which resembles an 8 mm film spool. Wider tapes, flat sheets, discs and motion picture films coated with the magnetic oxide dispersion are also available.

A comparison of the magnetic properties of certain recording materials shows the progress made in recent years. Carbon steel wire in early recorders had a coercive force of 30 oersteds or less. The modern stainless alloy has a coercive force of 245, which enables it to operate at a fraction of the speed of the old wire.

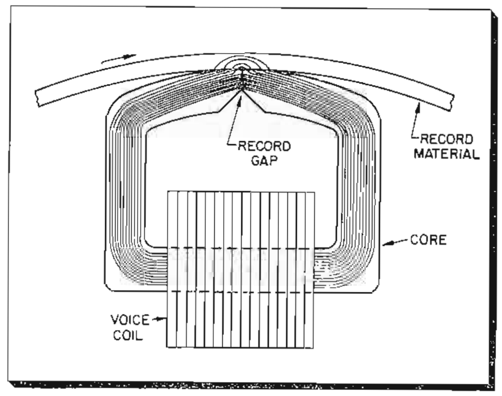


Fig. 7: Flux paths in head during recording

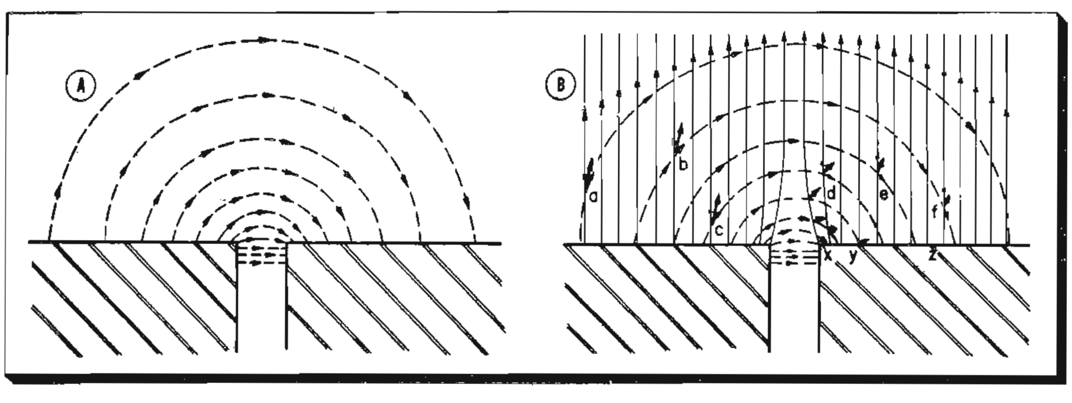
Similarly, the earliest tapes were made with carbonyl iron, which had poor magnetic properties. Later tapes using iron oxides were a great improvement, having a hysteresis loop as shown in Fig. 4, but still did not compare to present day materials of Fig. 5.

Recording Heads

The recording process impresses a magnetic pattern on the record medium by passage of the medium over a head, where each element in turn is acted on by a magnetic field, and becomes permanently magnetized according to the field it encounters. An important problem is to make the recording field as sharp as possible so that it affects a small portion of the record. The shorter the wavelength we can record, the slower we can run the record for a given frequency response.

One of the simplest recording heads is a bar electromagnet, with one pole

Fig. 8: Fluq paths of an X-field head. (a) Field produced by gap. (b) Vertical field added



contacting the record. This has a broad magnetic field and poor resolution. A better design is shown in Fig. 6a where the field is concentrated by a pair of opposed polepieces sharpened to a point. This design is unsuitable for wire recording because rotation of the wire gives fluctuating output. Staggering the polepieces as in Fig. 6b helps overcome this trouble, but at the expense of resolving power. A much better arrangement is shown in Fig. 6c which uses a narrow gap between flat faces to concentrate the field, instead of sharpened poles. The modified form of Fig. 6d substitutes a slot for the hole through the poles, for convenience in threading.

The recording head for tape in Fig. 7, consists of a high permeability magnetic core with a narrow air gap (about 0.0005 in.). It is difficult to take full advantage of very small gaps because the field is not sharply defined at the gap boundaries, but extends for a distance as we approach and leave the gap. There is also a problem caused by the decrease in field as we move in an upward direction, away from the gap. This makes the magnetizing field non-uniform through the cross section of the tape. In some designs the tape encounters undesirable, spurious fields as it enters or leaves the head. We also notice that the head is rather wasteful of flux, since most of it passes across the gap faces, rather than through the tape.

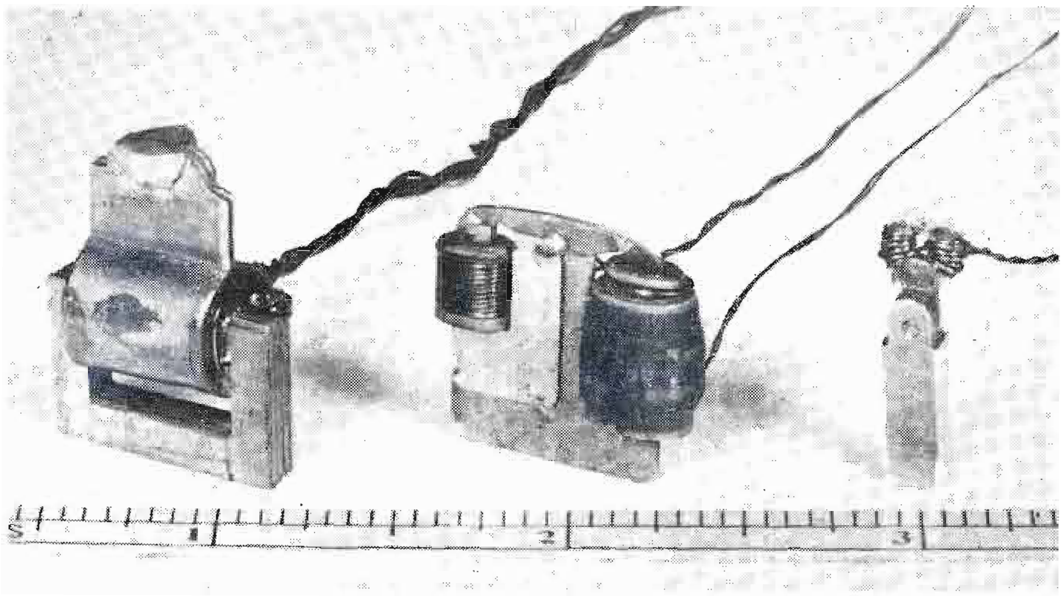


Fig. 9: (l to r) Turn-in-gap head energized by current through high conductivity spacer in gap; erase-record-playback head on single core; 1/8-in. diameter microhead

Heads have been designed to avoid these shortcomings. One promising type is the cross-field head of Fig. 8. To the gap field of an ordinary head (A) we add a vertical field as in (B). Vector addition of the field components gives a resultant which is more concentrated at one pole edge, and dies away more rapidly at the other. The result is a sharper recording

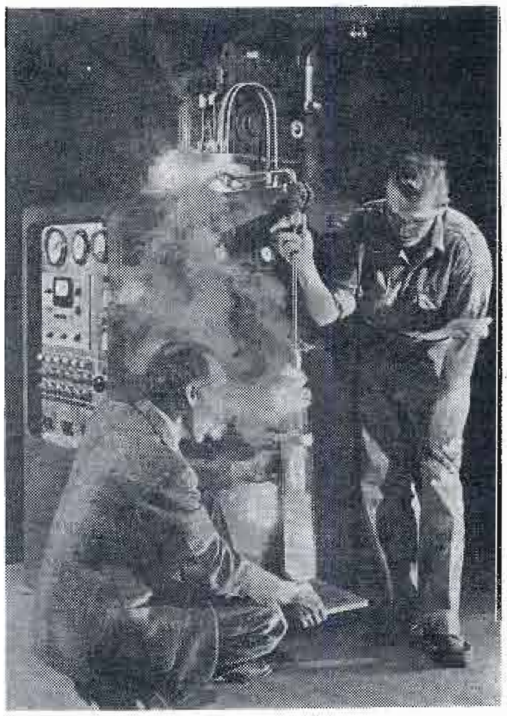
(*Continued on page* 122)

Superconductivity—A New Electronic Horizon

AN electric motor with 100% efficiency; a piece of lead which will carry a current better than a copper high-tension line—in fact to the extent that if a current were once started it would flow through the lead almost indefinitely without a battery to keep it flowing may appear as raw material for idle dreams. At room temperature, it would be right. But using extreme low temperature phenomena, super conductivity to be specific, these are both possible.

The strange properties of matter at temperatures in the region near Absolute Zero (−460° F) have been the object of much research in recent years. More particularly the development and commercial availability of reliable facilities for the production of extreme low temperature—the Arthur D. Little, Inc., 30 Memorial Dr., Cambridge 42, Mass., Collins Helium Cryostat—has brought into the range of every day investigation and use an entire field of pure research previously carried on in less than half a dozen laboratories. Today, there are over 60 laboratories engaged in cryogenic research, and low-temperature technology has been developed to the stage where excellent opportunities now exist for its practical application.

The general effect of low temperature is the production of ordered states of matter. If, at ordinary temperatures, something occurs with an energy smaller than several hundredths of an electron volt, it is swamped by the random agitation of the world about it, caused by thermal motion. Thus at normal temperatures a lower limit is set on the energy range of phenomena which may be reached. With a means of isolation (liquid helium, for example) from the energy of the outside thermal motion, the entire range of low-energy phenomena may be reached. Commuications and control processes should benefit especially from these studies, since the production, transmission, and processing of information are accomplished principally at low energy levels.



Transferring liquid helium to external dewar

Low Temperature Phenomena

Outstanding among the phenomena unique to very low temperatures is the conversion of certain metals and compounds into perfect electrical conductors. The fact that electrical resistance is proportional to temperature is to be expected from theory. On this principle then, the resistance of pure metals should gradually decrease to zero at Absolute Zero; and this is what happens with the best of normal-temperature conductors such as copper and silver in their pure state. In the case

(*Continued on page* 160)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Conelrad Transmitter

BOB CROSSTHWAITE,
Chief Engineer, KWYO,
Sheridan, Wyoming

TO simplify and speed up the necessary operations required to transmit on a Conelrad frequency, we have constructed, from spare parts, a three-stage transmitter using an 807 crystal controlled oscillator, 807 buffer and an 826 for the final, modulated amplifier. The unit has a built-in 350 v. power supply for the oscillator and buffer and a 10 v. filament supply for the final amplifier. The final amplifier is shunt fed so that a simple tap connection can be made to an unbalanced transmission line from the tank coil.

After the unit is tuned and proper loading has been determined, the following operating procedure should be followed: connect the final plate lead to any 1000-1500 volt source of modulated voltage; connect to transmission line and ground; turn on power and adjust audio input to the regular transmitter to proper modulating level. This procedure should work satisfactorily with any 250 watt transmitter using high-level modulation.

We are using the auxiliary transmitter in conjunction with an RCA type BTA-IL kilowatt transmitter which is equipped with a complete type BTA-250L transmitter adapted to drive the final modulated amplifier. To use the Conelrad transmitter with this equipment, the following connections are made: (1) In the exciter unit of the BTA-IL transmitter, disconnect the two leads from the center-tap of modulation transformer (IT6) and bolt these two leads together. (2) Remove the two coax cable lugs from lead-through insulators above plate caps of second audio (828) tubes and, using a high tension clip lead, connect from one of these lugs to center-tap of modulation transformer IT6. (3) Remove plate cap of 810 driver tube. Run long, high tension clip lead from Conelrad transmitter final plate through hole in top of exciter and clip to plate side of r-f choke (ILI2) above modulation transformer. (4) Open meter panel of exciter unit and remove tape from lugs on two leads from modulation transformer and connect these two cables to lead-through insulators to plates of 828 audio tubes.

We found it necessary to reduce the audio input to the transmitter about 10 db to avoid over-modulating the 828. Negative return is provided by the ground connection to the transmission line. Strong, clear signals were received on a car radio 10 miles from the antenna during a Conelrad test period. No attempt was made to check at a greater distance.

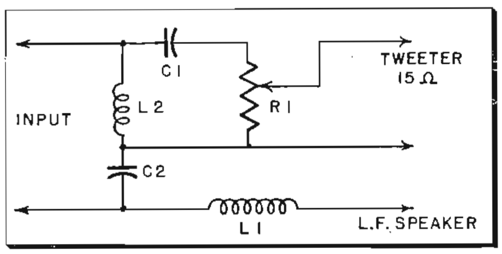
$$$ FOR YOUR IDEAS

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.

Audio Crossover Network

SAM DUDAS, WBRD,
Ft. Lauderdale, Fla.

HERE is a crossover network which is rather simple to build and does not involve too much money. To eliminate the rather involved calculations and simplify construction, the various values for L and C have been tabulated in the table below:



Crossover network circuit easily designed by chart for average impedances

Amp. Output and Cone-Impedance	C1 MF.	C2 MF.	L1 MH.	L1 Turns	L2 MH.	L2 Turns	R1
4-Ohms	32	50	.5	112	.3	90	6-Ohms
6-Ohms	22	35	.8	140	.5	112	10-Ohms
8-Ohms	16	25	1.0	160	.65	130	12-Ohms
10-Ohms	13	21	1.3	175	.8	140	15-Ohms
16-Ohms	8	13	2.0	212	1.3	170	25-Ohms
12-Ohms	11	18	1.5	200	.97	155	20-Ohms

Inductances "L-1 and L-2" are on a 1¼ in. wooden dowel form, ¾ in. long. Wire size is No. 16 enamelled, and windings should be about 13 turns per winding layer. It is suggested that sides be fastened to the form so that the coil will be as neat as possible. A breast drill will aid in winding the coils by using a screw centered in the bottom of the form. Coil dope or tape should be used when finished; about a pound and a half of wire will be installed at right angles to each other to reduce inductance effects.

Capacitors C-1 and C-2 must be paper or oil of the non polarity type; their values are not too critical and variations up to 10% can be tolerated without noticeable effect. The voltage rating should not be less than 50 working volts.

Since the division of power into the bass speaker and the tweeter will vary as a function of the impedance of the cone speaker, R-1 provides an effecive method of properly balancing the circuit . . . R-1 should be a wirewound resistor of the order of 10 watts and may be a tap type resistor.

The phasing of both speakers is important. Therefore, the leads to the tweeter should be switched while someone listens, when maximum loudness is obtained, the speakers are in phase.

See Both Sides of the Game

LARRY CRISSMAN,
Western Electric Co.
Winston-Salem, N.C.

A simple way was desired to enable a remote engineer to watch either end of a basketball court and at the same time be able to see the remote amplifier VU meter which was at one side of a rather high announcing table. By mounting a rear view mirror opposite the remote amplifier so the meter reflection can be seen in it, the operator can then ride gain and watch the game.

It would be well to keep the mirror out of the engineer's line of sight of the basket as well as out of the announcer's field of view. The meter reflection is a mirror image and therefore backward, but after a little practice it is as easy to read as the meter itself.

A mirror of about half the size of the meter face is large enough to give a good view of the meter provided the distance from the meter to the mirror is greater than from the engineer to the mirror.

Console Socket Modification

D. V. R. DRENNER, KGGF, Coffeyville, Kan.

WE recently made a modification to our Western Electric 23-A console quite similar to that noted by Mr. Roland Jordan Jr., WSBB, in TELE-TECH (May 1953, page 114).

Our method retained the spring-mounted socket assembly—a feature which is common to the 23 Series Consoles, A, B, and C. However, in place of the adapter we utilized *wafer* octal sockets in *direct* substitution for the original 1603 wafer sockets. The spring mounted assembly can be completely disassembled by the removal of four screws, and the new sockets installed with the same wire as previously used. This method also allows the grid lead to remain above the chassis, since we used 6J7 type tubes to replace the more expensive 1603's.

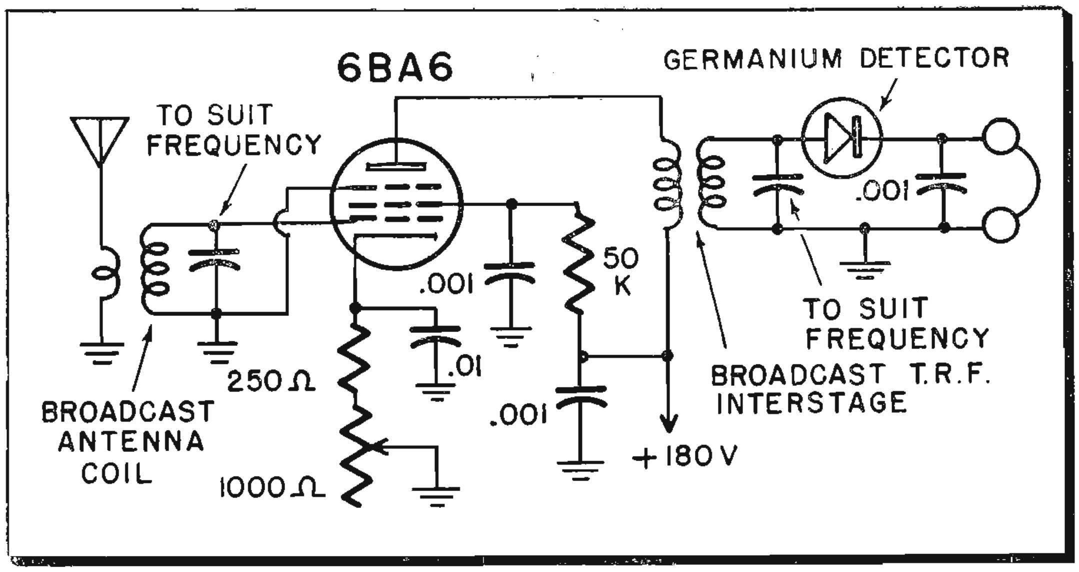
Since this conversion we have utilized the regular run of 6J7's as obtained from jobbers, making a noise check on several dozen tubes to find the best. Our noise and hum with the 6J7's is 62 db down; the average 1603 gave us only 52 db down—quite an improvement, and saving!

Cueing Receiver For Remote Amplifiers

R. S. HOUSTON, E. C. Page, Consultants, 600 Bond Bldg. Washington 5, D.C.

CUEING a remote operator, although handled in many different ways, has always been somewhat of a problem. Where there are two lines to the remote point, this is easily accomplished over the order wire. In programs where a portion of the material comes from the studio, it is usually important to hear everything that happens, to be certain that the remote is on the air or not. This is difficult to do on one line, especially where the studio operator is busy with other details of the program. Many times in smaller stations, the announcer does the operating, and may forget to return cue to the line at the conclusion of the program, thus leaving the remote operator with some doubt as to his status, especially if the program has run over, or short.

To circumvent this problem, a small receiver was installed in the amplifier to allow constant monitoring of the station's output, regardless of the source. The coils are standard broadcast coils and the tuning capacitors are fixed units selected to tune the station frequency. Since it is to be used with one station, variable tuning was not included, with a consequent saving in space. A standard TRF amplifier is used to give gain sufficient to allow operation at considerable distances from the transmitter, or under poor receiving conditions. This is followed by a crystal detector of the germanium variety. Since monitoring is to be done with phones, the output may be enough to operate them directly without any additional audio amplification. If extra gain is needed, a small high gain triode stage may be added. Some remote amplifiers have headphone amplifiers built in, and an arrangement can be made to switch them to the receiver. The use of the r-f. gain control shown was made necessary by operation in close proximity to the transmitter. However, it may not be necessary in many cases where the transmitter is a good distance from town.



Cueing receiver allows constant monitoring of station's output, regardless of source

Rectifier Insurance Policy

PHIL WHITNEY, Chief Engineer, WRFL, WINC, Winchester, Va.

STATION WRFL (FM) recently completed its second year of successful remote control operation by radio link. Upon checking the record, it was discovered that the most frequent cause of unscheduled visits to the mountaintop transmitter was the lowly 5U4G, used as the power supply rectifier for the remote control equipment, link receiver, protective devices, program and audio amplifiers, telemetering, etc.

Most of the time, the tube heater failed because of an open, but in some cases, the tube suddenly lost emission, went gassy, or shorted. We designed an adapter which would place a pair of tubes in parallel in place of the single rectifier in the original installation. Thus, when a tube fails, a second is already in the circuit to operate until the regularly scheduled inspection and maintenance visit. Each tube plate was separately fused with a ½ amp. AGC type fuse, and a cable runs from the chassis which contains several pairs of these tubes to each piece of equipment and the 5U4G socket.

A separate chassis was provided for mounting these tubes. It dissipated the heat away and many of the original chassis did not have room to mount a second rectifier. The unit was simply made, and the cable ends plugged into the old 5U4 sockets. In some cases it was deemed advisable to use a separate filament transformer for the extra rectifier where the original power transformer was not designed to handle the extra load of a second 5U4 heater. This transformer was mounted on the separate chassis.

The fuses in the rectifier plate circuits guard against possible short or gassy conditions opening the primary supply fuse and causing a failure. As the trend toward remote control operation for both AM and FM stations grows throughout the country, this hint might be incorporated in the design of the remote control equipment for those planning such an installation, and an adapter such as described here applied to those already in operation, would result in a more reliable and less expensive operation.

In one case of outage, a power transformer in a relatively unimportant piece of equipment shorted and took the primary fuse out in a circuit which also fed the program amplifier. Therefore, a separate fuse was provided for every piece of equipment no matter how small, and as far as possible, a separate power supply was provided for each indi-

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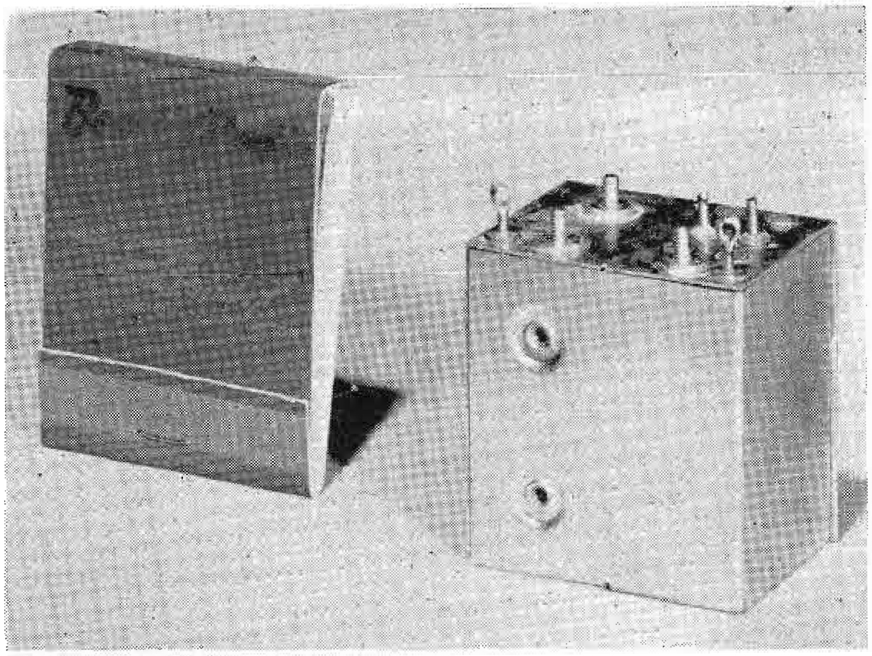


Design Procedure

Practical engineering approach shows how divided electrode X-cut crystals can provide high selectivity. Complete 425,000-ohm unit occupies only 2 cu. in., weighs 2 oz.

Fig. 1: High impedance type of crystal lattice filter

By WM. C. VERGARA
Bendix Radio Div.
Bendix Aviation Corp.
Baltimore 4, Md.

Of the many forms that crystal lattice filters may assume, the high impedance type pictured in Fig. 1 and shown schematically in Fig. 2 seem to offer most possibilities for use by the radio engineer. In addition to providing great selectivity in a small volume, it has the added advantage of providing voltage gain when used in a conventional pentode amplifier stage. The temperature stability of this filter is excellent although compensation for variations in the coils is usually required.

The maximum theoretical bandwidth obtainable with filters using quartz crystals has been shown[1] to be about 13.7% of the center frequency. In practice, the figure is probably closer to 10% or 11%.

A measured selectivity curve typical of crystal lattice filters is shown in Fig. 3 in order to provide a basis for the design assumptions which must be made. The dotted curve represents the theoretical performance of the same filter.

The first step in the design is to impose the following conditions, which are based on the desired performance:

f_a = Lower theoretical cut-off frequency
f_b = Upper theoretical cut-off frequency
$f_{\infty 1}$ = Lower maximum rejection frequency
$f_{\infty 2}$ = Upper maximum rejection frequency
Z_o = Filter image impedance

The cut-off frequencies must be selected somewhat further apart than would theoretically be necessary in order to compensate for the rounding effect encountered in practice. This effect is due, almost entirely, to impedance mismatch at the filter terminals rather than dissipation in the filter elements as has been demonstrated[2] by Mason.

Selection of the maximum rejection frequencies involves a compromise between attenuation level of the "wings" and sharpness of the curve just beyond the cut-off frequencies. Eq. 1 is the theoretical selectivity function expressed in decibels and can be used with good accuracy to effect this compromise.[1]

A check on the accuracy of the calculations can be had by making use of the fact that (A+C) = (1+B) for this filter.

$$\text{Attenuation} = 17.37\,\tanh^{-1}\frac{A+C}{1+B}\sqrt{\frac{\left(1-\frac{f^2}{f_A^2}\right)\left(1-\frac{f^2}{f_3^2}\right)^2}{\left(1-\frac{f^2}{f_2^2}\right)^2\left(1-\frac{f^2}{f_B^2}\right)}}$$

where

$$A = 1 + m_1 + m_2$$
$$B = m_1 + m_2 + m_1 m_2$$
$$C = m_1 m_2$$

$$m_1 = \sqrt{\left[1-\left(\frac{f_{\infty 1}}{f_B}\right)^2\right] \Big/ \left[1-\left(\frac{f_{\infty 1}}{f_A}\right)^2\right]}$$

$$m_2 = \sqrt{\left[1-\left(\frac{f_{\infty 2}}{f_B}\right)^2\right] \Big/ \left[1-\left(\frac{f_{\infty 2}}{f_A}\right)^2\right]}$$

f = any frequency

$$f_2^2 = \frac{f_A^2 f_B^2 (1+B)}{f_A^2 + B f_B^2} =$$

Series Resonant Freq. of Y_1

$$f_3^2 = \frac{f_A^2 f_B^2 (A+C)}{A f_A^2 + C f_B^2}$$

Series Resonant Freq. of Y_2 (1)

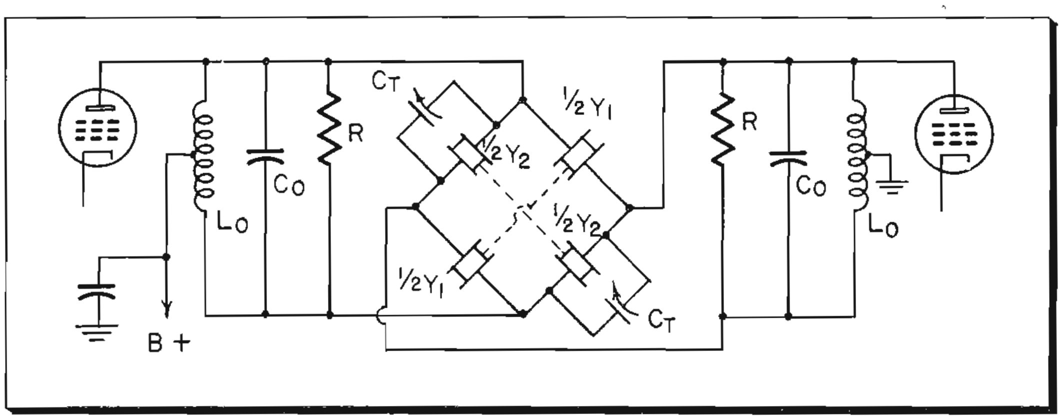
The remaining quantity, Z_o, is selected on the basis of the required stage gain using Eq. 2.

$$\text{Gain} = 1/8\ G_m Z_o \qquad (2)$$

The factor, 1/8, is based upon the fact that the effective input impedance presented to the driving tube is ¼ of the total, and in addition, the filter is terminated at each end by a resistance equal to the magnitude of the midband image impedance, Z_o.

The next step is the design of the two similar divided electrode crystals,[3] Y_1 and Y_2. These crystals are −18½° X-Cut quartz plates with four electrodes instead of the usual two. This type of unit, shown in Fig. 4, replaces the two identical crystals required in each pair of opposite arms of the bridge. They also provide other advantages over the use of separate crystals; namely, transformer action within the quartz plate tends to compensate for circuit unbalances.

Fig. 2: Crystal lattice filter can provide voltage gain, has excellent temperature stability



for Crystal Lattice Filters

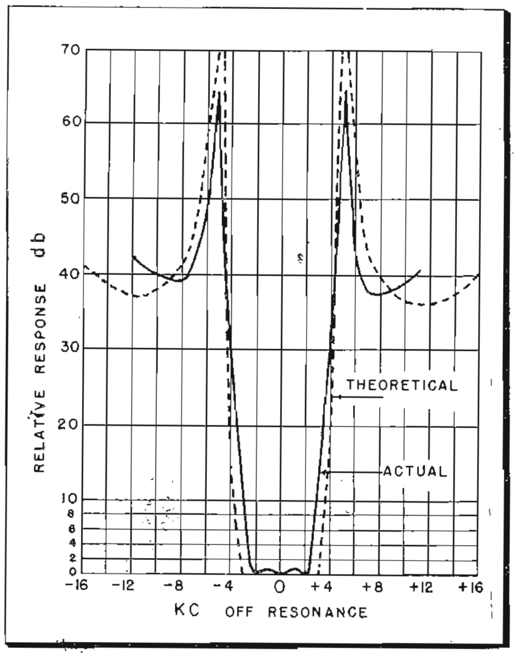


Fig. 3: Measured selectivity curve of crystal lattice filter. Dotted curve is theoretical

The design values[1] of the equivalent series inductance L_s and capacitance C_s for each section of the crystals are given in Eq. 3.

$$L_{S1} = \frac{Z_0 (1 + B)(f_A^2 + B f_B^2)^2}{2\pi f_A f_B (f_B - f_A)(f_B + f_A)^2 (AB-C)}$$

$$L_{S2} = \frac{Z_0 (A + C)(A f_A^2 + C f_B^2)^2}{2\pi f_A f_B (f_B - f_A)(f_B + f_A)^2 C(AB-C)}$$

$$C_{S1} = \frac{(f_B - f_A)(f_B + f_A)^2 (AB-C)}{2\pi Z_0 f_A f_B (f_A^2 + B f_B^2)(1 + B)^2}$$

$$C_{S2} = \frac{(f_B - f_A)(f_B + f_A)^2 C(AB-C)}{2\pi Z_0 f_A f_B (A + C)^2 (A f_A^2 + C f_B^2)} \qquad (3)$$

An infinite number of −18½° X-Cut crystals can be ground having the element values given in Eq. 3. Some of these have serious spurious responses[4] which adversely affect filter performance. It is possible for thin crystals to move these responses to a frequency at least 25% higher than the filter frequency by maintaining the ratio of crystal width to length, (l_w/l_y), between 0.35 and 0.80. If we assume a value, K, for this ratio, the crystal dimensions in centimeters are given by:

$$l_y = 10^7 / 2\pi f_2 \; (6.375)$$

$$l_w = K\, l_y$$

$$l_t = \frac{1}{2}\left[\frac{K L_s}{139}\right]$$

$$\text{where} \quad K = l_w / l_y \qquad (4)$$

The expression for l is multiplied by ½ because L_s is the series inductance for only half of the crystal. The design should be such that the value of l_t is small compared to the other crystal dimensions,[4] and of the order 0.025 to 0.075 centimeters. This is accomplished by selecting suitable values for K and Z_0.

The remaining reactive elements[1] are determined from the expressions of Eqs. 5 and 6.

$$L_0 = Z_0 (f_B - f_A) / 2\pi f_A f_B$$

$$C_0 = \left| \frac{(A f_A^2 + C f_B^2) f_B}{2\pi Z_0 f_A (f_B - f_A)(f_A^2 + B f_B^2)} - \frac{(f_A^2 + B f_B^2) f_A}{2\pi Z_0 f_B (f_B - f_A)(A f_A^2 + C f_B^2)} \right| \qquad (5)$$

The capacitance, C_t, is equal to the difference between the parallel capacitances of the crystals ½ Y_1, and ½ Y_2. These values can be obtained by the use of Eq. 6.

$$C_{PARALLEL} = C_P = 0.402 \frac{l_w l_y}{2 l_t} \; \mu f / \text{section} \qquad (6)$$

It should be observed that C_t is generally a small capacitance and in the practical case, allowance must be made for the effects of stray wiring capacitance.

The remaining quantity to be determined is the terminating resistance, R. If the shunt impedances of the associated tubes can be neglected, the terminating resistance, R, should have a value such that

$$R R_{EQ} / (R + R_{EQ}) = Z_o$$

where $R_{eg} = X_1 Q$ is the equivalent shunt resistance of the coil, L_o. The value of R is then seen to be:

$$R = Z_o X_{Lo} Q / (X_{Lo} Q - Z_o) \qquad (7)$$

The crystal manufacturer is given the following information for each crystal unit:

a) Series resonant frequency
b) Crystal thickness
c) Crystal series capacitance per section

The following data are provided for information only, since the crystal has already been specified completely:

a) Crystal length
b) Crystal width

Alignment of the filter stage is accomplished by adjusting C_0 (or L_0) near one of the cut-off frequencies and C_t at the maximum rejection frequencies. The former adjustment provides a flat response (usually less than 1 db peak to valley ratio) within the passband while the latter is used to locate f_{001} and f_{002} at the design frequencies. There is little interaction between adjustments.

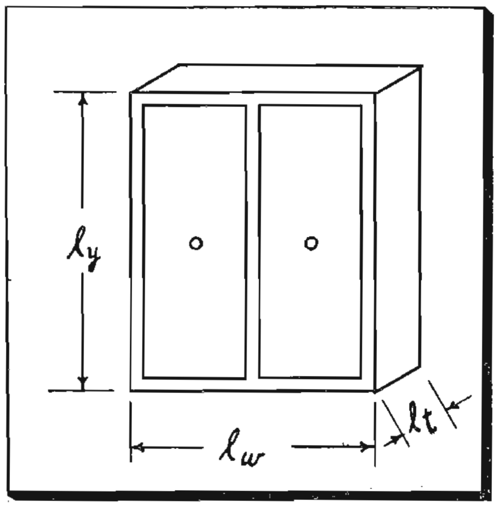
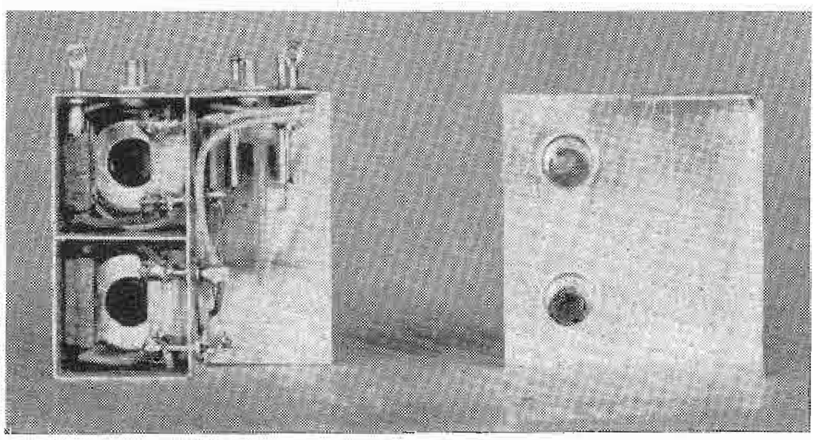


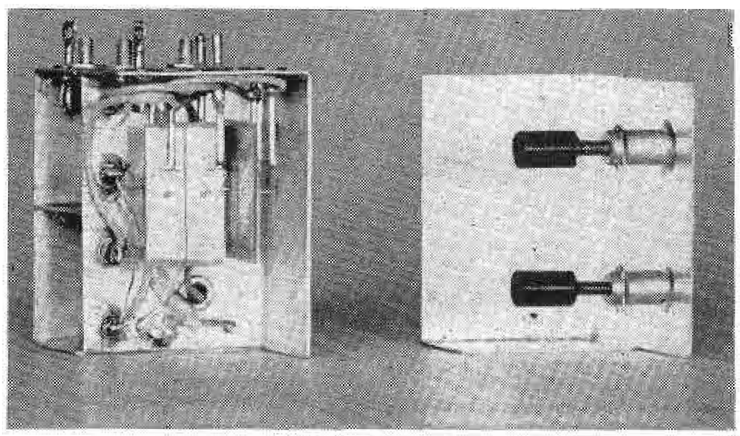
Fig. 4: Divided electrode X-cut crystal

Figs. 5 and 6 show a high impedance crystal lattice filter designed for 135 KC. This filter occupies a volume of 2 cu. in., weighs 2 oz., and has an image impedance of 425,000 ohms.

1. W. P. Mason, *Electrochemical Transducers and Wave Filters*, D. Van Nostrand.
2. W. P. Mason, "Resistance Compensated Band-Pass Filters," *B.S.T.J.*, Oct., 1937.
3. W. P. Mason, "Electrical Wave Filters Employing Crystals with Normal and Divided Electrodes," *B.S.T.J.*, April, 1940.
4. W. P. Mason, "Electrical Wave Filters Employing Quartz Crystals as Elements," *B.S.T.J.*, July, 1934.

Figs. 5 and 6: Two views of a high impedance crystal lattice filter for 135 KC. Filter occupies volume of 2 cu. in., and weighs 2 oz.





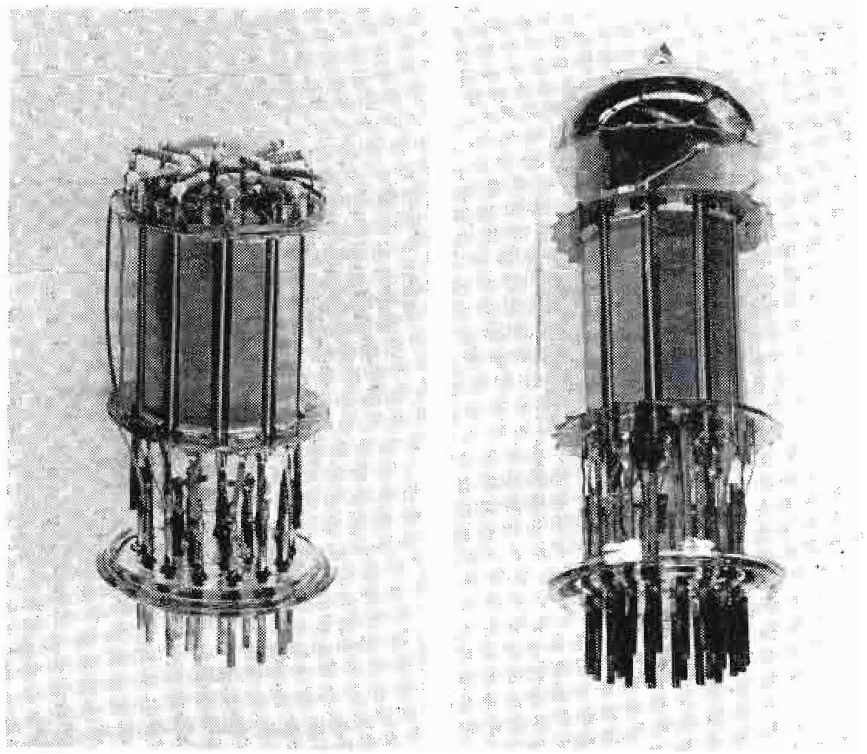


Photo of Burroughs multi-output tube which promises to be extremely valuable in general application as well as computers

Beam Switching

Family of tube types also finds use in instruments, communications and general applications. Unique feature permits electron beam to be switched in ten positions to perform complex functions. Auxiliary electrodes keep associated circuitry at minimum

By SAUL KUCHINSKY
Research Div., Burroughs Corp.
511 N. Broad St., Philadelphia 23, Pa.

The growth of the electronic industry in recent years, especially in the field of computers, instrumentation, and communications, appears to have advanced more rapidly than comparative tube developments. This has resulted in the use of large numbers of standard tube types and associated components to perform necessary complex functions. As a consequence, the probability of system failure may be unfortunately high despite the introduction of intensive reliability programs. Considerable effort has been given to the problem of reducing this mass of components by the design of special purpose tubes. Almost without exception, vital factors of high cost, large size, and excessive power, common to these types have limited useful and progressive applications.

The family of beam switching tubes described here have characteristics more suitable for general use. These tubes have the following features in common: they are high vacuum, small in size, use standard operating voltages to control moderate currents, and can be mass-produced to meet accurate specifications. The internal structures, as illustrated in the four cross-section views, Figs. 1-4, approach the ultimate in simplicity, while providing the desired versatility.

These tubes are unique in that an electron beam may be formed, controlled, and switched in as many as ten discrete positions to perform complex functions. They were designed and developed with specific characteristics beyond the capabilities of existing types. Both electrostatic and crossed electric-magnetic field types are included. A small inexpensive permanent magnet provides the necessary axial field in the latter type.

The comparatively small number of auxiliary electrodes necessary to control the beam with respect to the multi-positions and outputs is indicative of the minimum of associated circuitry. The large cathode-anode spacings reduce contact potential, and sublimation effects. This should contribute to the uniformity of production lots initially and throughout life. It appears, therefore, that conditions for reliability may be met by these tubes more effectively than with standard grid types.

Fig. 1: Selector tube SEL-10. Electrostatic ribbon beam deflection with two plate inputs

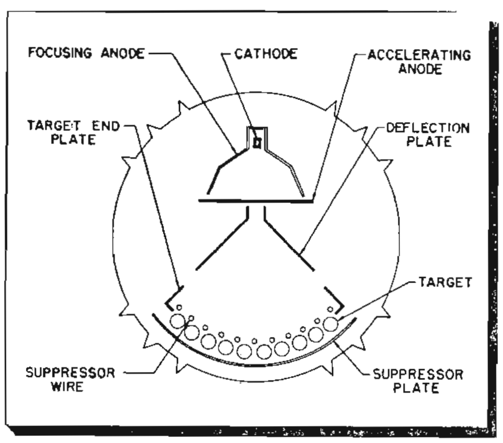
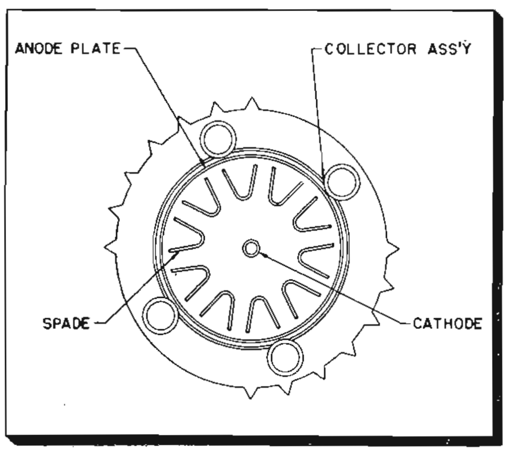


Fig. 2: Coding tube TR-BC-11. Magnetron switching with 10 beam positions, 4 outputs



Magnetron Switching Tubes

A major limitation of the basic coaxial design is the lack of versatile outputs. The ten spades require specific impedances and voltages to

Fig. 3: Multi-output tube TR-SR-11. Magnetron switching with 10 beam positions, 10 outputs

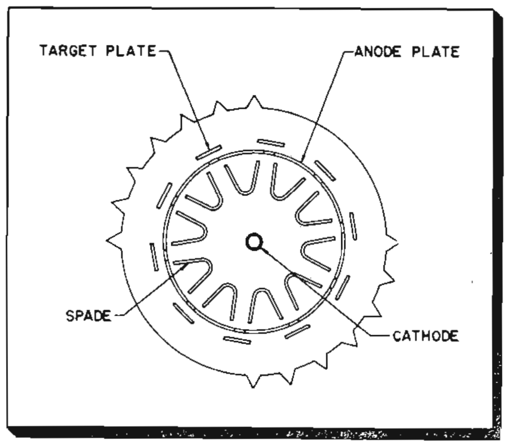
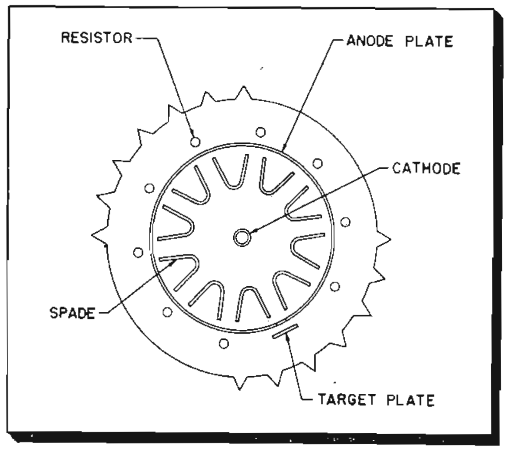


Fig. 4: Decade counter tube TR-DC-11. Magnetron switching with 10 stable beam positions



Tubes for Computers and Controls

perform their function of beam formation and locking. Small variations in capacities, in the order of a few μμf, will detract from the overall tube reliability. Thus the adaptation of these spades as outputs usually necessitates critical buffering and amplification. The Burroughs types, in contract, have maintained the purpose of these control elements solely for beam formation and locking while providing separate means for outputs. In the basic type, only a small percentage of the beam is intercepted by the spade in forming its stable locked in position, while the major portion goes to the anode. This anode current may assume an important function in the switching operation, but it is unused in the static electron output position. The Burroughs magnetron switching types apply this previously unused beam to provide large output currents. The designs (see Fig. 5 for examples) are such that outputs are not critically limited as to impedance or voltage levels, nor do they affect tube stability.

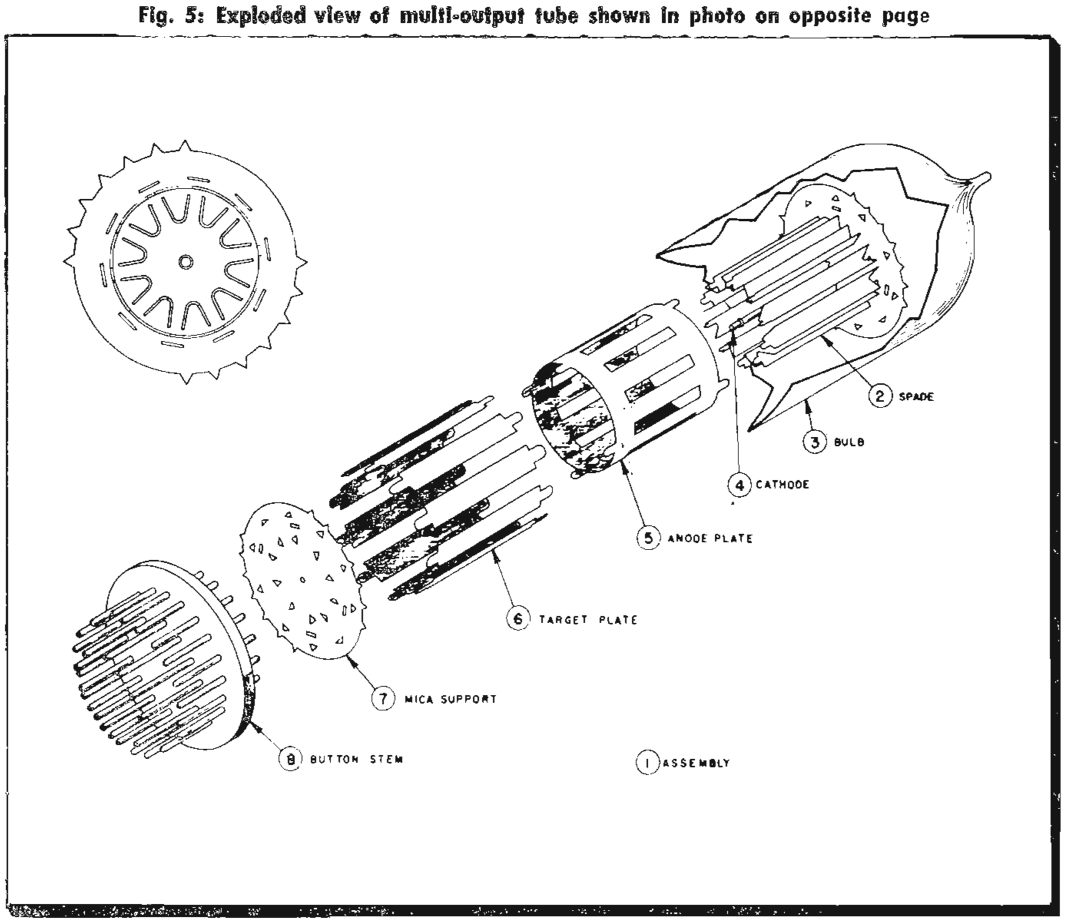
Some accomplishments of magnetron switching tubes worthy of note are:

1. Operation of tube type, with vacuum mounted resistors, at controlled beam switching rates above 6 MC.
2. Communications switching with 75% modulation at modulation frequencies from audio to video; 100% with external commutation means.
3. Reliable operation of tubes at voltages as low as 22 volts with outputs greater than 0.5 MA.
4. Improvements in output efficiencies (ratio of output current to cathode current) to above 90%.

The coding tube type TR-BC-11 (Fig. 2) is a novel adaptation of the coaxial type which extends its application considerably. A method is provided, in the same size envelope, to produce simultaneous parallel coded outputs for each decimal position. The anode is modified by a system of binary coded apertures and the addition of a coaxial collector-ring assembly. In each locked-in position a coded portion of the beam is permitted to impinge on the associated collector rings to indicate the respective decimal position in parallel coded form.

The present tube is a ten-count tube with both decimal and parallel binary coded outputs on a standard 20 pin button stem. By use of vacuum mounted resistors, as described hereafter, a standard 9-pin button stem is sufficient in applications where only coded outputs and one zero preset is required.

Fig. 5: Exploded view of multi-output tube shown in photo on opposite page



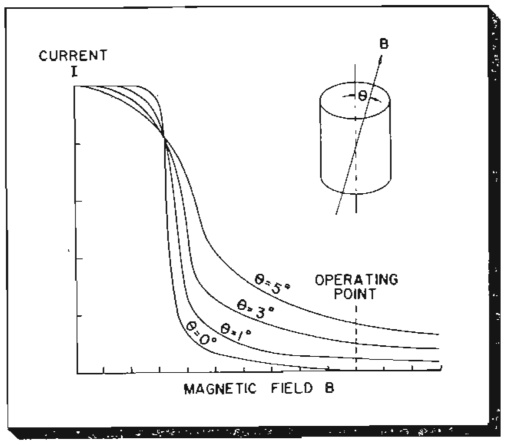


Fig. 6: Magnetron cutoff characteristics

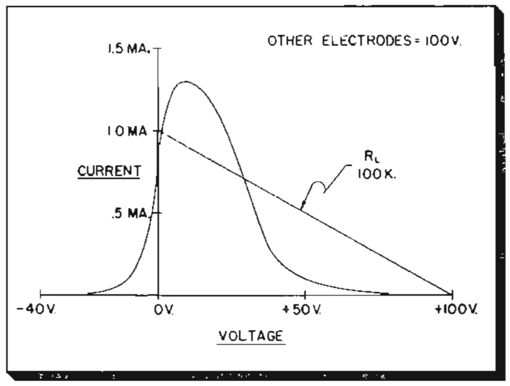


Fig. 7: Typical spade characteristic

Multi-output tube type TR-SR-11 (Fig. 3 & 5) adds the feature of ten individual outputs to the coaxial design in the same size envelope. As in the coding tube, application is made of a major portion of the beam to provide a sizeable current and to remove limitations as to output impedance, voltage levels and cross talk. This permits performing many useful functions directly, without buffering or amplification.

One version of this tube is a ten-count tube with both the beam holding decimal outputs and the improved multi-outputs available on a 30 pin button stem. By use of vacuum mounted resistors, in applications where only the multi-outputs and one zero preset is required, the same tube type is mounted on a "standard" 20 pin button stem for which a production socket is available. This all-purpose tube type is suggested wherever a "working" output is necessary in every position. Some applications are: arithmetic units, shift registers, business machines and desk type computers combining high speed electronic information with low speed electromechanical devices (punched cards), analog to digital converters, communications switching and multiplexing; and as general purpose types for any multi-output switching, counting, measuring, sampling, gating, modulating, or control devices.

The decade counter tube type TR-DC-11 (Fig. 4) provides a large single output for every ten input pulses, and one zero preset position with the convenience of a standard 9 pin button stem. This output is of the improved type used in the multi-output tube. This facilitates performing many useful functions directly without amplification. The small number of stem leads is made possible by use of internally mounted vacuum resistors to perform functions of beam forming and locking.

This tube is suggested for all counting functions where a working output in every position is superfluous. Many of the applications of the multi-output tube type, through proper systems design can be performed by single output tubes.

Vacuum Mounted Resistors

In most applications the spades perform only the function of locking the beam in position, and other elements are used for inputs and outputs. In such cases, by placing the spade load resistor within the

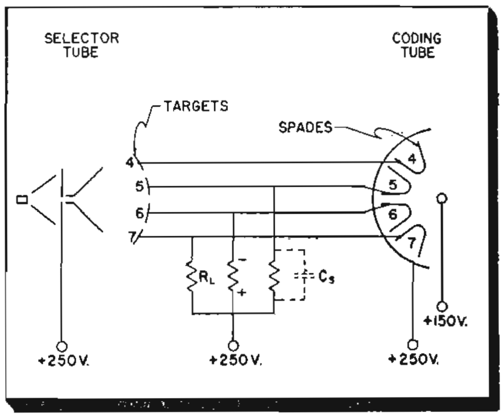


Fig. 8: Basic coding circuit for selector tube

vacuum tube, the following advantages are gained:

1. The reliability of tube performance is increased. Spade capacities can be reduced and equalized very accurately. The upper frequency limit is extended.

2. Stem lead requirements are reduced, permitting use of standard sockets for multi-output tubes.

3. An increase in the reliability of carbon-deposited resistors in vacuum.

In the past decade, isolated instances have been noted where resistors were used in vacuum. These were of a composition type and there was an unknown factor present as to their effect on vacuum and life of the tube. In recent years, the advent of carbon-resistors which consist of variations of a carbon deposition on a pure ceramic, have offered a reliable solution.

Principles of Operation

The formation, switching, and control of the beam of the magnetron switching tube may be effected in many ways. Several of these methods are described briefly to indicate the versatility of the tubes, to clarify applications already demonstrated, and to stimulate further adaptions.

The beam switching phenomenon within the tube appears to be accurate, reproducible, and controllable in the order of 0.1 µsec. Its control through proper input design can be made to respond to a broad range of requirements from milli-microsecond pulses to dc levels and mechanical devices. The flexible outputs represent a current source approaching pentode characteristics. The combination places this tube type in the category of performing functions beyond the capabilities of existing means.

Tube Cutoff: A small inexpensive permanent magnet provides the necessary axial magnetic field of about 350 gauss. When all the elements are positive (+ 100 volts) with respect to the cathode, the tube is at cutoff. This is similar to the magnetron cutoff condition, in that the radius of curvature of the electron path is such that the positive electrodes do not receive current as shown in Fig. 6.

Beam Formation from Cutoff: If the tube is initially at cutoff, the beam may be formed in any of its ten "on" positions by sufficiently lowering the potential of the respective spade. A typical spade characteristic is illustrated in Fig. 7. With a proper load resistor, as shown, bistable characteristics are obtained at 100 volts and about zero volts. Thus the one spade forming and locking the beam is near cathode potential while the remaining ones are at high positive levels.

The beam, thus formed, is so well defined that effectively all the current goes to the leading edge of the spade and the immediate adjacent anode section, with the latter taking a major share. In practice, either a dc potential or a very high speed pulse may be used to form the beam in any position from cutoff condition.

Random Switching Subsequent to

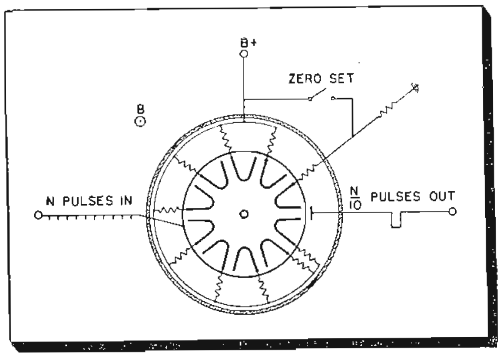


Fig. 9: Decade counter circuit using TR-DC-11

Beam Formation: Note the limitations of random switching, by the above method, once the beam is formed. Any controlling electric field introduced in a nearby leading direction, determined by the magnetic polarity, may be effective on the existing electron path and result in switching to the new bistable position. By the same token, this field introduced directly behind the electron path will have no switching effect whatever. These conditions may prevail for half a beam revolution.

Beam Positioning

One positive method of beam positioning from any alternative location is to establish the equivalent of tube cutoff conditions before or simultaneously with the lowering of the new spade potential. This can be done at high speeds limited only by the RC of the spades. If this operation is done mechanically or at low speeds the same precautions must be taken to insure the correct respective order of events.

Beam Switching, Pulse Counting Successively Clockwise or Counter Clockwise: The polarity of the axial magnet determines the direction of beam rotation. The beam may be moved to successive positions by application of pulses of discrete width and amplitude to either the anode, the common spade input through the individual load impedances, or to the cathode. Each mode of operation requires individual circuit parameters with resulting varying input and output characteristics. This operation differs from prior mentioned methods of beam switching in that a common point of control is used. The switching field is present equally at all radians. Therefore, it is necessary that this pulse be of discrete width, whereby the electric field so introduced remains for a proper time for the beam to switch to the adjacent position. If this pulse duration is too small, the beam will not switch. If it is too long, the beam may switch

(*Continued on page* 108)

New Test & Measuring Equipment

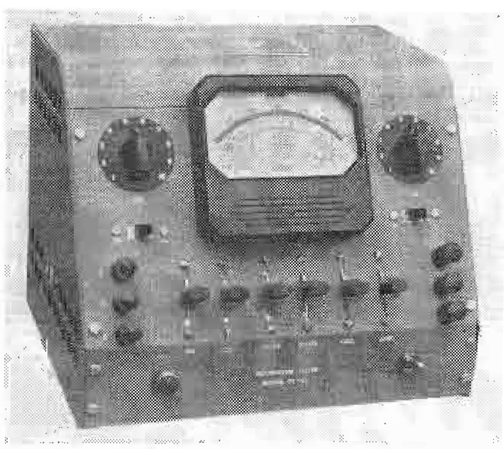
Null Meter

Model 100A phazor null meter enables phase sensitive null detection and eliminates noise and harmonic components.

Useful for a bridge, potentiometer, or other null type circuit, the instrument finds application in synchro zeroing, incremental impedance detection, and phasing transformer devices. Null direction is shown on a centered meter. Phase and magnitude in null circuits are separate adjustments. Sensitivity is 6 mv off scale deflection. Frequency range is 30—10,000 CPS. Input impedance is 2.5 megohms shunted by 15 μμf. Instrument overload is prevented by electronic limiting. Power input is 105-125 v, 60 cps, 25 watts. The unit is 9 in. high, 15 in. wide, 8 in. deep.—**Industrial Test Equipment Co., 55 East 11th St., New York, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

Transistor Tester

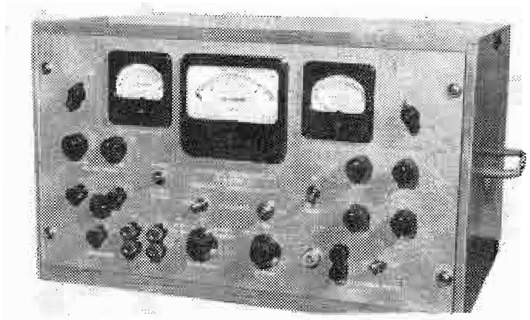
The Model TT-11 transistor tester checks NPN, PNP, and junction and point contact transistors, diodes, or other semi-conductor devices on a direct-reading "go-no-go" basis. The unit performs both static and dynamic tests, and results are independent of voltage and temperature variations. Static tests include foreward diode (emitter-base) and reverse diode (collector-base) characteristics. Dynamic tests include both amplification and oscillation comparisons with the reference transistor. The internal dc power supply



to the transistor is adjustable positive or negative Ie, 0-10 Ma and Ec, 0.5 V. **Electronic Research Associates, Inc., Box 29, Caldwell N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Transistor Analyzer

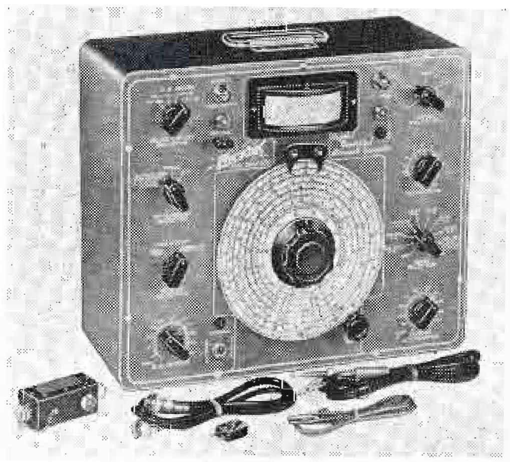
The Model TA-1 transistor analyzer measures the emitter-to-collector current gain α of both N-type and P-type point contact transistors and the base-to-collector current gain β of PNP and NPN type transistors directly on a panel meter. When used with an oscilloscope, the TA-1 will produce curves of emitter-to-collector current gain against emitter current (I_e) and base-to-collector current gain against base current (I_b). Constant collector voltage is ob-



tained from a regulated power supply the output of which is available for external use.—**Polyphase Instrument Co., 705 Haverford Road, Bryn Mawr, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES

Microvolt Signal Generator

Designed for aircraft radio servicemen, the Model 292XAL can provide continuous coverage from 125 KC to 165

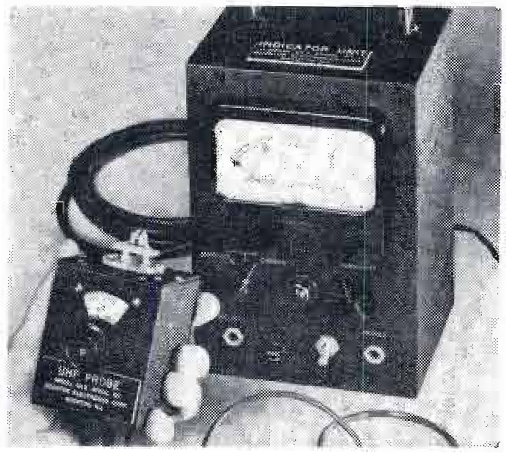


MC on fundamentals. Providing complete coverage of the aircraft band, including all necessary i-f frequencies, the unit also covers all the r-f frequencies with calibrated output. Further, it can be externally modulated from 15 to 10,000 cps, and measure both the input and the output of the unit under test. **The Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio**—TELE-TECH & ELECTRONIC INDUSTRIES.

MORE NEW PRODUCTS
for the electronic industries
on the following pages

UHF Grid Dip Meter

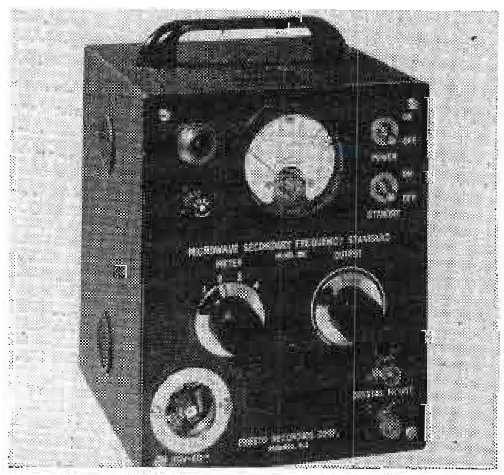
Model 101B UHF grid dip meter operates in the frequency range 300-3000 MC. The frequency is approximately lin-



ear from 300 to 425 MC, 425 to 650 MC, and 650 to 1000 MC. Easy coupling of to-be-measured circuits is accomplished by three plug-in coils externally mounted on the UHF probe. The dial is calibrated to a frequency accuracy of ± 2%. A three position switch on the power supply panel enables the instrument (power supply and UHF probe) to be utilized in the CW, modulated CW, as a detector, or a field strength meter.—**Boonton Electronics Corp., Boonton, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES

Microwave Standard

The modified model 100 Microwave Secondary Frequency Standard is half the size and weight of the original design. It provides a versatile and relatively inexpensive instrument to generate signals over the 200 to 11,000 MC range to an accuracy of ±0.005%. No tuning is required. This instrument, for laboratory or production use, delivers to the 50 ohm input of a typical microwave receiver an uninterrupted series of CW signals spaced every 100 and 200 MC over the complete frequency range. 50 MC markers are useful up to 9000 MC. Dimensions have been reduced

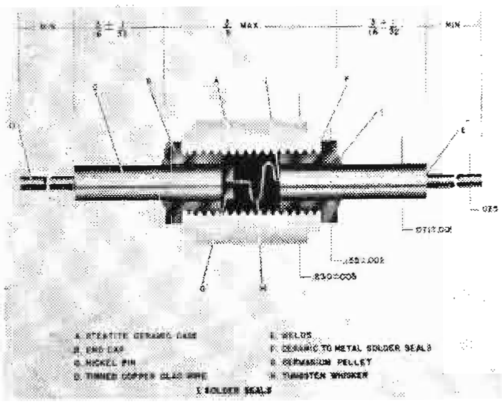


to 7⅜ in. H x 6 in. D x 6 in. L. Weight is only 8½ lbs.—**Specialty Products Div., Presto Recording Co., P. O. Box 500, Paramus, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES

New Technical Products By and

Vacuum-Tight Germanium Diode

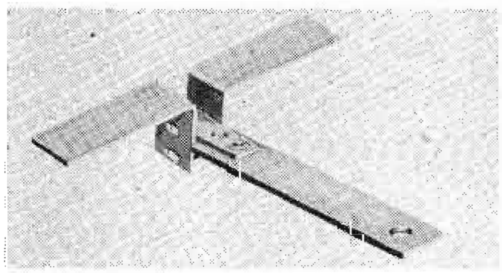
The design of the germanium diode shown consists essentially of small low-loss ceramic case into which two Monel



metal end-caps are threaded. Metallization of the case makes the diode vacuum tight. A specially treated germanium pellet and tungsten whisker are adjusted for optimum performance by force-fitted, knurled, nickel pins. Nickel terminal pins and flexible tin-leads enables the unit to be clipped into spring holders or directly soldered. **Bomac Laboratories, Inc., Semi-Conductor Dept., Salem Rd., Beverly, Mass.** —TELE-TECH & ELECTRONIC INDUSTRIES.

Correcting Magnet

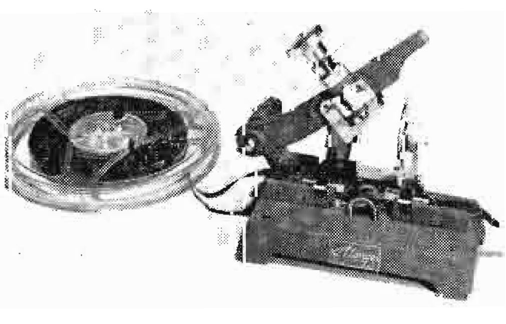
A new Alnico magnet is designed to correct permanently the pincushioning effect on 21 in., 24 in., and 27 in. TV



picture tubes. Any specified type of mounting bracket can be furnished.—**Heppner Mfg. Co., Round Lake, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Non-Magnetic Tape Splicer

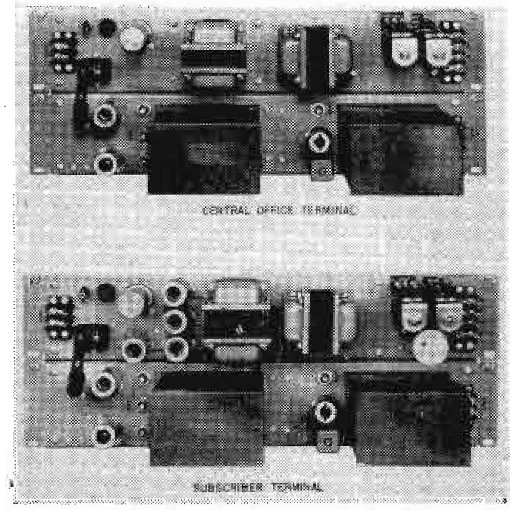
The non-magnetic splicer shown holds the recording tape in horizontal grooves. The cutting arm has three knives. When the arm descends and the plunger is pressed down, the pivotal center knife



cuts the tape at 90°, 67½°, or 45° responsively to its setting. Spring pads hold the recording tape securely in place as the side knives cut the splicing tape exactly to the width of the recording tape. When the strip is edited, and the splicing strip is placed over the splice juncture, the arm is again pressed down and the splice is completed. **Alonge Products, Inc., 163 West 23rd St., New York 11, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Carrier-Telephone Set

The carrier-telephone equipment, Type 16A, provides carrier voice channels for rural telephone subscriber-



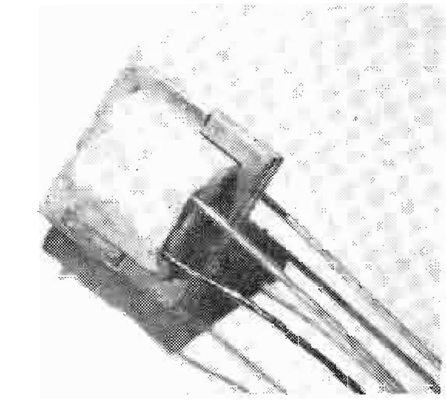
service, inter-office trunk circuits, industrial wire circuits, and multi-channel radio links. When used on open-wire or cable two-wire circuits, the equipment can provide up to three duplex channels in addition to the existing voice-frequency circuit servicing channel. When used on radio links, up to six voice channels are provided in addition to the normal voice-frequency circuit servicing channel. Each channel is self-contained and self-powered from 115 v. 50-60 cps ac and requires only a 7 in. relay rack space. Each carrier channel terminal consists of two 3½ in. rack panels. **Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.** TELE-TECH & ELECTRONIC INDUSTRIES.

Improved Tubing and Sleeving

A revised formulation of BH "649" provides braided Fiberglass tubing and sleeving for electrical insulation that will withstand continuous operating temperatures of 130°C. After 1,000 hrs. at this temperature the tubing shows slight stiffening, but no change thereafter and permanent flexibility within max. heat stability and resistance to flow is afforded. BH "649" comes in sizes to fit A.W.G. bare wire from #24 to 6/0. On special order it can be made to 2 in. in diam. **Bentley, Harris Mfg. Co., Conshohocken, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Transistor Circuit Transformers

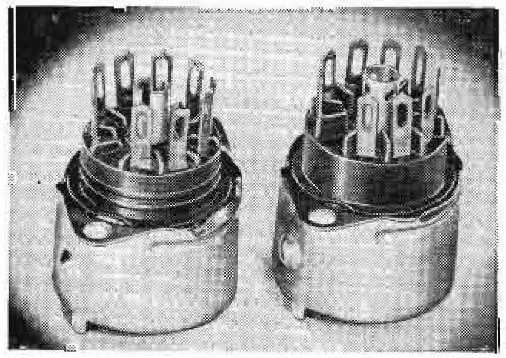
Specifications for "Tinyformers" for use with interstage No. M1 transistor circuits include match impedance 20,000



to 1,000 ohms; primary inductance 5.5 henries, with 0.5 ma dc at 1,000 cps; primary dc resistance, 1,150 ohms. Materials are: high-permeability, nickel-alloy core; Nylon bobbin; enamel-coated magnet wire; high-temperature flexible lead wire (125 C). According to the manufacturer, the moisture resistant units differ little in physical characteristics from large size transformers, though they measure only 11/32 x 3/8 x 3/8 in., and weigh only 0.005 lb. **Gramer Transformer Corp., 2734 N. Pulaski Rd., Chicago 39, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Socket Design Change

The new miniature tube socket, injection-molded by the Elco Corp., Philadelphia, Pa., increases the performance

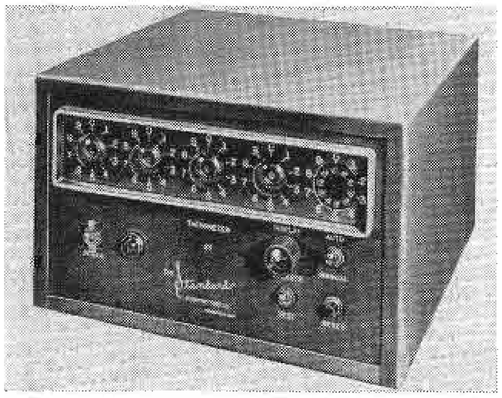


altitude "ceiling" 15% by extending the insulating barriers on the socket base and using "Kel-F" trifluorochloroethylene polymer as the socket insulation. Additional advantages stem from the zero water absorption and non-wettability of "Kel-F" polymer which precludes electrical leakage due to water contact and the formation of conductive fungus. Further, the non-inflammability and non-carbonizing characteristics of the insulation permit the socket to be used at temperatures up to 390° F. without loss of efficiency. Plasticizer-corrosion is eliminated, and the fluorocarbon plastic is inert to practically all acids, alkalis, and solvents, it is said. **Chemical Mfg. Div., The M. W. Kellogg Co., Jersey City, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

For the Electronic Industries

Electronic Tachometer

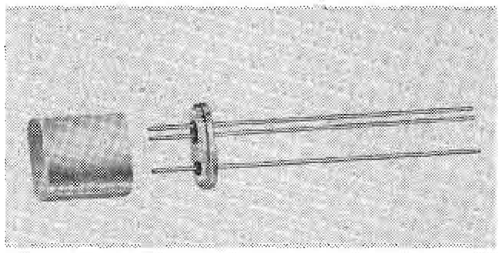
The new "Standard" electronic tachometer, designed for the measurement of speed, frequency, or events per unit



of time, incorporates an 11 plug-in subchassis, 22 vacuum tubes, and 7 plug-in cold cathode counter tubes. To give a clear, sharp readout, the unit employs a new cold cathode glow transfer tube. The instrument has a count accuracy of ± 1.0, a time base accuracy of 1 part per million. Its power requirement is 100 watts. Its size is 12 x 8 x 12 in.—**Standard Electric Time Co., Dept. 212, Springfield, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Transistor Mount

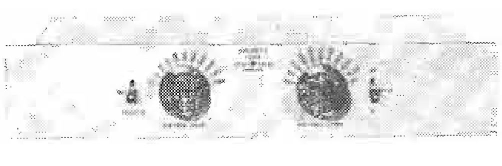
A glass-to-metal sealed base combined with a metal cover is a feature of a new transistor mount which facili-



tates the mounting of the germanium in a complete vacuum or inert gas atmosphere. Dimensionally, units are available as small as 0.250 in. long, 0.165 in. wide and 0.437 in. high. The base is constructed of glass-to-kovar metal with three 0.018 in. leads, sealed through. The cover, a metal can, is made of 10% nickel silver metal. All parts with the exception of the cover are hot tin dipped at 530° F., to facilitate soldering and eliminate production rejections. **L. L. Constantin & Co., Rt. 46 and Franklin Ave., Lodi, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Variable Filter

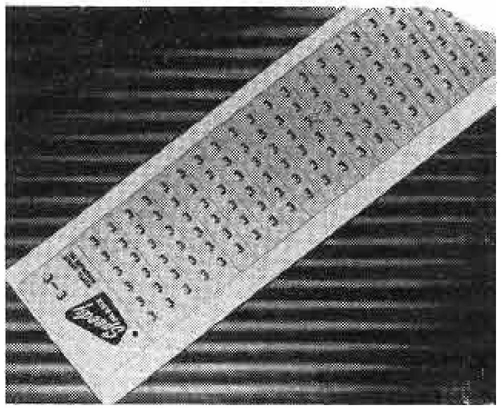
The Type 6517-E, "sound effects" frequency control. Input level is -70 variable high and low pass filter has ten positions each for high and low dbm min. and +28 dbm max. Insertion



loss, zero; power requirements, none. Two key switches enable the insertion of either filter section, or both on cue. Designed for sound and electronic research and recording, transmission, and reproduction control, the unit has a wide spectrum with over-lapping cut-off frequencies, and zero phase distortion over transmission range. All inductances are toroidally wound, and hum pickup is eliminated. **Cinema Engineering Co., Div. Aerovox Corp., Burbank, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Identification Markers

Speedy MARX are prepared on fine adhesive stock, which, with clear, easy-to-read type, makes identification-



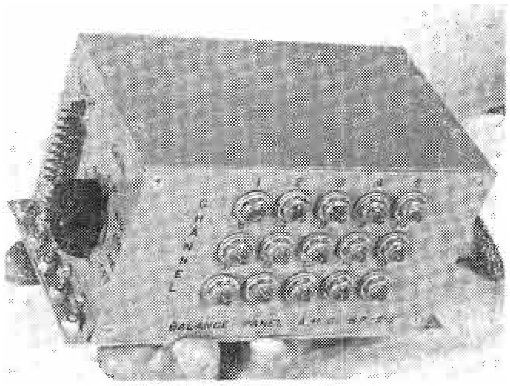
marking a simple operation on wire, cable, pipe, etc. Standard code cards are available in solid numbers and letters, in combinations and sequences. Electronic and electrical terms can be had in black and white, and ordered in standard NEMA colors. Available, too, are many new cards which carry the terminology of various industries, such as the marine and chemical fields. Coding calling for special sizes, colors, and designs can be made to specification. **North Shore Nameplate Co., Glenwood Landing, L. I., New York.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Pickup Indicator

The 12.5 MC carrier frequency of the Model ST-12 electronic pickup indicator makes it possible to measure acceleration, vibration, and displacement with the same instrument, yet enables uniform response to transients having much higher frequency components than have been measurable hithertofore. Long life subminiature tubes give greatly improved signal-to-noise ratio, stability, accuracy, and linearity with a minimum of sensitivity to mechanical shock and vibration. Requiring less than $\frac{1}{5}$ cu. ft., the single channel unit weighs only 13 lbs. Seven channels can be mounted in a standard 19-in. panel. Used with an RG-10 dc amplifier, the model ST-12 will drive any hf recording or indicating galvanometer.—**Rutishauser Corp., 490 S. Fair Oaks Ave., Pasadena, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Miniature Electrical Balance Panel

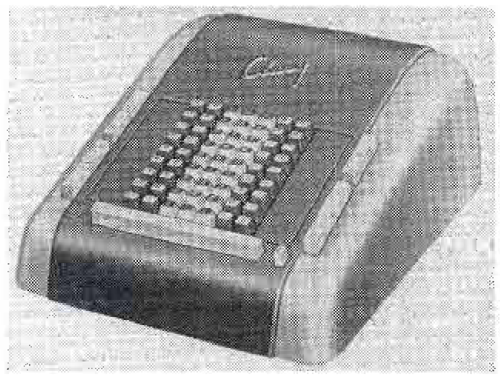
The Model BP-2, 15-channel balance panel is constructed entirely of miniaturized components. The panel meas-



ures $6\frac{1}{2}$ x $3\frac{1}{4}$ x $3\frac{3}{16}$ in. and weighs 1.5 lbs. The instrument is designed for use in flight test instruments and similar applications. Model BP-2 applications may include electrical balancing circuits involving strain gages, accelerometers, position pick-ups, or any sensing device that operates on electrical bridge circuits. The instrument incorporates miniature ten-turn balancing potentiometers with a linearity of ± 0.5%. **American Helicopter Co., Inc., 1800 Rosecrans Ave., Manhattan Beach Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Electrical Input Keyboard

Model No. 107 electrical keyboard can remotely enter numerical data and control signals into computers, plotters,

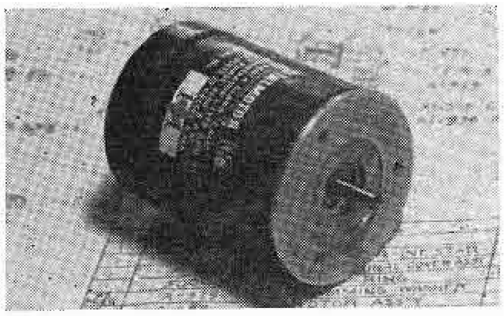


recorders, storage devices, and other data processing apparatus. Its input capacity is seven 1-9 digit columns. Keys latch when depressed, but a latched key will release when another key in the same column is depressed. Depression of any control key operates a normally open contact. The keyboard can be wired to provide zero pulse when no key is depressed, and a solenoid can be provided for automatic clearing from a feedback pulse, though a clear key provides manual release. Each input key operates a S.P.D.T. normally-closed switch. Each control key closes a S.P.S.T. switch. Contact rating is 1.5 amps at 115 v. ac with non-inductive load. The 14 x 11 x $6\frac{1}{2}$ in. plastic case is shock-proof. **Clary Multiplier Corp., San Gabriel, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Power Supplies

Indicating Generator

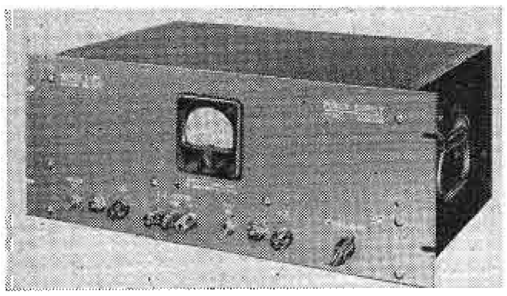
Model GPM-44 indicating generator is a two-phase, permanent-magnet field, pressurized unit with a leakage of less



than 0.7 cu. cm. per min. when mounted with an "O" ring seal under conditions required for military aircraft applications. The standard unit develops 27 v. and 4,000 rpm loaded with 10,000 ohms per phase with an average of 1.5% harmonic content.—**Dalmotor Co., 1375 Clay St., El Camino Real, Santa Clara, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

Regulated Power Supply

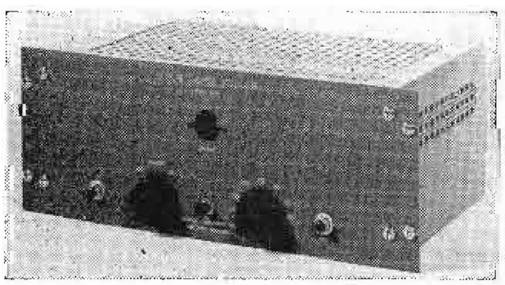
The model 150 voltage regulated power supply features one regulated dc output that is continuously variable



from 0—150 v. and delivers from 0—50 ma. In the range 20—150 v., output voltage variation is less than ½% line fluctuation and from 105—125 v. load variation is from minimum to maximum current. Below 20 v., output voltage variation for line and load is less than 0.1 v. Ripple voltage is less than 5 mv. Either positive or negative terminal of the supply can be grounded. Dimensions are 7 x 19 x 11 in. This unit is designed for relay rack mounting or bench use.—**Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

Chopper Stabilizer

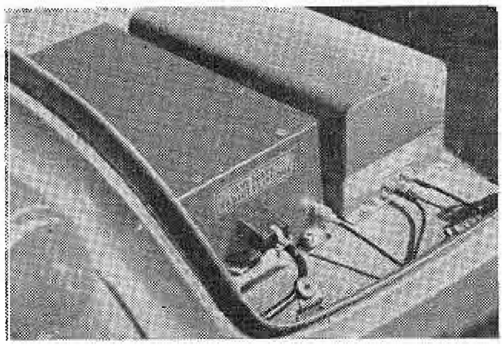
Model 122B chopper stabilizer designed for use with the Kay-Lab model 121 super-regulator restrains the output voltage of ordinary power supplies to standard cell stability. The circuit of



the unit compares a fraction of the output voltage with a standard cell, and a corrective generated ± 30 v, 5 ma, polarized signal is fed back to the power supply under regulation. The desired output voltage is calibrated by a precision attenuator to an absolute accuracy of 0.1%. Long time drift is maintained to an accuracy of 0.1%; short time drift to a few parts per million. The equipment finds application in the computing field, laboratories concerned with strain gage work, magneto-meters, and standards establishment.—**Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego 10, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

Power Booster

The new booster shown will increase the power output of any 10 w radiotelephone transmitter, regardless of its



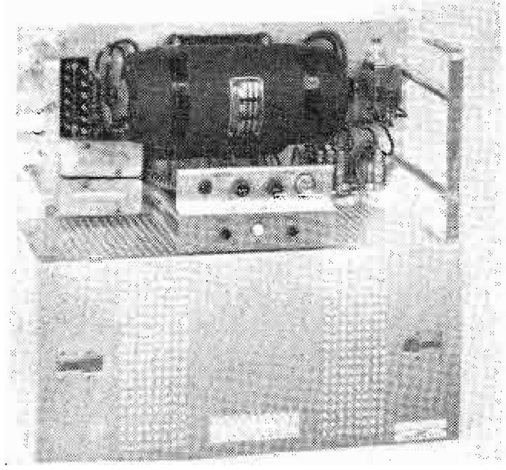
make, if it is operated in the 152—174 mc band. Moreover, it will considerably increase the effective range of the equipment because it uses maximum power only when it is needed, conforming to the engineering requirements of the FCC. Desired power is selected by a dashboard switch, but the unit is activated only when the mike button is pushed. A 25-50 mc band unit is expected to be available soon.—**Kaar Engineering Corp., Middlefield Rd., Palo Alto, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES

Voltage Regulator

The Model 116-A 400-cycle voltage regulator is announced for use as a precision regulator of voltage supplies used in the development of aircraft or other electronic equipment. RMS output voltage is adjustable, with regulation of 0.01% up to half the rated load (50 va) and to 0.02% up to the full rated load (100 va). Regulation is maintained with allowable input volt-fluctuations of ±10% about the adjusted output level, and frequency fluctuations of ±5%. Recovery time from transients is less than 0.01 secs. Developed harmonics are less than 1%. The instrument measures 17 x 9½ x 7 in. **Avion Instrument Corp., Div. of American Car & Fdry Co., 291-30 State Highway #17, Paramus, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Emergency AC Power Supplies

Types 5060A and 5070A emergency power supplies can provide up to 250 watts of 110 v. ac power from 24 or



48 v. storage batteries. Designed for use where ac operated equipment cannot be interrupted even for short intervals, the units are particularly suited for communication systems. The rated load capacity, it is said, is ample to assure uninterrupted operation of a three-channel carrier terminal, a carrier repeater, or a small radio station. Automatic transfer to the emergency source can be coupled within 0.5 second after failure of the normal power supply. The units are designed to be wall mounted or installed on a standard 19-in. relay rack. **Lenkurt Electric Co., 1105 County Rd., San Carlos, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Miniature HF Alternators

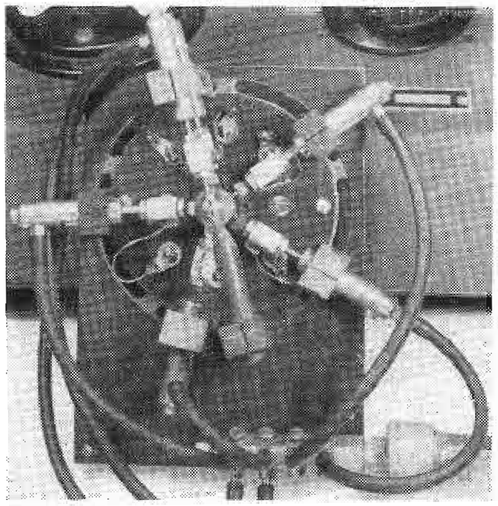
The 2½ in. diam. Model A-17 miniaturized hf alternator weighs only 22 oz.; nevertheless, it delivers 350 watts

output at 5,000 cps and a shaft speed of 25,000 rpm. The unit exmplifies the extremely high power outputs of a new line of small alternators which range from 125 to 4,000 watts at 5,000 cps with shaft speeds ranging from 10,000 to 50,000 rpm. **D & R, Ltd., 402 Gutierrez St., Santa Barbara, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Laboratory & Plant Equipment

Miniature Air Vises

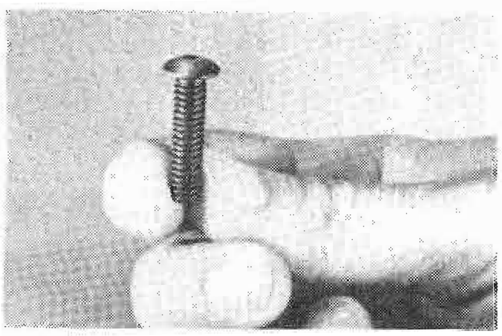
Model MAC 38, minature pneumatic cylinder, and Model MAN 12, miniature port air manifold have been especially



designed as plant production aids for such purposes as electrical contact activators in test jigs and fixtures, light work-holding set-ups, automatic production feeders, etc. They are reported to be ideal for holding delicate parts while soldering, welding, brazing or assembling. Cylinders will operate off foot bellows, an especially valuable feature for those plants not having compressed air piped around. Spring loading returns piston when air pressure is released. Air hose connections may be made at sides or ends of cylinders. Removable material holders add to equipment flexibility. **Clippard Instrument Lab., Inc., 7390 Colerain Ave., Cincinnati 24, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES

Button Head Cap Screw

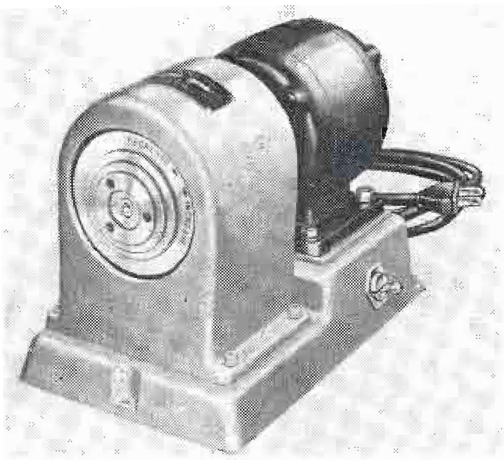
The new Allen button head cap screw has a rounded top and flush edges which prevent exposed sides, which produce a



more streamlined surface in applications that do not permit countersinking. Though the new screw is shallower than the standard Allen hex socket screw, it acquires needed strength by cold-working its body and cold-drawing its head which imparts strength to the special Allenoy steel by keeping the steel fibers continuous. Sizes of the new button head cap screw range from #8 x 1/4 in. through 5/8 in. x 2 in. standard with NC threads. Their sizes are also standard with NF threads with the exception of 1/2 in. and 5/8 in. diameter.—**The Allen Manufacturing Co., Hartford, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES

Rotary Wire Stripper

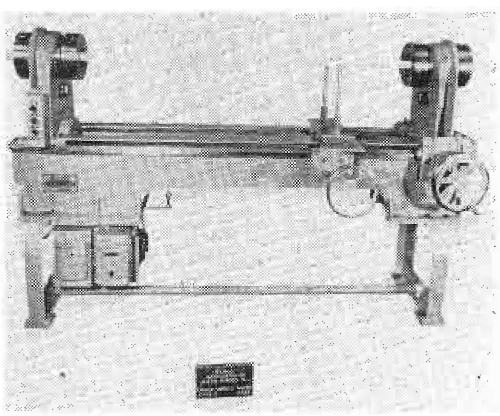
The single-bladed Model G-5 rotary wire stripper is adjustable to 0.001 in., and is designed to cut through and pull off insulation ranging from 0.028 in. through 0.255 in. without damage to the conductor. Stranded wires are twisted by the stripping operation. A wide range of keyed, adapter guide-bushings is available for selective application to the work. Included with the 6½ x 10¼ x 7¼ in. equipment is



a portable, bench-height stand. **Rush Wire Stripper Div., The Eraser Co., Inc., 1068 S. Clinton St., Syracuse 4, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

Glass Lathes

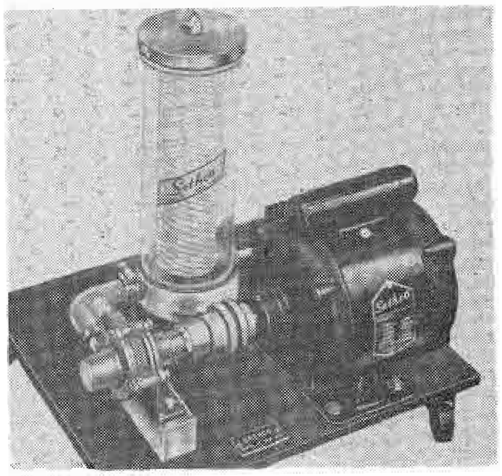
The Model 2253 lathe for glass development work employes anti-friction bearings throughout. The heads or stocks utilize oversize, double-row, pre-loaded, precision bearings. The fire carriage runs on roller bearings. The silent chain drive is equipped with tension regulation, and the drive shaft and all moving parts are shielded against heat, dirt, and broken glass. Head stock, tail stock, and drive are lubricated automatically. The main drive clutch is controlled by a readily accessible clutch lever, and the extra-



large, especially-offset hand-wheels have a high gear ratio to assure easy and sensitive traverse. **Kahle Engineering Co., North Bergen, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES

Self-Priming Filter Pumps

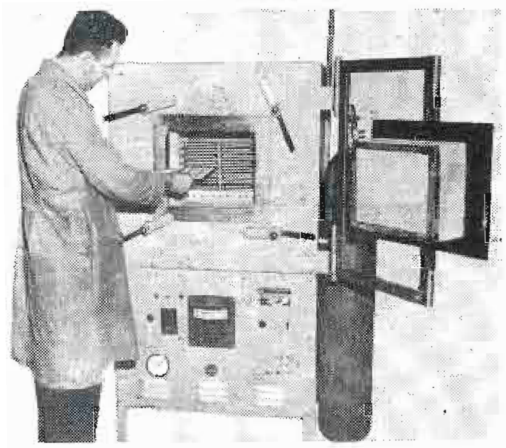
Models LSIN-5 and LSIN-10 pumps filter non-aqueous solutions and virtually any acid or alkaline solution;



and remove particles from 150 down to 1 micron. The filter assembly is fabricated from high-temperature Lucite, Haveg, stainless 316, or epoxy resin. It is also available rubber lined. The pumps have a self-priming suction lift of approx. 15 ft. and deliver 6 gal/min on open pumping and 40 psi before shut-off. The rated capacity of Model LSIN-5 is 50 gal/hr; Model LSIN-10, 100 gal/hr. The 110 v., 60 cps, single-phase, capacitor-start, ball-bearing motors are totally enclosed. **Sethco, 70-78 Willoughby St., Brooklyn 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES

High Temperature Vacuum Furnace

A new type high-temperature electric furnace, the "Airfre", has been placed on the market for production and



laboratory use in which temperatures up to 2,500 F. and up to 29 in. vacuums are required. The unit is built in a number of different sizes and is complete with vacuum pump, gauges, pressure-controller, variac, ammeter, and temperature-controller, and wired for ready operation. The photo shows the removal of a tray of mercury-vapor contact thermostats after submission to specified heat. **K. H. Huppert & Co., 6830-32 Cottage Grove Ave., Chicago 37, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES

WASHINGTON
News Letter

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

FCC MUST PRODUCE—Final FCC money bill for fiscal 1954—giving FCC $7,400,000 with established floors of $809,000 for safety and special radio services and $1,018,000 for television application processing—means that the Commission will have to slash backlogs for mobile radio and TV or face prospect of very unsympathetic Congress when appropriations time comes around again next year. FCC Chairman Rosel H. Hyde stated after passage of money bill that the primary objective of the safety and special bureau must be to eliminate the backlog of unprocessed applications and to bring the disposal of applications to a current basis of authorization. He pointed out also that the modernization of the rules and standards for the various mobile radio services, and the promulgation of rules and standards for the significant new services—microwave specifically—is a must. Microwave rules may take some time once FCC staff actually starts writing them, for policies must be coordinated between common carrier and safety-special bureaus.

INDUSTRY POISED FOR COLOR TV—With the full and vigorous support of the entire radio-television industry for the color television standards just submitted to the FCC by the National Television System Committee, the only thing holding up color TV after FCC endorsement of the standards appears to be the actual tooling of production lines to turn out the transmitters and receivers. TV broadcasters and set manufacturers have announced plans to have the color facilities available and on the air by dates ranging from mid-September through the end of 1954. Once industry swings into production, however, the later estimates are sure to be moved forward. Initial high costs of color TV receivers will prove to be a slowing factor in the spread of color video, but set manufacturers insist that prices will be within reach of mass market possibly within three years after start of production.

TELEPHONE SWITCHING—A new card translator and other automatic switching equipment placed in operation by the New Jersey Bell Telephone Co. in mid-August is cutting in half the time required to complete calls to and from the West Coast and intermediate points. Behind the card translator and related equipment—which selects automatically the most direct and fastest routes on long distance calls dialed direct by the telephone company operators—is a vast network of wire and switching equipment filling the top three stories of New Jersey Bell's dialing center in Newark. The system, which includes about 1000 steel frames, weighing from a half-ton to a full-ton each, 130,000 relay switches, 22,000 miles of wire and over 50,000,000 hand-soldered connections in the Newark building, together with interconnections with other long distance offices throughout the nation, was installed at a cost of about $15,000,000 and took four years to complete. New Jersey Bell explained that the card translator will look at long distance numbers that the operator or customer calls, determine where the call should go and steer it to its destination by the quickest route available. If one route is busy, it will select another route, having the ability to make decisions in a matter of seconds.

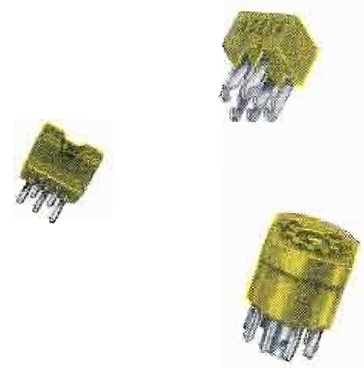
MARINE ELECTRONICS—Development of a standard electronic identification device to aid in the reduction of marine casualties and to facilitate safe movement of vessels in congested and restricted areas is under way by a study group of a dozen government and industry organizations coordinated by the Radio Technical Commission for Marine Services in Washington. Basic function of the marine identification device is to close a gap presently existing when marine radar and two-way voice radio communications are used jointly for navigational purposes. The problem is the ability to associate a particular voice communication with the proper radar echo when more than two vessels are within range of one another or when more than one vessel is within range of a shore-based radar unit. Organizations taking part in the study include the Coast Guard, the FCC, the Navy, Sperry Gyroscope Co., Raytheon Manufacturing Co., Radiomarine Corp. of America, Federal Telecommunication Laboratories, Westinghouse Electric Corp., Tropical Radio Telegraph Co., Esso Shipping, Jansky and Bailey, radio consultants for the Lake Carrier's Association, and the National Federation of American Shipping.

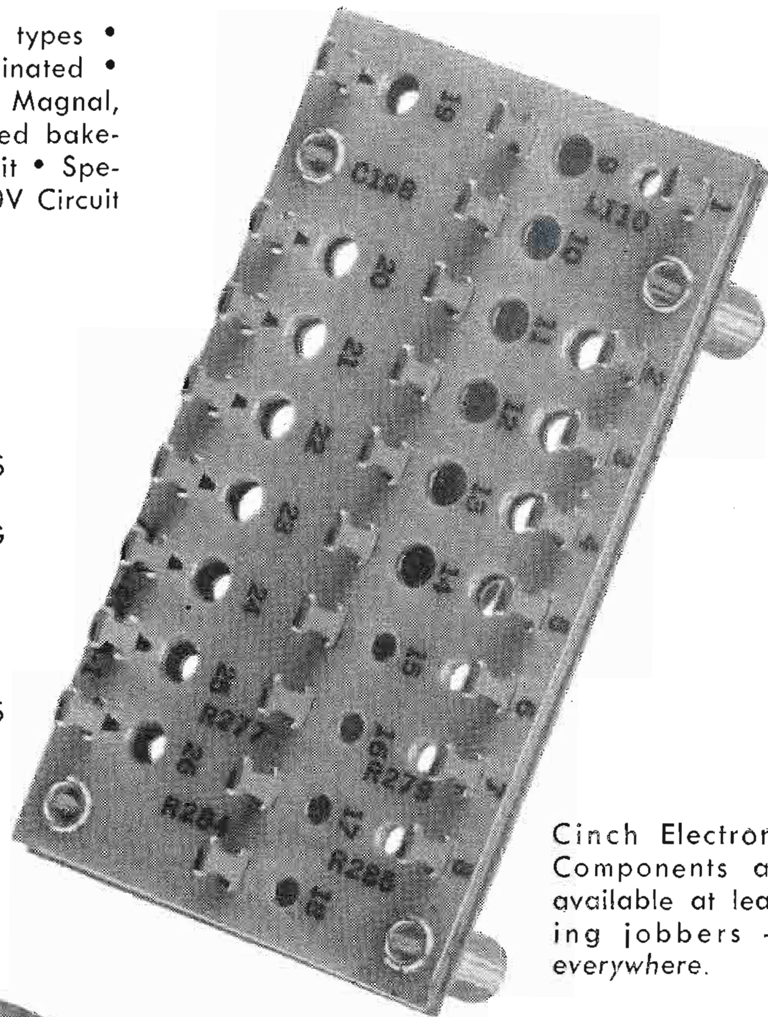
SPLIT-CHANNEL MOBILE RADIO—The 44-page report of the Joint Technical Advisory Committee on the feasibility of split-channel operation in the land mobile radio services prepared at the request of the FCC, has completed its preliminary rounds of the Commission's engineering staff and is in line for more thorough study in advance of FCC rule-making regarding narrow spacing of the land mobile frequency assignments. While strongly supporting the feasibility of split-channel operation, the JTAC report states, however, that the use of narrower channel equipments is not by itself sufficient to obtain an appreciable increase in the number of usable channels in areas requiring a large number of channels. Sharing of channel assignments on a geographical basis, and efficient use of assignments in the same area, it says, will gain more.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington, Editor

Cinch ELECTRONIC COMPONENTS





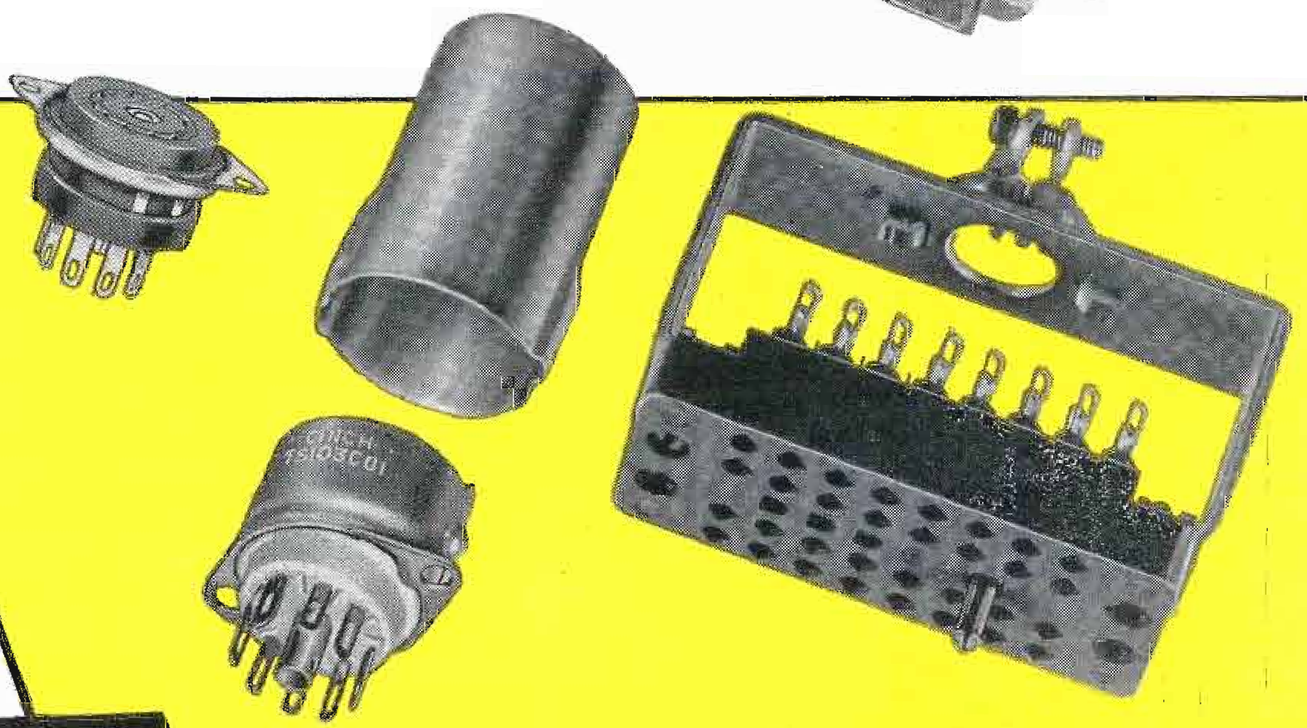
OCKETS: Tube (Receiver, Transmitter and Special): Battery, all types • :-R Tube • Crystal • Electrolytic • Glass Type; 4 to 7 prong laminated • ıfra-red Ray Tube • High Altitude Airborne Types • Kinescope; Magnal, uodecal, Diheptal • Loktal-Miniature-Multiplug-Noval-Octal (Molded bake-te, steatite, teflon, Kel-F and laminated) • Plexicon • Printed Circuit • Spe-'al Sockets to Specs • Sub-Miniature; Hearing Aid Types • TV; 110V Circuit ıreakaway • Vibrator • Pencil Tube Transistor • Diode

.NTENNA JACKS
ANANA PINS AND JACKS
ARRIER TERMINAL STRIPS
ANNING STRIPS
\TTERY PLUGS & SOCKETS
INDING POSTS
IODE SOCKET
ƆNNECTORS, MULTI CONTACT
JSE STRIPS, BLOCKS & BOARDS
ƎRID CAPS
ƎRID CAP SHIELDS
HERMETICALLY SEALED TUBE SOCKETS
METAL STAMPINGS
MICRO-CONNECTORS
MOUNTING DEVICES
PHONO TIP JACKS
PRINTED CIRCUIT, CONNECTORS
SHIELDS, TUBE-MINIATURE & NOVAL & BASES SOLDERING LUGS—200 VARIATIONS
STRAP NUTS
TRANSISTOR SOCKET
TUBE HOLDERS—SPRING TYPE
VIBRATOR PLUGS AND SOCKETS

TERMINAL ASSEMBLIES: Blocks, boards in laminated and molded, assembled with lugs, pins, screw terminals, contacts, clips, turret lugs and other hardware to specifications.

This list includes products of the Howard B. Jones Division

Cinch Electronic Components are available at leading jobbers — *everywhere.*



CONSULT CINCH

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

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

REMOTE CONTROL SYSTEMS

(*Continued from page 75*)

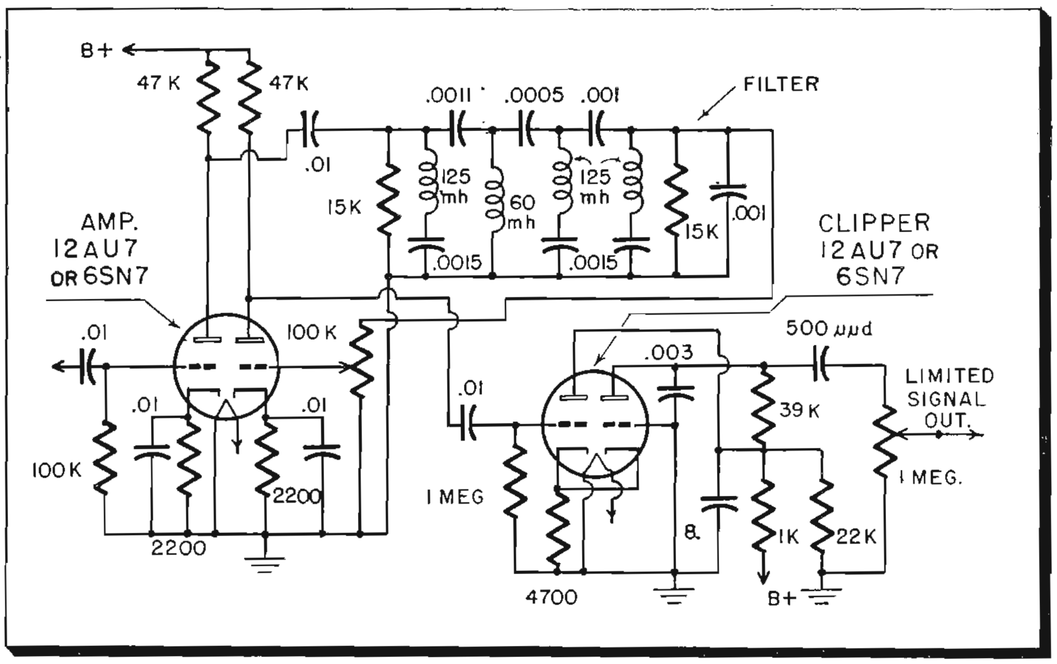


Fig. 11: High-pass filter and limiter keeps program audio from falsely operating controls

ing several receivers tuned to other stations in the Rural Radio Network, the station break at this station posed quite a problem of its own. When the time comes for the "break," a turntable is started at the controlling station, upon which is the recorded call sign for that station. Contacts on the turntable relay close a circuit which transmits a control signal to the controlled station. This initiates operation of a magnetic tape playback machine, utilizing an endless tape. Station identification announcements are recorded on the tape in ten second intervals. At the end of each of these intervals, a conductive paint coating on the back of the tape operates a relay which stops the machine. The tape is then in position for the next initiating pulse.

The controlled station is monitored at the control point "off-the-air," using a standard FM receiver. This audio is introduced into the station's monitoring amplifier and speaker system alternately with the program of the controlling station, through the use of an electronic "flip-flop" circuit giving about six samples of the program of each station per minute. To the operator, normal operation offers an undetectable switching so that the programs whose levels are adjusted to be exactly the same, sound like the same unbroken program. In case of failure of either transmitter, an annoying silence occurs six times per minute, immediately announcing a failure. Program deterioration is likewise noticeable.

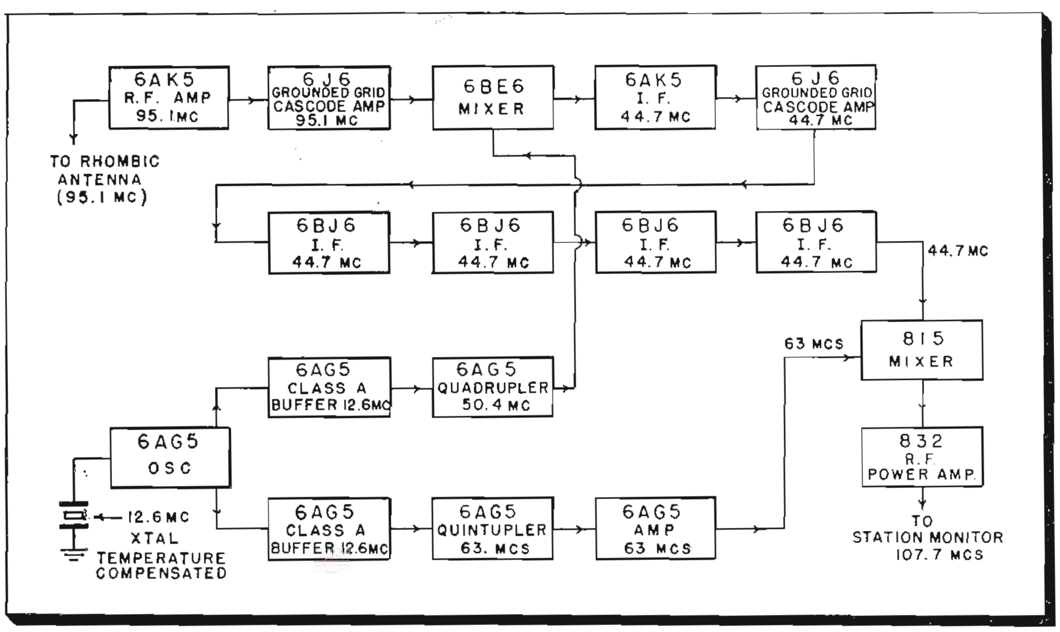
The frequency and modulation monitor problem varies from station to station as the distance of the control point from the transmitter varies. Naturally, a transmitter at a great distance creates the problem of getting sufficient r-f to drive the monitors. The problem at WVBT was unusually tough, and a clever array of equipment solved it for them very satisfactorily. A dual conversion cancellation oscillator circuit was used to convert the 95.1 MC WVBT frequency to 107.7 MC, for which resultant frequency a monitor, calibrated for it, was provided. This allowed ample means for amplifying the weak signals picked up on the antenna, a 5-¼ wave terminated rhombic, to the *watts* of r-f power needed to operate the monitor. The block diagram of the amplification and conversion system is shown in Fig. 12. Needless to say, all monitoring situations do not demand this complex a system, but it does demonstrate that with the ingenuity possessed by the American engineer, most of his problems can be resolved.

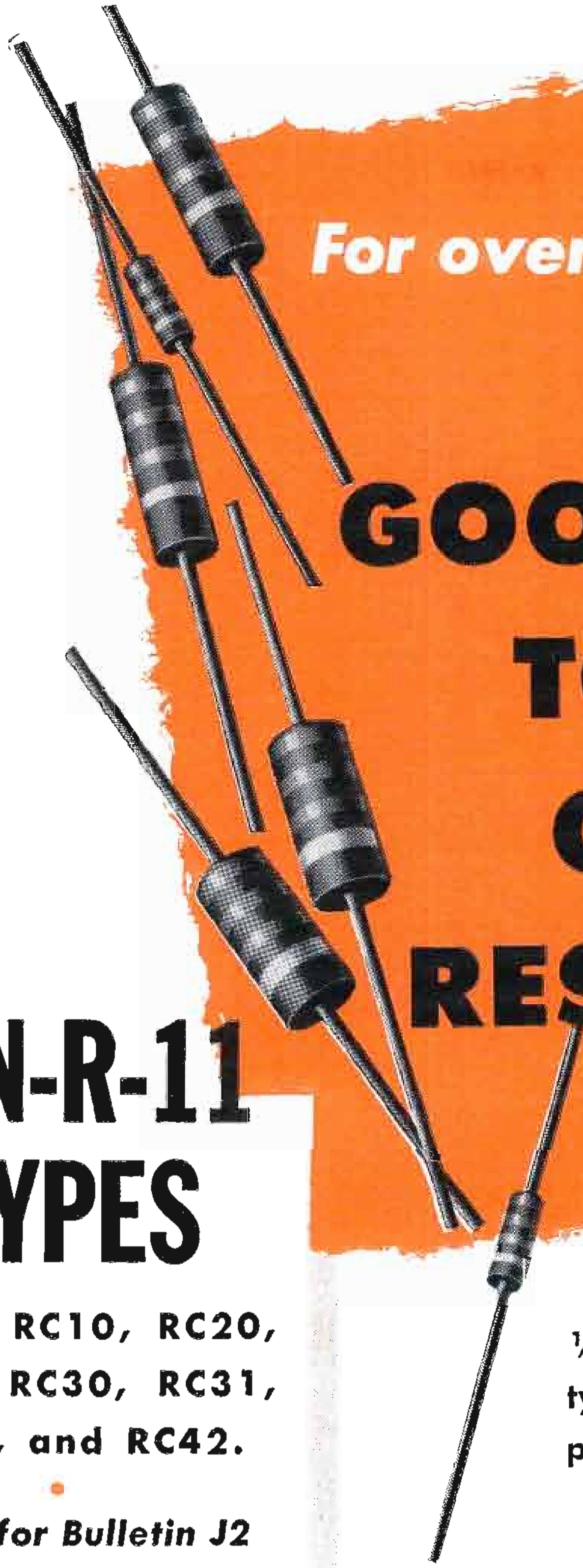
With the new remote control regulations now apparently fixed, it appears that more and more broadcast stations will take advantage of its economic and technical aspects. As mentioned previously, many stations report less equipment failures and time lost since the installation of remote control equipment than when a "green" or inexperienced operator was maintained at the equipment. A fair prediction would be that many new stations will construct their transmitters on the most advantageous spot from an engineering standpoint, and control them from studios strategically located in the center of the business district the station serves. The expense can thus be reduced in the cost of the transmitter building which need be only large enough to house the equipment but must, however be satisfactorily ventilated and made intrusion-proof.

In this respect, a simple intruder alarm system could be made from an inexpensive intercom, coupled into one of the telephone control pairs through isolating capacitors, and running continuously. The operator at the studio could then hear certain types of intruder or equipment troubles.

The author wishes to thank the following chief engineers for their full cooperation in the preparation of this article: Mr. Tom Humphrey, Rural Radio Network, Mr. G. Harold Brewer, Station WARK, Hagerstown, Md.; Mr. Jim Beaty, WRHI, Rock Hill, S.C.; and others, as well as the secretary of the FCC for furnishing the information on requirements and application forms.

Fig. 12: Diagram of converter and amplifier which permits modulation and frequency monitoring





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STACKPOLE

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Penna.

PULSE MAGNETRONS

(*Continued from page 62*)

(1) The input average power under 1.2 μs pulses is never to exceed 450 watts.

(2) The peak power may not be more than 450 kw or the duty cycle more than 0.002. The simultaneous application of two of the maxima, namely pi and Du would give an average input power of 900 w which, by observing Pi above, is seen to be forbidden.

(3) Likewise the peak anode current is limited to 30 a. This will not in general be compatible with the limit on peak input power of 450 kw. Thirty amperes may imply a higher pi, or 450 kw may simply a higher i_b. Or, if the test specification centers on the "absolute ratings" so that in the *average* tube 30 amps implies 450 kw, there will be a significant variation between tubes which fully comply with the test specification. Under these conditions, then, to comply with the intent of these ratings, the system must be so designed that neither limit is exceeded under any operating condition with any tube that conforms to the test specification including line voltage effects.

Difficult Pulse Widths

The "absolute ratings" of this pulsed magnetron, as in the case of many others includes two alternatives. These alternatives involve different pulse widths (but in others may include also different duty cycles, etc.). They represent maximum (or minimum) allowable values of the various parameters under the condition of pulse widths specified. For applications which are intermediate between such ratings, a linear interpolation will usually be satisfactory. As an example of interpolation from the "absolute ratings" again refer to the extracted JAN specification sheet. Here pi maximum is specified at 450 kw at 1.2 μs, then for operation at 3.1 μs, which is half way between the two pulse widths for which ratings are given, pi should be limited to 375 kw, half way between the values of 300 and 450. The desirability of such operation should be checked with the manufacturer through the appropriate channels or tested by actual operation in the system.

Absolute Ratings

Occasionally, as in this case, specific limits are set by notes under the "absolute ratings" as the case of Note (b) which states that "The tube shall not be operated longer than 6 μs, in any 100 μs interval," and is an absolute maximum rating.

There are certain precautions that must be observed in determining the conformance to absolute ratings. Among these are the following:

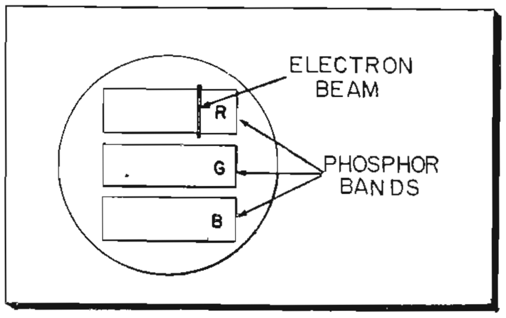
1. In pulsed tubes, there is usually specified a maximum current or voltage. These are to interpreted as instantaneous maxima. Under many conditions, an initial spike of some magnitude may occur. This can be quite destructive to the tube. While it is often not possible to eliminate this spike completely, it should be held to a minimum and should be regarded with much suspicion in cases of malfunction of a tube type.

2. Related to the above is the specification on rate of rise, or time of rise, of either voltage or current that is often included in the absolute ratings for a pulsed tube or under "pulsed service." Non-conformance to this specification is frequently a cause of trouble. Furthermore, the conformance or not of a system to this specification may vary with other factors. For example, it may happen that tubes from different manufacturers will show different interelectrode capacities. This may reflect back on system performance so as to appreciably modify the observed rate of rise. It is important, then, that this measurement be made on a typical selection of tubes under the conditions of operation at which the system will be employed.

Large-Screen Color TV System

A new large-screen color TV projection system, suitable for use in the theatre TV medium, comprises several novel features. It was invented by Solo S. Roth, and is covered by Patent No. 2,598,941.

As shown in the accompanying illustrations, the cathode-ray tube has three color phosphor bands (red, green and blue). Each band is several inches high, and runs horizontally across the screen. In operation, received signals cause the rectangularly shaped electron beam (vertical bar) from a Pierce cathode to sweep across the phosphor band. The beam covers the entire height of one band, and each sweep across the tube represents a single line scan. For the next repetition of this color line, the beam sweeps across the same band. Compared to a conventional tube, the result is that instead of a particular phosphor line (consisting of small spots) being scanned 30 times per second, a large phosphor area with considerable amount of light flux is scanned for the first raster line, and then scanned again 1/15,750 second later for the second raster line.

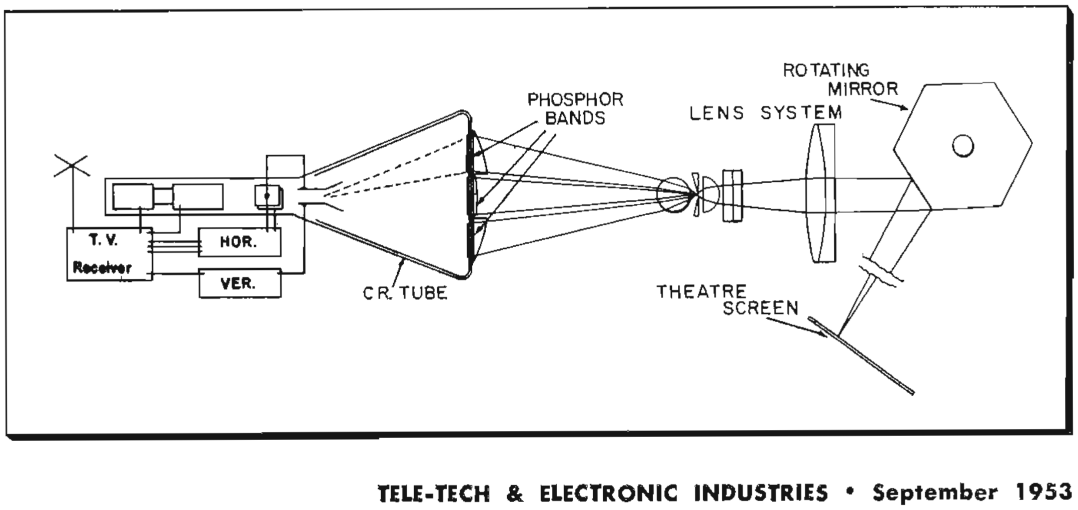


CRT has three wide color bands, each representing one scanning line. Vertical bar beam produces high-intensity light output

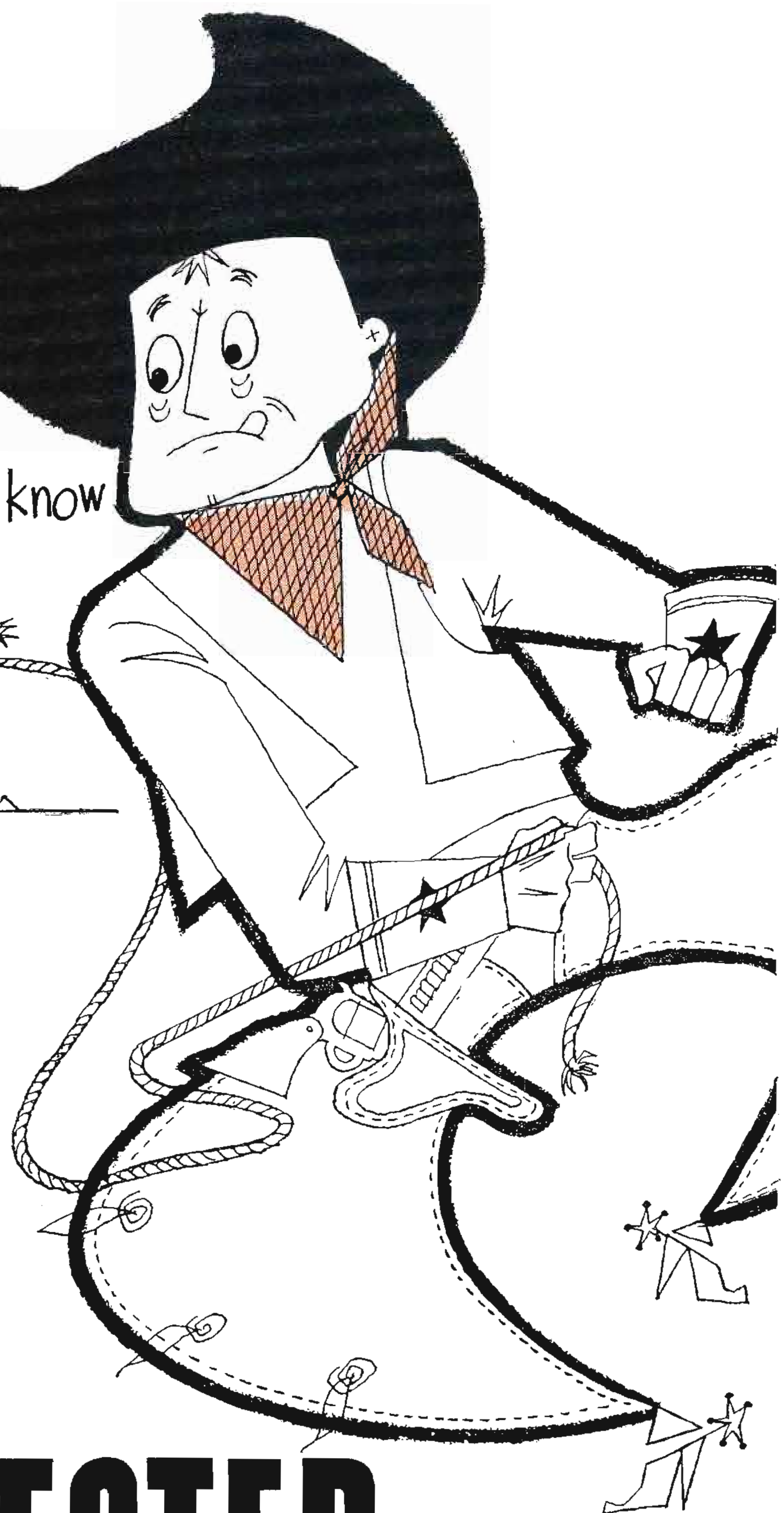
The three bands of light are then passed through a slit and lens system to a rotating mirror which is in sync with the vertical deflection. This mirror focuses the three colored light beams on the theatre screen, where they merge, and also places each line in its proper raster position. In essence, each picture element starts off as a large light area on the tube screen and is projected on the theatre screen as a small intense spot.

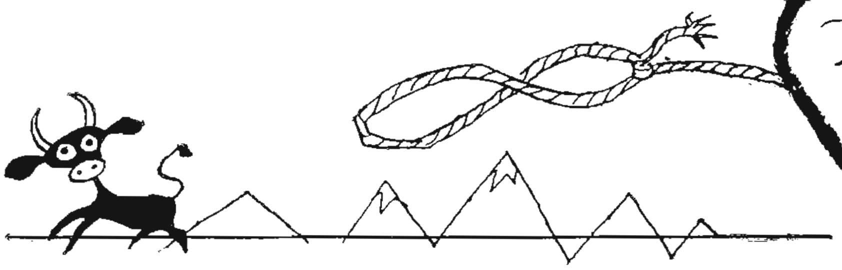
It is believed that the large phosphor area, though illuminated for a short time for a particular raster line, may produce more effective light than a conventional system. However, this is still open to investigation, as are other phosphor and lens considerations.

Light from three phosphor bands passes through slit and lens and is reflected to theatre screen by rotating mirror. Each picture element, illustrated for a short duration, starts as a large light area on the CRT and is projected as a small intense spot



let 'er go, skipalong,
stick with the "K" brand you know





"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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NTSC Color Standards

(Continued from page 63)

video range from the blanking level to the reference white level.

3. The overall attenuation versus frequency of the luminance signal shall not exceed the value specified by the FCC for black and white transmission.

D. Equation of Complete Color Signal

1. The color picture signal has the following composition:

$$E_m = E_Y' + E_Q' \sin(\omega t + 33°) + E_I' \cos(\omega t + 33°)$$

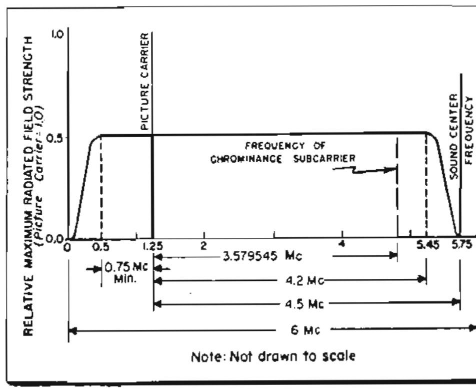
where

$$E_Q' = 0.41\,(E_B' - E_Y') + 0.48\,(E_R' - E_Y')$$

$$E_I' = -0.27\,(E_B' - E_Y') + 0.74\,(E_R' - E_Y')$$

$$E_Y' = 0.30\,E_R' + 0.59\,E_G' + 0.11\,E_B'$$

The phase reference in the above equation is the phase of the (color burst + 180°). The burst corresponds to amplitude modulation of a continuous sine wave.



Idealized amplitude characteristic of picture transmission spectrum of NTSC color signal

Notes: For color-difference frequencies below 500 KC, the signal can be represented by

$$E_m = E_Y' + \left\{\frac{1}{1.14}\left[\frac{1}{1.78}(E_B' - E_Y')\sin\omega t + (E_R' - E_Y')\cos\omega t\right]\right\}$$

In these expressions the symbols have the following significance:

E_m is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E_Y' is the gamma-corrected voltage of the monochrome (black-and-white) portion of the color picture signal, corresponding to the given picture element.

E_R', E_G', and E_B' are the gamma-corrected voltages corresponding to red, green, and blue signals during the scanning of the given picture element.

The gamma corrected voltages E_G', E_R', and E_B' are suitable for a color

(Continued on page 104)

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picture tube having rpimary colors with the following chromaticities in the CIE system of specification:

	x	y
Red (R)	0.67	0.33
Green (G)	0.21	0.71
Blue (B)	0.14	0.08

and having a transfer gradient (gamma exponent) of 2.2 associated with each primary color. This does not imply that the voltages E_G', E_R', and E_B' are necessarily of the form of $E_G^{1/\gamma}$, $E_R^{1/\gamma}$, and $E_B^{1/\gamma}$.

E_Q' and E_I' are two orthogonal components of the chrominance signal corresponding respectively to narrow-band and wide-band axes, as specified in paragraph D.5.

The angular frequency ω is 2π times the frequency of the chrominance subcarrier.

The portion of each expression between brackets represents the chrominance subcarrier signal which carries the chrominance information.

2. The chrominance subcarrier is so proportioned that it vanishes for the chromaticity $x = 0.310$, $y = 0.316$.

3. E_Y', E_Q', E_I' and the components of these signals shall match each other in time to 0.05 μsecs.

4. A sine wave of 3.58 MC introduced at those terminals of the transmitter which are normally fed the color picture signal shall produce a radiated signal having an amplitude, (as measured with a diode on the R.F. transmission line supplying power to the antenna) which is down (6 ± 2) db with respect to a radiated signal produced by a sine wave of 200 KC. In addition, the amplitude of radiated signal shall not vary by more than ± 2 db between the modulating frequencies of 2.1 and 4.2 MC.

5. The bandwidths assigned prior to modulation to the color-difference signals E_Q' and E_I' are:

Q-channel bandwidth
at 400 KC less than 2 db down
at 500 KC less than 6 db down
at 600 KC at least 6 db down
I-channel bandwidth
at 1.3 MC less than 2 db down
at 3.6 MC at least 20 db down

6. The angles of the subcarrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75% of full amplitude, shall be within ±10° and their amplitudes shall be within ±20% of the values specified above. The ratios of the measured amplitudes of the subcarrier to the luminance signal for the same saturated primaries and their complements shall fall between the limits of 0.8 and 1.2 of the values specified for their ratios.

See also pages 11 and 17 this issue for late news on color-TV.

these pushbuttons are fast on cues . . .

They're the controls on the *new* AMPEX 350 Tape Recorder

Their quick, positive action will give station operators a new "sureness" with tape. Cueing is exact; editing is faster; fumbling is out. Remote control is available too. Responsiveness has always been a part of the *Ampex Standard of Excellence* — but now it is better than ever, making the AMPEX 350 truly the NEWEST OF THE BEST.

• STARTING WITH A SPLIT SYLLABLE

From pressing of the start button to stable tape motion takes 1/10th second. Tape can be backed off from starting cues as little as one to two inches. Precise starts become routine. Reliability is supreme.

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Even at 15 inches per second, the tape stops within less than two inches after the button is pressed. Band type brakes give positive stops; no drift or tape spillage can occur.

• EASIER CUEING AND EDITING

The Model 350 can be shuttled rapidly between fast forward and rewind without stopping. Cues for starting, editing or dubbing are speedily located. And for convenient editing, the capstan drives on the "pull side" of the heads.

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A new switch selects proper tape tension either for 10½-inch NARTB reels or for 5 or 7-inch plastic RMA reels. Proper tension means longer tape life, more accurate timing and truer performance.

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CUES for BROADCASTERS

(Continued from page 87)

vidual unit. A small pilot light was installed in each chassis so that the maintenance engineer could immediately spot the defective piece of equipment.

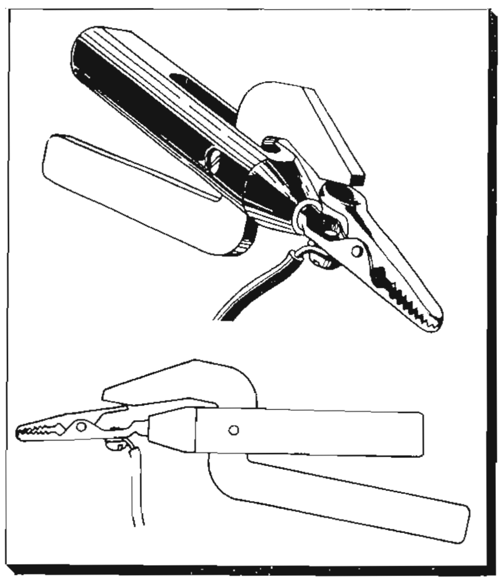
A breakdown of outages during the over two years of operation by remote control shows better than 96% for staying on the air during the scheduled time, even though the schedule has been greatly expanded since remote control operation was started. Of the outage time, over 50% was due to power failures, about 40% due to breakdowns in the commercial transmitter and link, and less than 10% due to breakdowns in our home made remote control equipment.

Extension Handle for Alligator Clip

A. C. HUDSON, Radio & Electrical Eng'g. Div., National Research Council, Ottawa, Canada

A DEVICE which has been found convenient in the studio is shown in the diagram. A standard alligator clip is forced into a 0.204 in. hole in a handle made of 5/8 in. bakelite. The handle is 3¼ in. long. An operating arm, also of bakelite, is fitted as shown in the diagram.

This device has been found useful for multimeter leads, scope leads,



Insulating handle for "hot" alligator clips made from 5/8 inch bakelite.

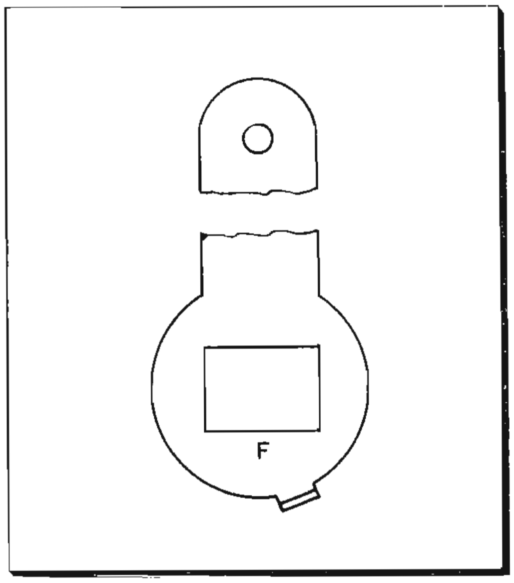
clip leads, etc., because it permits working on a "hot" chassis with little danger of touching live terminals.

It is not desirable to bring the lead out through the handle, and the device should be made as light as possible. The figure does not represent the ultimate in light-weight construction, but rather the first form in which the gadget was built in our laboratories.

Rewind Slippage Cure

HAROLD SCHAAF, Chief Engineer, WRFD, Worthington, Ohio

TO keep the rewind assembly on an Eicor model 15 tape recorder adjusted properly, the following modification was made. The recording transport was removed and in-



Curing rewind slip on Eicor: enlarge idler wheel lever hole as shown at (F) file until desired thrust is obtained

spection revealed the rewind depended upon an idler wheel running between the rewind drum and the motor shaft. The pressure between the idler and the motor shaft was so light at times that the motor shaft would not drive the idler.

Repositioning of the motor did not help. Further inspection revealed the thrust of the idler wheel toward the motor shaft is controlled by an oblong hole in the idler lever assembly, and a stop pin. Filing the hole about 1/64 in. as shown in the diagram, allows more thrust on the idler wheel resulting in reliable rewind drive.

Simple Tone Generator

ED MARZOA, WJWL, Georgetown, Del.

WHEN setting up a remote, a simple method of providing tone for a line check can be obtained by draping the earphones over a microphone to cause feedback as the gain of the unit is advanced. This has proved quite satisfactory when talk-back circuits are not available and for setting up remote equipment in a very quiet room, or empty auditorium and a phone call is made to the studio for a line check.

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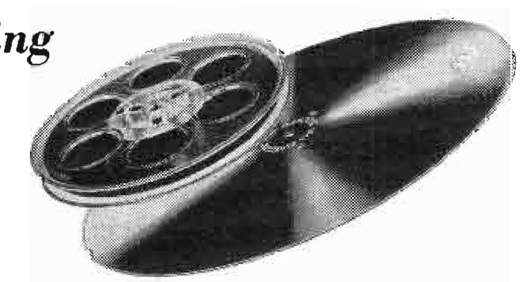

NO ONE listens to recorded sound with a more critical ear than the professional recordists who make America's finest phonograph records. Here there can be no compromise with quality.

That's why it's significant that so many of them repeatedly specify Audiotape and Audiodiscs to meet their most exacting requirements. For example, it was found that 29 of the 30 best selling records of 1952 were made from Audiodisc masters. And over 43% were first recorded on Audiotape before being transferred to the master discs.

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Beam Switching Tubes

(*Continued from page 90*)

two or more positions. If it is a dc field, a free-running movement of the beam will result. Each of these phenomena can be applied to useful purposes.

Beam Switching, High Speed Bi-directional: A method of high speed count reversal without the loss of a single count, for adder-subtracter applications, is made possible by paralleling two tubes with inverse magnetic polarity. The direction of count through a common load network is determined by allowing one tube to function, while the other tube is in cutoff position. Reversing the status of the two tubes, controllable by a high frequency flip-flop, is all that is necessary to reverse the direction of count.

Selector Tube High Speed Random Position Control: The Burroughs Selector Tube Type Sel-10 characteristics are especially suited for applications as a high speed control device for magnetron switching tubes. This electro-static beam deflection type is described in more detail in separate section. As applied, it is only necessary for the Selector Tube output to start the formation of the proper "crossed" electric field through the common load impedance, (each of the Selector Tube's ten output targets tied to a respective spade) as shown in Fig. 8. The bistable characteristics of the spade complete the operation of beam formation and locking in, resulting in a most reliable form of position selection and memory device.

The individual Selector Tube output target receiving beam current is determined by the deflection plate input voltage. When used as a control device for magnetron switching types, the output position of the latter is also a function of the Selector Tube deflection plate voltage. Many novel analog to digital devices and applications of this feature appear to be practicable.

Total Count Variations: The present tube design calls for a total count of ten. By making spades common, and with minor changes in circuit and operational parameters each tube can be made to count any arbitrary total number below ten. Thus, the tube can be applied as a flip-flop, or as a ring counter with from three to ten counts.

Modulation: It has been determined that the beam can be modulated, in the order of 25%, without, appreciably affecting tube operation.

(*Continued on page 110*)

Seal shown actual size

Look again!

See an individual sub-miniature hermetic seal with a barrel diameter of .100. We make others as small as .090. For the tiniest mounts in the world.

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Seal illustrated is No. 1625-2; also available in .100 is No. 1625-1; and SK-2170-2 with barrel diameter of .090. New multi-header sub-miniatures may be had with a variety of terminations.

Write for information concerning your own problems and for a copy of our 32-page catalog.

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FIRST AND FOREMOST IN MINIATURIZATION

This modulation can be applied at the cathode, to individual spades, or to a common spade input. Thus, the tube has useful potentialities as a communications switching device. By proper variations of input and output circuitry, a single input communications channel can be switched to any of ten output channels or any of ten input channels to one output. Through use of cascaded stages the extension to more complex systems appears practicable. Precautions are necessary to limit the modulation below the critical amplitude level causing instability or oscillation. The use of Multi-output Tube, Type TR-SR-11, with its flexibility as to output impedance and its freedom from crosstalk, is especially suited for this purpose.

Self Oscillation: By reducing the anode potential to that of the cathode, the tube will oscillate with a free-running movement of the beam to successive spade positions. The direction is determined by the magnetic polarity and the frequency is controlled by the space RC constants and tube operational characteristics. In this manner, output frequencies ranging from 10 KC to 10 MC were obtained. Various alternative methods of obtaining this operation are possible.

Multi-Output Tube Type TR-SR-11 (with Vacuum Mounted Resistors): Burroughs Type TR-SR-11 is a small co-axial tube using crossed electric and magnetic fields, with ten stable beam positions, ten individual target outputs, and provisions for presetting to "zero".

MECHANICAL

Overall length	2-3/4 in.
Bulb diameter	1-1/8 in.

Stem—20-pin button
Permanent magnet—Alnico VI, 350 gauss axially magnetized, i.d. 1-3/8 in., O.d. 1-19/32 in., length 1-3/4 in., weight 6 ozs.

ELECTRICAL

Heater Voltage	6.3 ± 10%	ac or dc
Heater Current	0.3	Amps.
Cathode Current	10	ma
Spade		
Voltage	100	v.
Current	1.5	ma
Typical Impedance	150	K ohms
	2	μμf
Anode		
Voltage	100	v.
Current	5	ma
Targets		
Voltage	150	v.
Current per Output	3.5	ma

Fig. 9 indicates the extreme simplicity of a decade counter circuit using tube Type TR-DC-11 with vacuum mounted resistors. Operational characteristics are similar to those tabulated for the Multi-output tube. The maximum pulse count rate is above 2 MC. Typical tube pulse input requirements are 100 volt amplitude and 0.3 μsec pulse width.

A standard Burroughs Pulse Generator Unit supplying pulses of less than ten volts amplitude to an amplifying triode directly in series with the magnetron switching tube has demonstrated accurate pulse count-

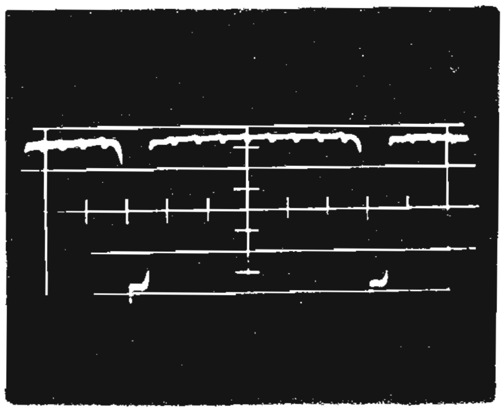


Fig. 10: Output wave of 500 KC across 6 K ohms

ing from single pulse inputs to the highest frequency without adjustment.

Fig. 10 shows a typical output waveform at 500 KC operation across a 6 K ohms load resistor.

The Selector Tube, Sel-10, consists of a highly efficient ribbon-beam forming electrode structure, two deflection plate inputs, and ten individual outputs (Fig. 11). The target receiving current is determined by the deflection input voltage. A typical deflection plate characteristic is shown in Fig. 12.

The compact gun design has demonstrated beam current efficiencies

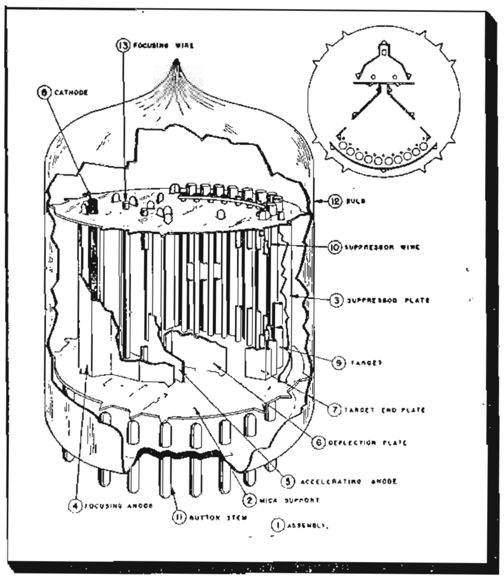


Fig. 11: Structural details of selector tube

of over 90%, and definitions in the order of several tenths of a millimeter. The rectangular cathode is coated on only the one narrow edge for proper ribbon-beam formation. The suppressor and multi-output structure has been resolved towards

(*Continued on page* 112)

simplicity, while maintaining objectives of low crosstalk. Two end plates have been added which serve as field equalizers, and may be used as additional outputs. Primary current operation has been preferred for purposes of reliability.

Many of the features described for the magnetron switching types are applicable to the Selector Tube, even though its function and principles of operation are different. In particular, these are the references to size, voltages, currents, adaptation to mass production, and maintenance of accurate specifications.

MECHANICAL

Overall length	2-3/4 in.
Bulb diameter	1-1/2 in.
Stem—20-pin button	

ELECTRICAL

Heater Voltage	6.3 ± 10% ac or dc
Heater Current	0.3 Amps.
Acceleration anode	250 v.
Focus anode, operating voltage	0 v.
cutoff voltage	−15 v.
Deflection plate quiescent voltage	200 v.
Deflection factor (Note 1)	12.0 v.
Individual output targets voltage	250 v.
minimum current	1.0 ma
Maximum crosstalk—target outputs	10%
Beam definition	0.030 in.

Note 1. The deflection factor is the deflection voltage required to displace the focused beam from the center of one target to the center of the next target.

Tube Construction

In general, fabrication techniques common to the vacuum tube industry will suffice for these types.

One variation should be particularly noted: all metal parts are made of non-magnetic materials,

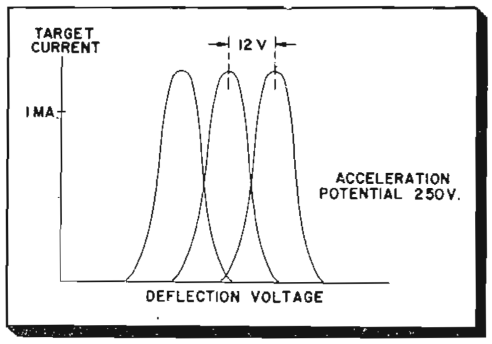


Fig. 12: Selector deflection characteristic

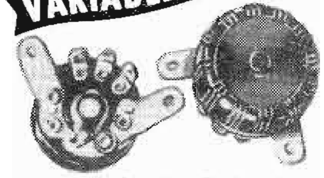
with the common exception of cathodes and stems.

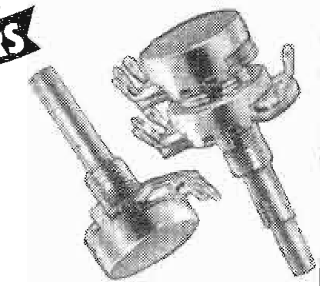
Both reverse coiled and folded heaters have been used in these tubes. No appreciable differences were noted in present applications for either dc or ac power sources.

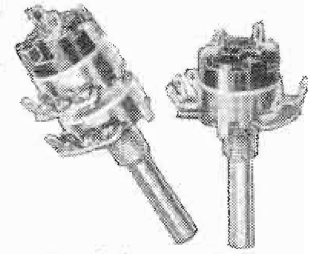
The use of multi-lead button stems where versatility demands, adds a valuable feature of utility,

(*Continued on page* 114)

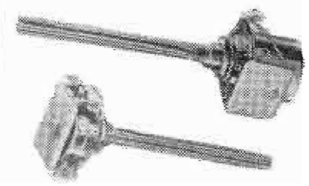
1 VARIABLE RESISTORS


Model 1 Radiohm® Miniature

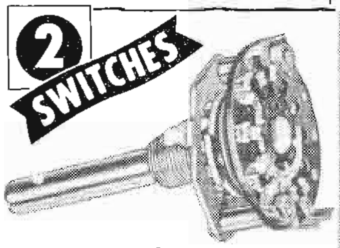

Model 2 Radiohm

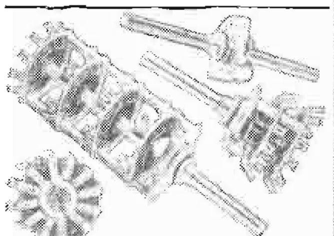

Model 2 Radiohm (including JAN types)

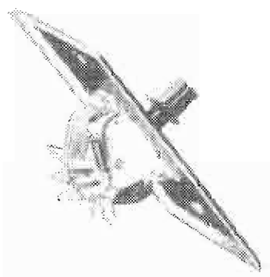

Model 2 EXPRESS (†) for immediate production needs


Compentrol (†) Infinitely variable loudness control

2 SWITCHES


Series 20 Miniature Phenolic or Steatite Insulation


Standard Size Phenolic or Steatite Insulation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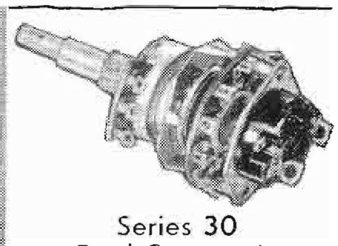
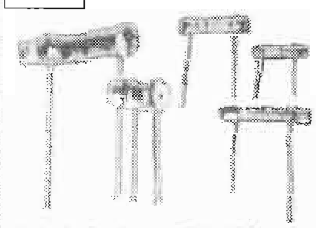
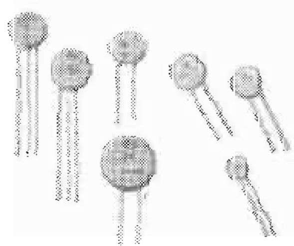
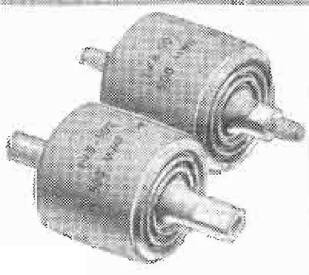

Series 30 Dual Concentric Switches and/or Controls Combinations


Tone Switch

3 CAPACITORS


BC Tubular TC Tubular


BC Discs TC Discs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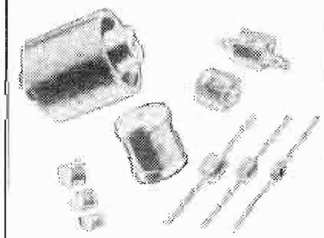
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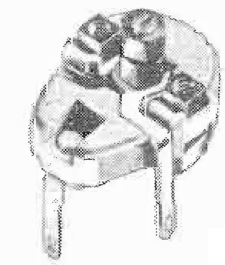
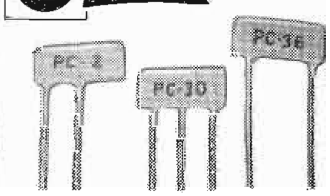
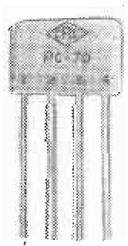

Ceramic Trimmers

4 P.E.C.


Miniature Resistor and Resistor-Capacitor Units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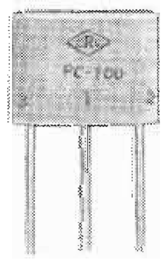
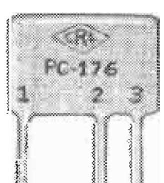
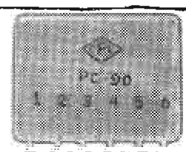
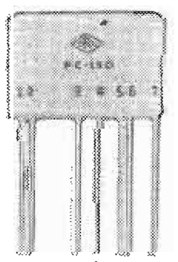
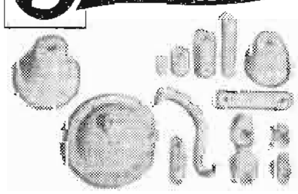

Vertical Integrator

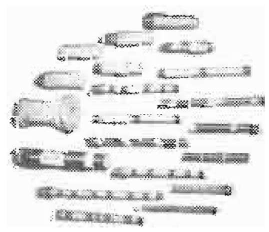

Special Plates to suit manufacturer's requirements




Audet® Audio-detector plate

5 CERAMICS


Custom Ceramics (Steatite, Centradite, Zirconite.)


Metalized Ceramics

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Name.......................................Title..............................

Company..

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City.............................Zone..........State........................

and reduces overall tube dimensions.

Application of these tubes to the following devices has already been demonstrated.

1. Megacycle Counter, binary and decimal outputs
2. A Coding System for Pulse Code Modulation
3. Statistical Tabulator

Potential applications are seen in the following devices.

1. Business machines
2. Desk-type computers
3. Arithmetic units
4. Multiple channel communications switching
5. Industrial control
6. Analog to digital converter—100 levels
7. Loran

A new family of beam switching tubes has been introduced which appears to be exceptionally suited to perform many of the complex functions of computers, electronic instrumentation and communications. Four Burroughs magnetron and electrostatic beam switching tube types are tabulated for reference:

Magnetron Switching Tubes

Coding Tube
Multi-output Tube
Decade Counter Tube

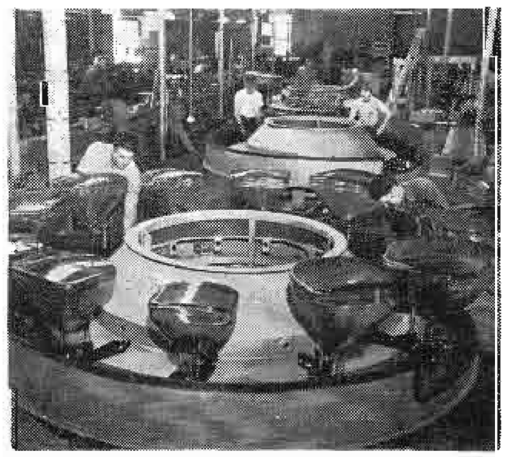
Electrostatic Beam Deflection Tube

Selector Tube

These tubes are especially adaptable to mass production techniques in reliable, ruggedized forms. Low cost availability of this versatile family would encourage their preference and use in many systems and devices.

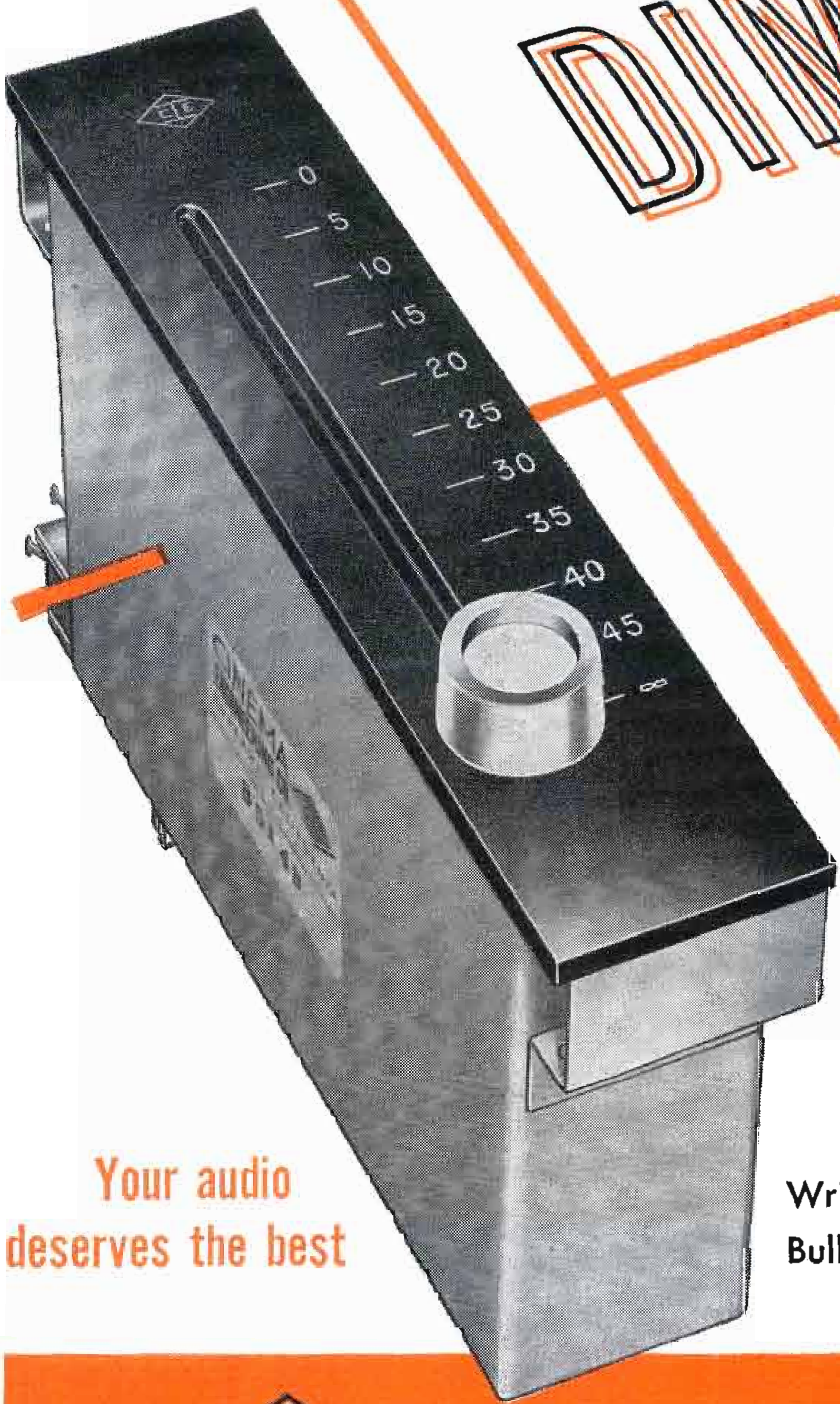
This paper was presented at the 1953 IRE Convention in New York on March 25.

ENTWISTLE BULB WASHER



An electronically controlled machine for washing TV picture bulbs is the first item in a new line made by the James L. Entwistle Co., 1475 Elmwood Ave., Providence, R. I. Rotary washer has 12 position, including 10 automatically sequenced acid and wash operations

MIXING IN A NEW DIMENSION?



1D...2D...or 3D...
whichever is your choice...
Cinema's straight-line mixer controls
will always do a fine and distinctive job.

Now is the time to change over to natural-convenient mixing and dubbing ... eliminate knob twisting. Use Cinema's new 8514-B straight-line for the smooth continuous attenuation that only this new control can give you.

Your audio
deserves the best

Write today for
Bulletin C-1025

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DIVISION AEROVOX CORPORATION

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In New England & Upper N. Y., *Samuel C. Hooker Co.*
Metropolitan N. Y., *Audio-Video Products*
Philadelphia, *W. Henry Cordray*
Cleveland, *Edwards-Lohse Associates*
Minneapolis, *A. J. Warner Co.*
Seattle, *Jas. J. Backer Co.*
Denver, *Dick Hyde Co.*
N. Calif., *David Ross Co.*
Ottawa, Canada, *Samuel C. Hooker, Ltd.*
Export, *Frazar & Hansen*

Incentive-Pay Plan

(Continued from page 77)

pensating, in part at least, for this as well. The employees themselves have a mutual benefit plan which supplements these payments so that an ordinary operation or illness results in very small expenses or loss of salary to any individual.

Life insurance up to two times annual base pay is provided, although a maximum of $20,000 is set. This insurance starts with $1,000 at six months and builds up to two times salary at the end of ten years. It reduces to one times annual base pay after the age of sixty and on retirement returns to $1,000.

Pensions and Retirement

The company very early established a pension plan but on January 1, 1941, formalized, by paying into an insurance company, a fund for prior services, thus bringing the plan up to that date. The employee pays 1% of base pay in addition to social security and 2% above the social security limit. The company contributes three times any amount paid by the employee. Retirement is mandatory at the age of sixty-five.

These retirement payments are supplemented by a profit-sharing plan. Under this plan any earnings above 6% of the net worth of the company are shared equally by the employees and the company, subject to certain but unimportant limitations by the U. S. Treasury Dept. This plan was initiated ten years ago, and employees who have been with the company during that period have already accrued more than two year's pay to their credit. Under special circumstances these funds may be withdrawn to meet emergencies, but if so withdrawn, they are obviously no longer available to provide increased retirement benefits. These funds are not taxable to the employee until actually withdrawn by him, either on retirement or otherwise.

Two cafeterias are provided where food is sold at cost; all overhead and salaries are paid for by the company. A credit union is also maintained with the company paying the overhead. A winter party including dinner, entertainment, and dancing is an annual feature. A summer picnic is another regular feature. In these items expenses are shared between company and employees. There is also a dramatic club, a baseball team, a glee club, a hockey team, plenty of bowling, and other activities. The company aids in these programs.

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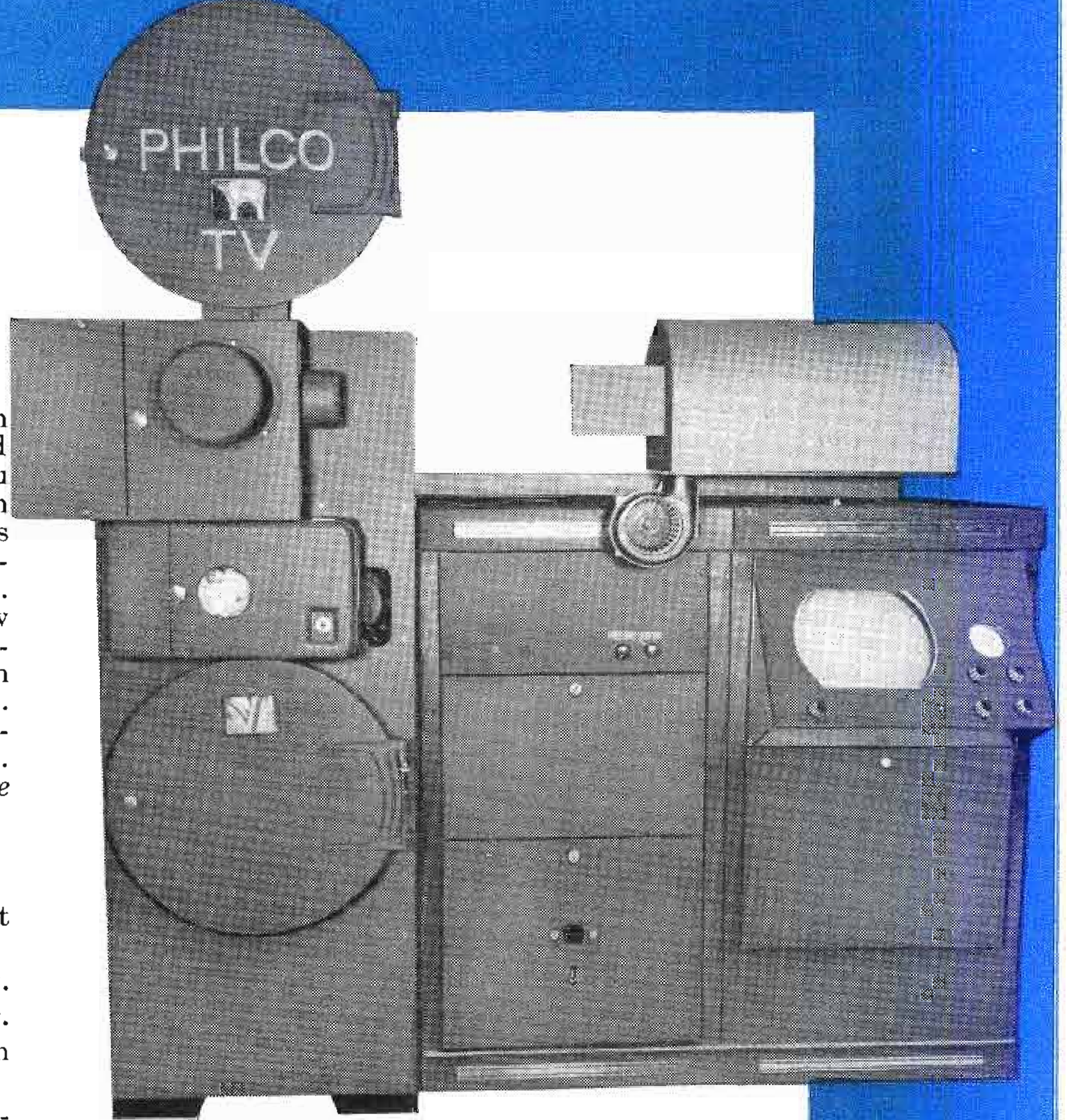
A REVOLUTIONARY NEW FILM PROGRAMMING SYSTEM

This new Philco TV Film Scanner will put realism and life into your film programs . . . It will build audience acceptance surpassing anything you have ever experienced with conventional film projection systems. Developed by Philco, this unique Film Scanner is a complete, yet inexpensive program source for both film and slides. It is quiet, compact and easy-to-operate. New design principles employing continuous film motion and flying-spot scanning techniques result in superb film reproduction and greatest reliability. Film motion is continuous and smooth . . . resulting in greater film life and utmost dependability. Moreover, this Philco Film Scanner *is adaptable to any color system or any TV standard.*

CHECK THESE PHILCO FEATURES:

- Operates at any Film Speed . . . Can Project Stationary Frames.
- Cold Illumination Source—No Film Burning.
- Smooth Film Movement . . . Reduces Film Wear.
- Distortionless Optical Compensation for Film Shrinkage.
- Automatic Film Registration and Extreme Picture Steadiness.
- Shading Adjustments Eliminated by Flying-Spot Scanner.



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PERSONAL

William A. Keetch, former chief engineer, has been elected vice president in charge of engineering by Robinson Aviation, Inc.

Dr. Waldo H. Kliever, former director of research of the Minneapolis-Honeywell Regulator Co., has joined Clevite-Brush Development Co., Cleveland, to become vice-president and director of instrument development. Dr. Kliever will have charge of the measuring instruments and magnetic recording, and also, head a control development section.

Dr. Waldo H. Kliever

Raymond C. Cosgrove, formerly executive vice president of the Avco Manufacturing Corp., has been named chairman of the board of the National Co.

Earl M. Johnson, vice-president in charge of Mutual station relations has succeeded **J. R. Poppele** as vice-president in charge of engineering for MBS, WOR, and WOR-TV. **Robert C. Mayo,** WOR-TV sales manager since 1949, has become WOR-TV sales director, and **John F. Sloan** has become general sales manager of WPAT.

Bernard M. Dover, previously head of the Tuner Engineering Dept., Emerson Radio & Phonograph Corp., has been named project engineer on TV receivers at CBS-Columbia Inc. **Robert S. Sterling,** formerly with Link Radio Corp. and **Frank J. Froehlich,** formerly with Sperry Gyroscope, have been appointed electronic and project engineers, respectively, for military equipment by the company.

John B. Coullard has been appointed sales engineer for the G-E Electric Components Dept., with his office at the LeMoyne Ave. plant at Syracuse, N.Y.


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TRU-OHM PRODUCTS
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MANUFACTURERS: Power Rheostat, Fixed Resistors, Adjustable Resistors, "Econohm" Resistors
Write for FREE Engineering Catalog NOW!

PERSONAL

(Continued)

Irwin S. Boak has been appointed head of the J. M. Ney Co. Industrial Division Research and Development Laboratory. Before his New England States engineering experience, Mr. Boak was associated with RCA's Tube Laboratory, Lancaster, Pa.

Raymond P. Wallace has been appointed chief patent engineer of Mycalex Corp. of America. Mr. Wallace will head the patent department and have charge of patent procurement on new products, methods and processes. In 1942, under the Manhattan Project, he was on the staff of the Radiation Laboratory of the University of California. Transferred to the Patent Engineering Department, eventually he became the chief patent engineer of the Radiation Laboratory.

Raymond P. Wallace

Cmdr. Russell G. Sergeant, USNR, is now Technical Division Officer of the Electronic Supply Office, Great Lakes, Ill., the control point of the entire electronic supply system of the U.S. Navy.

Jay W. MacFarland, research physicist, formerly with Bell Aircraft Corp., **G. Wayne Hawk, Maxwell H. Kaplan, William V. Wright, Jr., Eldon E. Monson,** and **Richard W. Chaplin** have joined the Guided Missile Laboratory of the Hughes Aircraft Company Research and Development Laboratories, Culver City, Calif. **Lyman S. Robbins,** formerly with Sandia Corp., **E. Harold Johanson,** formerly with Navy Electronics Laboratory, and **Thomas O. Tindall** are now affiliated with the company's Field Engineering Department. **Don Lebell,** formerly at the University of Calif., and **Richard T. Barrett** have become members of the Advanced Electronic Laboratory and **Robert H. Vreeland** has joined the Microwave Laboratory.

DO YOU KNOW WHAT THIS IS???

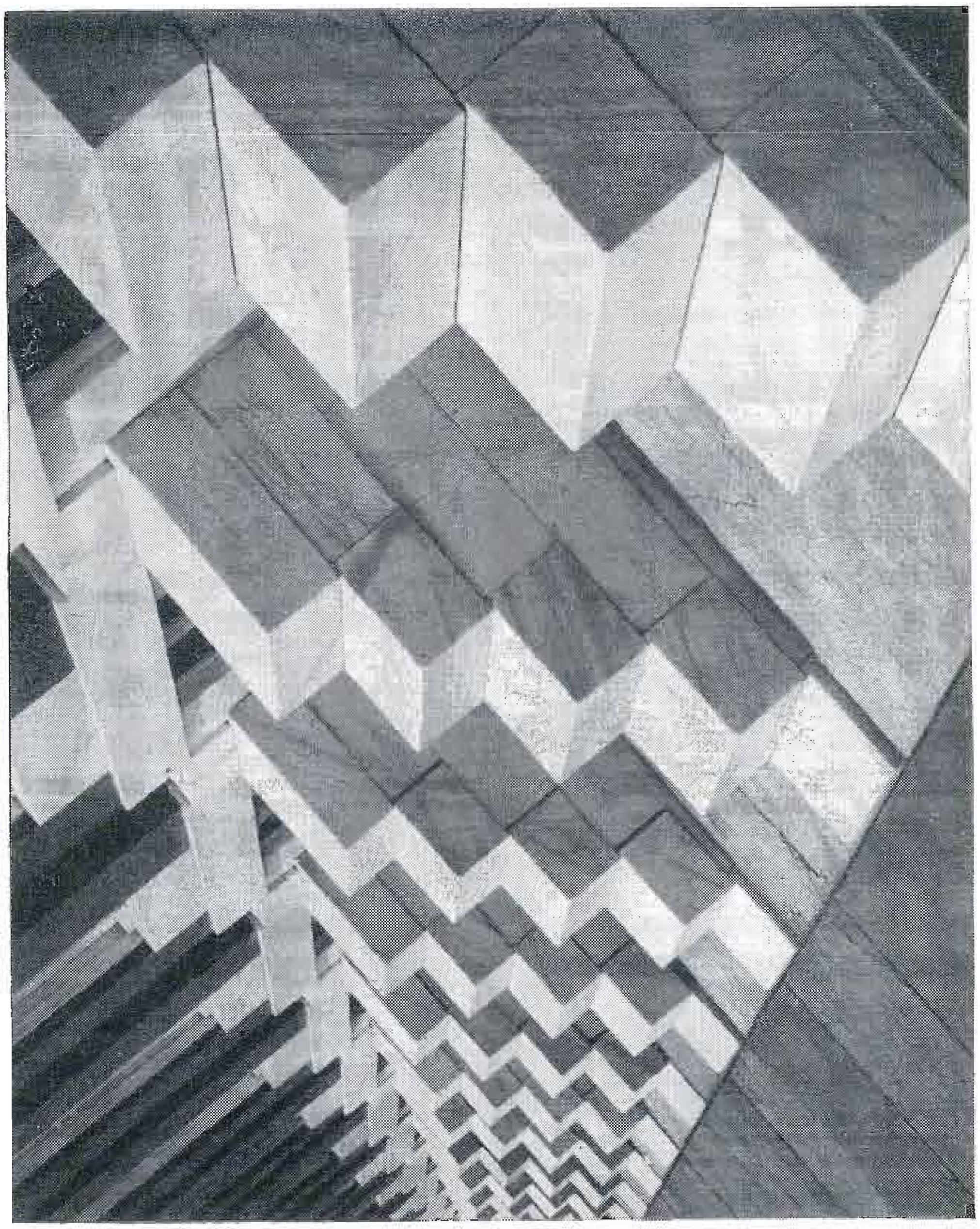


Photo from "My Maryland"— A. Audrey Bodine

. . . AND WHAT IT MEANS TO YOUR FUTURE?

These are the traditional white marble steps* of Baltimore, photographed from an unusual angle. There are no unusual angles of employment with Westinghouse in Baltimore, since every opening is a step toward a well-planned future.

In your plans, be sure to include the Baltimore Divisions of Westinghouse. Here operations are deliberately keyed to a balance between civilian and military work, which means that continued peak production is a matter of policy, rather than chance.

Salaries are commensurate with training, experience and ability. In addition to a highly respected patent award plan, opportunities for advanced degrees and relocation expenses, Westinghouse offers all of the usual employee benefits, *plus!*

Currently we have an opening for a:

- SERVO MECHANISM ENGINEER
- TECHNICAL WRITER
- ELECTRONIC OPERATION ANALYST (MILITARY WEAPONS)
- ELECTRONIC CIRCUIT ENGINEER
- ANTENNA AND WAVEGUIDE ENGINEER

. . . and other engineers who can complement our already fine organization.

To apply, send resume to—

R. M. SWISHER, Jr.
Employment Supervisor
Dept. S-3

westinghouse

Electric Corporation
109 West Lombard Street,
Baltimore 1, Md.

If you are already employed at your highest skill in a defense industry, do not apply.

* Actually, most Baltimoreans now prefer to live in the spacious and attractive suburbs which surround the city.

Magnetic Recording

(*Continued from page* 83)

field, more uniform through the cross-section of the record medium. Other heads are shown in Fig. 9. To the right is a microhead, about ⅛ in. in diameter which is more efficient than standard sizes. In the center is a combination erase-record-playback head built on a single core. At the left is a turn-in-gap head which has no conventional winding, but is energized by current sent through a high conductivity spacer in the gap itself.

When we make a record using audio only in the head, the recording is a distorted version of the input current. Investigation shows a relation between applied field and retained magnetization as in Fig. 10, which is an inherent property of the recording medium. We would like a straight line relationship between these quantities. One way of obtaining it would be to apply dc bias to shift the operating point to P. This is wasteful since we now use only half of the magnetization curve. Another way is to presaturate the record and then subject it to a recording field containing a component opposite to the saturated direction, plus the audio to be recorded. This action is shown in Fig. 11. At the zero cycle of audio, the bias brings the magnetization down to 0, and leaves a retained magnetism 0′ after the record leaves the head. At the positive and negative audio peaks the magnetization reaches A and C respectively, and results in a final state A′ and C′. The chief faults of

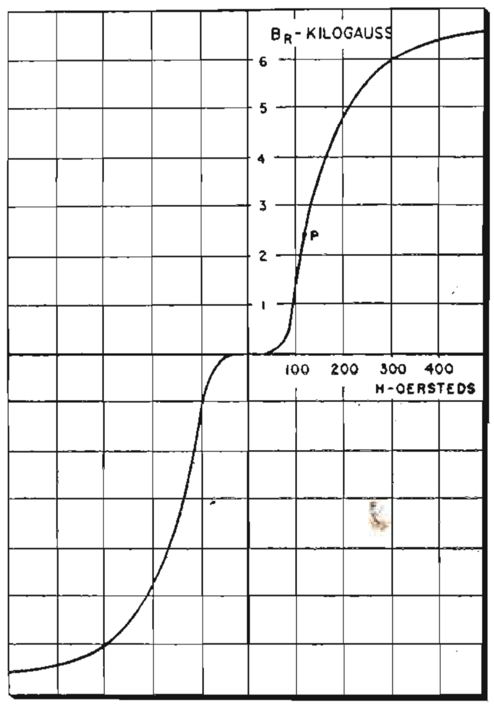
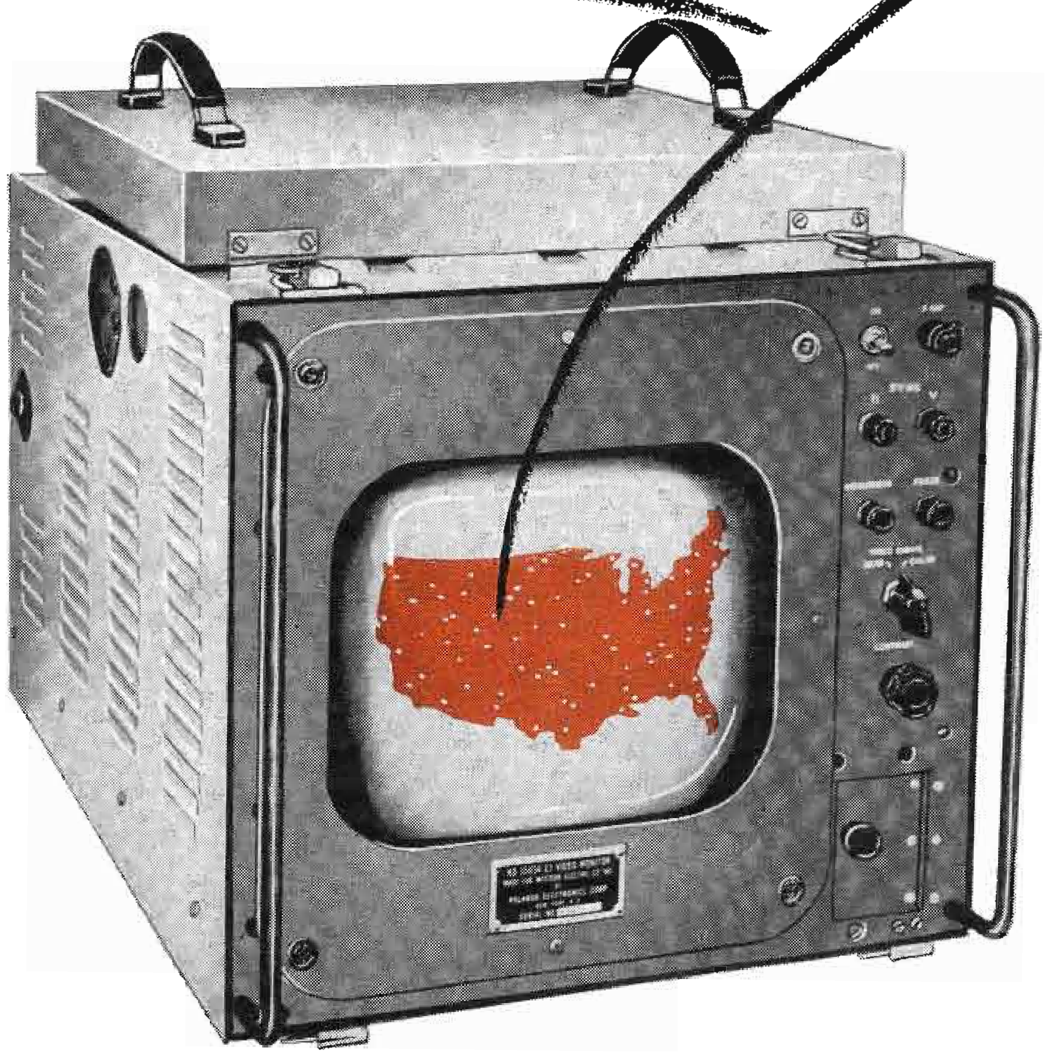


Fig. 10: Relationship of retained flux density and applied field for typical magnetic record

(*Continued on page* 124)

In More and More TV Installations Across the Country



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FEATURES:

- High resolution in excess of 450 lines
- 12½" Kinescope
- Unusually short retrace time
- Excellent vertical and horizontal linearity
- Light weight
- Complete with internal power supply
- Minimum of Maintenance

SPECIFICATIONS:

Input Video Signal	0.25 to 2.0 volts peak to peak
Signal Polarity	Positive, Negative or Balanced
Input Impedance	66 MMF across 470,000 ohms
Input Power	105-125 volts, 2 amps, 50/60 cps
Resolution	Greater than 450 lines
Kinescope (Aluminized back)	12KP4A
Retrace Time	4.2 microseconds
Focus	Magnetic
Linearity	Better than 2% across raster horizontally and vertically
Weight	60 lbs.
Size	19"x19"x20"
Tube Complement	3-1X2A; 1-5R4GY; 2-6AC7; 1-6AH6; 1-6BG6; 1-6BL7GT; 1-6CD6; 7-6SN7; 1-6X5; 1-12KP4A

Employing a 12½" aluminized kinescope, this unit is capable of presenting a bright, high definition picture with exceptionally good "sync" stability over a wide range of operating conditions.

The monitor is designed to work with balanced or unbalanced (black positive or black negative) video lines.

When the M-105 is used with color (CBS System) video signals, the presentation is black and white. Viewed through a properly synchronized color wheel, a complete and true color presentation is obtained.

For further details, contact your nearest Polarad representative or write us today.

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REPRESENTATIVES: Albuquerque • Atlanta • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York • Ontario • Philadelphia • San Francisco • Seattle • Syracuse dc bias are even-harmonic distortion and noise.

High frequency bias has so many advantages that it is used almost exclusively at present. Here a supersonic flux, usually between 20 KC and 300 KC is superimposed on the audio flux to be recorded. In magnitude this bias flux reaches to the points x, y, where the B-H curve of Fig. 12 is rising rapidly. When we filter the high frequency component from the output, there remains an audio flux which is a faithful reproduction of the input audio component. In practice, the filtering is automatic, since

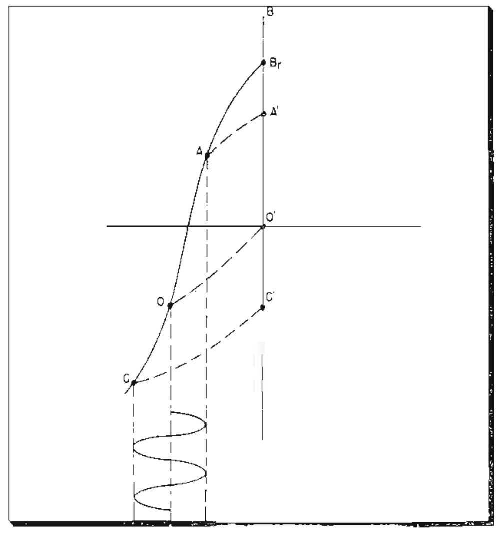

Fig. 11: DC bias with presaturated recording

the high frequency component is beyond the resolving power of the head-tape system. We notice two important advantages of high frequency bias: (1) When the audio is zero, the record is demagnetized, and has a very low noise level. (2) Recording is symmetrical, so that even-harmonic distortion is absent.

Typical recording circuits are shown in Fig. 13. Four methods of introducing the high-frequency bias are shown. The parallel connection of (A) is simple, but introduces the bias voltage into the audio amplifier. The series connection (B) makes isolation easier. With both (A) and (B) the number of turns on the recording head is limited because high bias voltages might result is breakdown. This is avoided in arrangement (C), where bias is introduced by a few auxiliary turns on the recording head placed in series with the erase head. In some designs, as in (D), we can obtain sufficient bias in the recording head by induction from the erase head in close proximity.

In construction, the pickup head is similar to a recording head; in fact the same head is often switched so that it serves either function. See Fig. 7. When a typical recorded element passes over the gap, a portion of the flux goes through the magnetic core and links the coil. But much of the flux is lost. For example, portions are shunted across the pickup gap, while some flux completes its circuit in air.

The voltage induced in the voice coil is given by:

where $$E = KCGfN\phi_r, \qquad (1)$$

E is the induced voltage;

K is a coefficient that takes into account the incomplete coupling of tape to head, conversion factors, etc.;

C is a coefficient that decreases with rising frequency because of core losses;

G is a coefficient that decreases at shorter wavelengths because of finite size of the gap;

f is the recorded frequency;

N is the number of turns on voice coil;

ϕ_r is the residual flux in the tape.

In specific problems the best results are obtained by grapical treatment, but analytical studies are valuable in giving an insight of the processes involved. From Eq. (1) we see

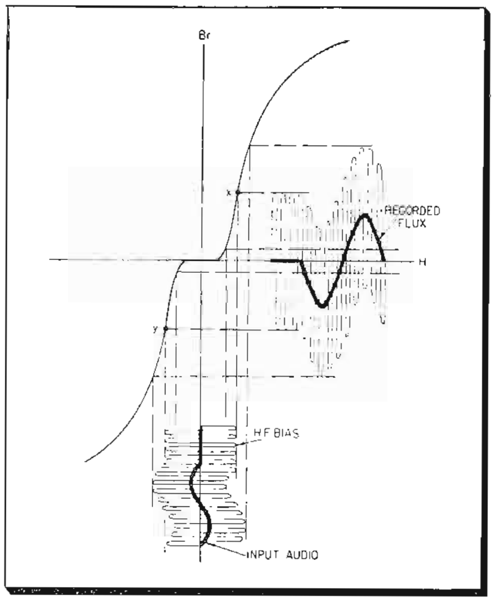

Fig. 12: High frequency bias imposed on audio

that the output voltage is directly proportional to frequency, so we expect the output voltage to rise 6 db for every octave increase in frequency. This is borne out in the response curve of Fig. 14. Here the playback of a tape, recorded with constant current in the head, rises about 6 db per octave in the range from 100 to 1000 cycles. Above 1000 cycles the losses tend to reduce C, G, and ϕ_r of Eq. (1):

(A) Eddy currents, hysteresis losses, and skin effects in the core reduce flux in the voice coil.

(B) When the effective gap size (g) becomes comparable to the recorded wavelength (λ), output is further reduced by

$$G = \frac{\sin \pi g/\lambda}{\pi g/\lambda} \qquad (2)$$

(*Continued on page* 126)

HOW TO SLOT a circular strip ½" wide by ⅜" thick by 19" in diameter? Formica solved the problem by postforming this ingenious ring for Curtiss-Wright Corp., Propeller Div.

MINIATURIZATION is but one advantage of Formica printed circuits. Engineering developed better adhesives, postforming, molding and fabricating of complete circuit parts.

For complete information on Formica laminated plastic sheets, tubes and rods, and special molded, postformed and fabricated parts . . . for electrical, chemical and mechanical applications . . . write for Formica general catalog. THE FORMICA CO., 4644 Spring Grove Ave., Cincinnati 32, Ohio, U. S. A.

'DIAMOND H' RELAYS

pack more performance into less space . . .

Rating for rating, "Diamond H" Series R hermetically sealed, miniature aircraft type 4PDT relays are smallest (1.6 cubic inches), lightest (3.76 ounces), have widest temperature range (−65° to +200°C.), greatest operating shock resistance (to 50 "G" and higher) and excel all others in their field in ability to break high currents and high voltages.

Ideal for high frequency switching, their inter-electrode capacitance is less than 5 micro-microfarads contacts to case, less than 2½ mmf between contacts, even with plug-in type relay and socket. Vibration range is from 0 to 500 cycles per second and upward at 15 "G" without chatter. Coil resistances up to 50,000 ohms are available, with contact loading through 10 A. resistive for 100,000 cycles (30 A. resistive for 100 cycles) at 30 V., D.C., or 115 V., A.C. Sensitivity approaches 100 milliwatts at 30 "G" operational shock resistance. They meet all requirements of USAF Spec. MIL-R-5757 . . . and far surpass many. Various standard mounting arrangements available. Write for Bulletin R-150 or ask for "Diamond H" technical assistance.

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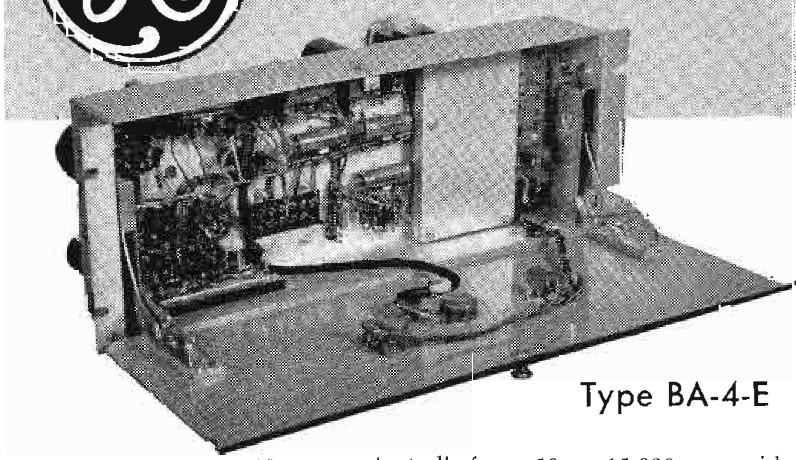

Type BA-4-E

OUTPUT 10 watts, ± 1 db from 50 to 15,000 cps, with 1½% or less distortion

HIGH GAIN 105 db...use for talkback, transcription cue, and playback applications

COMPACT Requires only 4 rack units of space—7"

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GENERAL ELECTRIC

(C) At short wavelengths the mutual demagnetizing effect of closely adjacent poles reduce the residual flux. Core losses and partial erasure during the recording process also reduce the ϕ_r.

These factors stop the rise in output voltage with rising frequency. Above 3000 cycles the output in Fig. 14 falls off, until at 10 KC it is 15 db below the peak.

At low frequencies, if wavelengths become longer than the head itself, the magnetic coupling of tape to head becomes inefficient and the output falls more rapidly than 6 db per octave. We begin to notice this effect in Fig. 14 below 100 cycles.

According to Eq. (2), we note that when the recorded wavelength equals the effective gap, the output is zero, but if we decrease the wavelength still further the output rises again. We get another null at $g = 2\lambda, 3\lambda, 4\lambda$ . . . ., etc. This is shown in Fig. 15, where a record was played back with gaps of different sizes. With an 0.1 in. gap we get a null at intervals of about 700 cycles. In special applications we can make use of these outputs which are supposedly beyond the resolving power of the heads. But in most cases we use the region to the left of the first null point and try to increase its upper limit by means of short gaps. Spurious pickup of the recorded flux at points other than the gap will also give rise to peaks and valleys resembling the response of Fig. 15, and the designer may have to take precautions to prevent them.

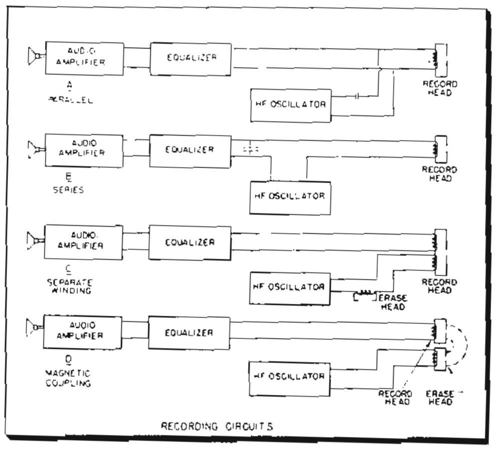


Fig. 13: Typical recording circuits, showing 4 methods of introducing high-frequency bias

Equalization

The characteristic of Fig. 15 must be corrected at both high and low frequencies if a flat response curve is desired. We can apply correction either during recording (pre-equalization), or during playback (post-equalization) or both. If we do all our equalization in recording, we must boost the input level of low frequen-

(*Continued on page* 128)

cies 20 or 30 db with respect to the peak at about 3000 cycles. We then find that the low frequencies would saturate or overload the tape long before its capabilities at medium or high frequencies were exceeded. On the other hand, if we did all our equalization on playback we would require 15 or 20 db boost at 10 KC with respect to the 3 KC peak, and this would emphasize the amplifier and tape hiss unduly.

Studies of the frequency spectra of speech and music show that components above 3000 cycles occur at lower levels than medium frequencies, and that at 10 KC we can boost the response as much as 15 db, without exceeding the medium frequency peaks. We can thus correct the high

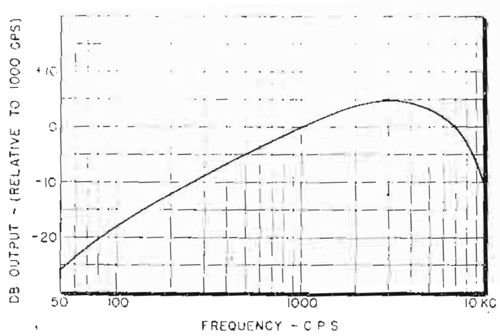


Fig. 14: Constant current response, 140A tape

frequency response of our tape characteristic completely by pre-equalization, and this is common practice in most magnetic recorders.

Most of the low frequency equalization must be done in playback. Many of the high quality machines do all of it in playback. But when the response extends down to 30 or 50 cycles, the heads and pre-amplifiers must be carefully designed to avoid hum, because the hum as well as the head output is boosted about 25 db. Recorders which cut off at 100 or 200 cycles do not require as much boost and are insensitive at hum frequencies, so their design is not difficult. A compromise is often used where half of the equalization is done on record, and half on playback. This reduces hum, and also simplifies switching because the equalizer is left in the circuit all the time.

Erasing

The erase head usually resembles the recording head, but the gap is five or ten times as large, and the winding is energized with enough input power to erase completely the highest level recordings. High frequency erase heads, which operate at bias frequencies leave the record in a demagnetized condition and give the maximum signal to noise ratio. DC and perma-

(*Continued on page* 132)

nent magnet heads are sometimes used for economy or for extra strong fields. Some of these are made to approximate ac erasure by subjecting the tape to a series of opposite poles, each weaker than the preceding one. DC heads are generally noisier than ac types.

Record media that saturate slowly at high fields and have high coercive force are more difficult to erase than record media that saturate rapidly at moderate fields and have lower coercive force. To erase the more difficult materials special measures are taken, including multiple gap heads, turn-in-gap heads, dc heads, etc. Erase efficiency of heads can be evaluated by plotting the erase effect on a saturated signal against the input power to the head. (Since power is difficult to measure at high frequencies, the volt-ampere input is usually taken for comparative purposes.)

Problems in Magnetic Recording

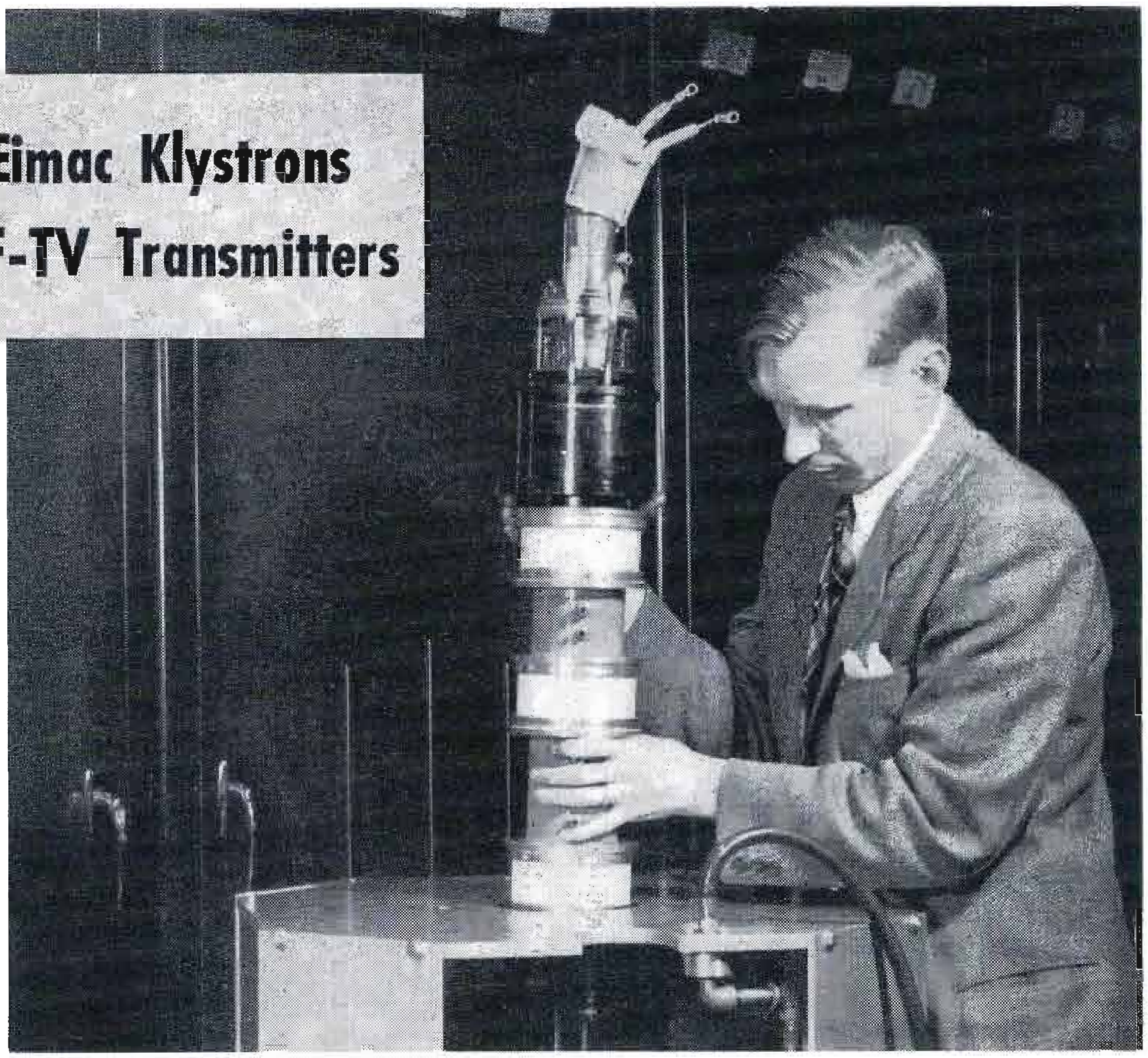
Flutter remains one of the most important problems in high quality magnetic recording. The ear can detect as little as 0.001% flutter under favorable conditions, while the best mechanical systems operate at levels of about 0.1%. In most cases the mechanical designs "just grow" on the drafting board without taking advantage of what is known about optimum capstan and flywheel sizes, compliances, etc. However, even with the best designs a very high order of precision is required in manufacture.

Noise is also a problem, for even when it is 50 to 60 db below the signal level, a careful listener can detect it. With the best modern systems, noise level is almost the only feature by which the recorded program can be distinguished from the direct program. Noise can be reduced by better tapes and better heads, but we soon reach a point where tube noise of high gain amplifiers is the limiting factor. High-output tapes and high output heads offer a solution, because they do not require as much amplification.

Frequency response improvements are always welcome. Even if we do not need the better high-frequency response we can always drop the speed. One thing that is often overlooked is the importance of good contact between tape and head. It can be shown that when a tape is separated a slight distance (d) from the head, the playback of a wavelength (λ) is reduced by a factor: db loss $= 56d/\lambda$, which can be a tremendous amount at high frequencies. This considers only the playback loss. Recording

(*Continued on page* 134)

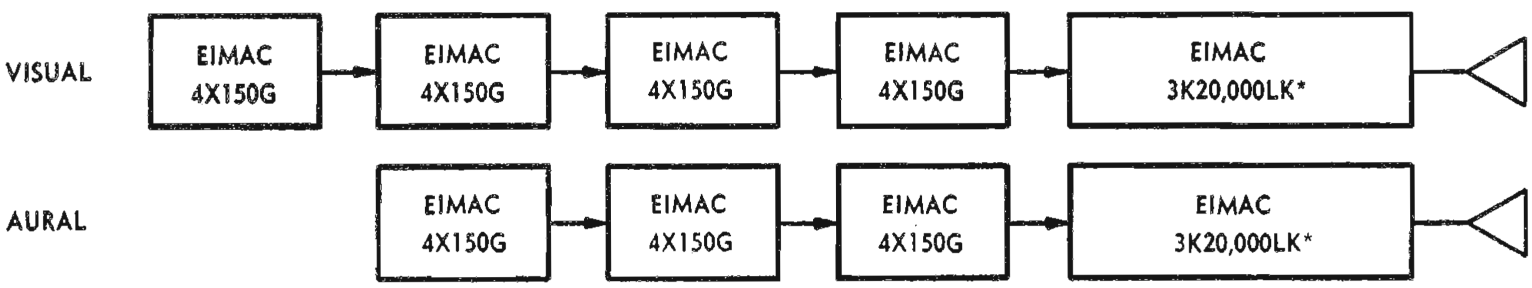
DuMont features Eimac Klystrons In 5 kilowatt UHF-TV Transmitters



W. H. Sayer, DuMont research engineer, places Eimac klystron in RF section of DuMont 5kw transmitter.

DuMont combines the latest in electronic design and engineering techniques in its new, up-to-the-minute five kilowatt UHF-TV transmitters. With Eimac klystrons as final amplifiers, DuMont utilizes the only tubes that offer all these features for high-power UHF-TV—1) Low initial cost and operating economy 2) Light weight 3) Reserve power for long life in typical operation 4) High power gain of 20 db. or more 5) Three tubes to cover the spectrum 6) Convenient external tuning makes efficient and accurate circuit alignment possible.

EIMAC TUBES IN DRIVER AND FINAL STAGES



For further information about Eimac klystrons write our Application Engineering department.

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*3K20,000LF channels 33-55
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Eimac TUBES

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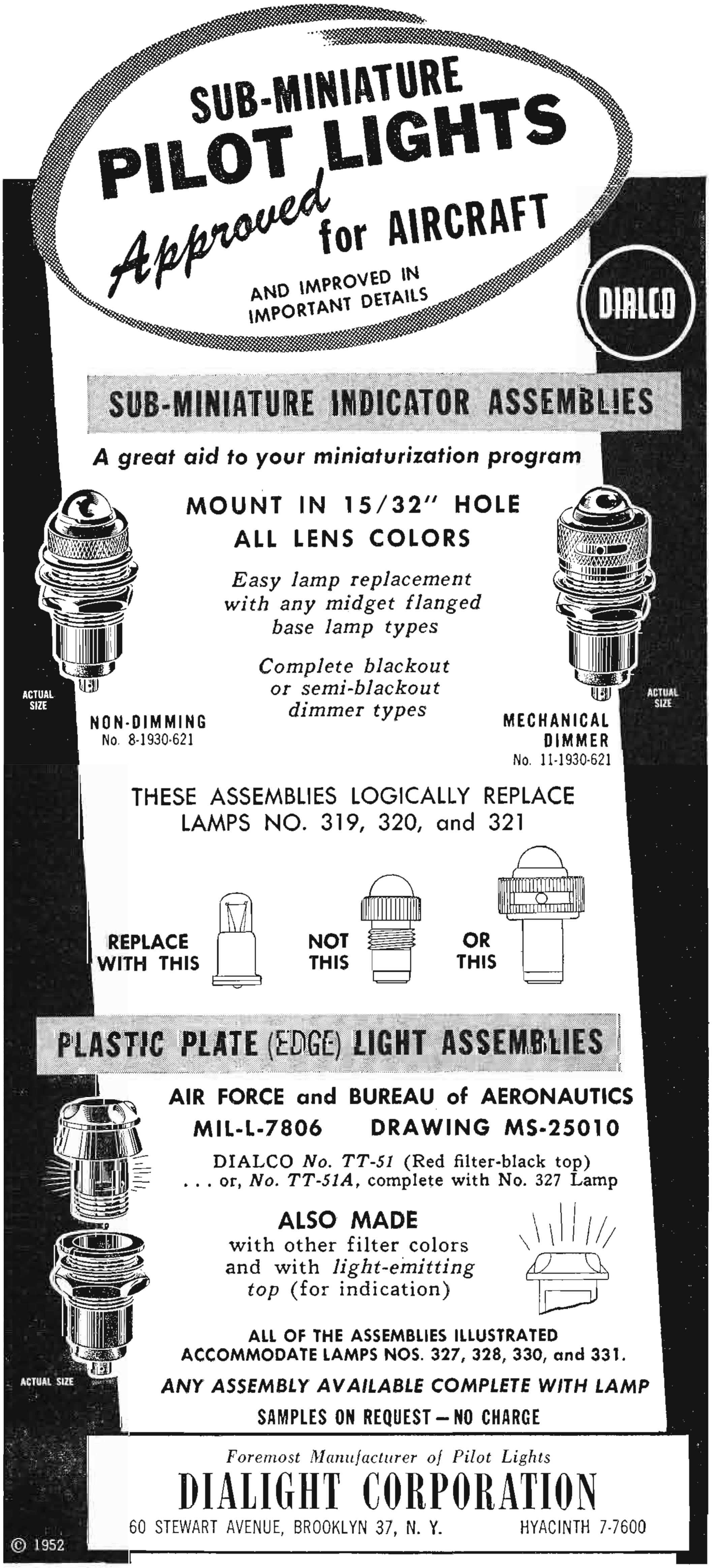


loss as great or greater must be added. At the present time we can record about 2000 cycles/ips of tape speed.

Transfer of recordings from layer to layer of a reel has been a problem in the past. This can be reduced to a negligible value by working with a record material of proper magnetic characteristics, by avoiding recording levels that approach saturation, and by storing the record away from high temperatures and magnetic fields.

Distortion is very low in magnetic records. It can be kept at a minimum by proper setting of the high frequency bias. The setting for lowest distortion is usually at a bias current considerably higher than the adjustment for maximum response, especially at high frequencies. An unusual type of distortion often occurs when supersonic bias is used, where the high frequency oscillator beats against harmonics of the recorded audio frequencies. This can be minimized by selecting a bias frequency at least five times as high as the highest audio to be recorded.

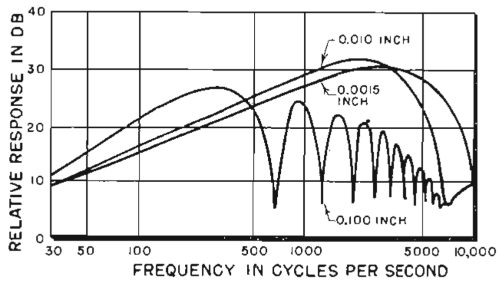


Fig. 15: Effect of gap length on response

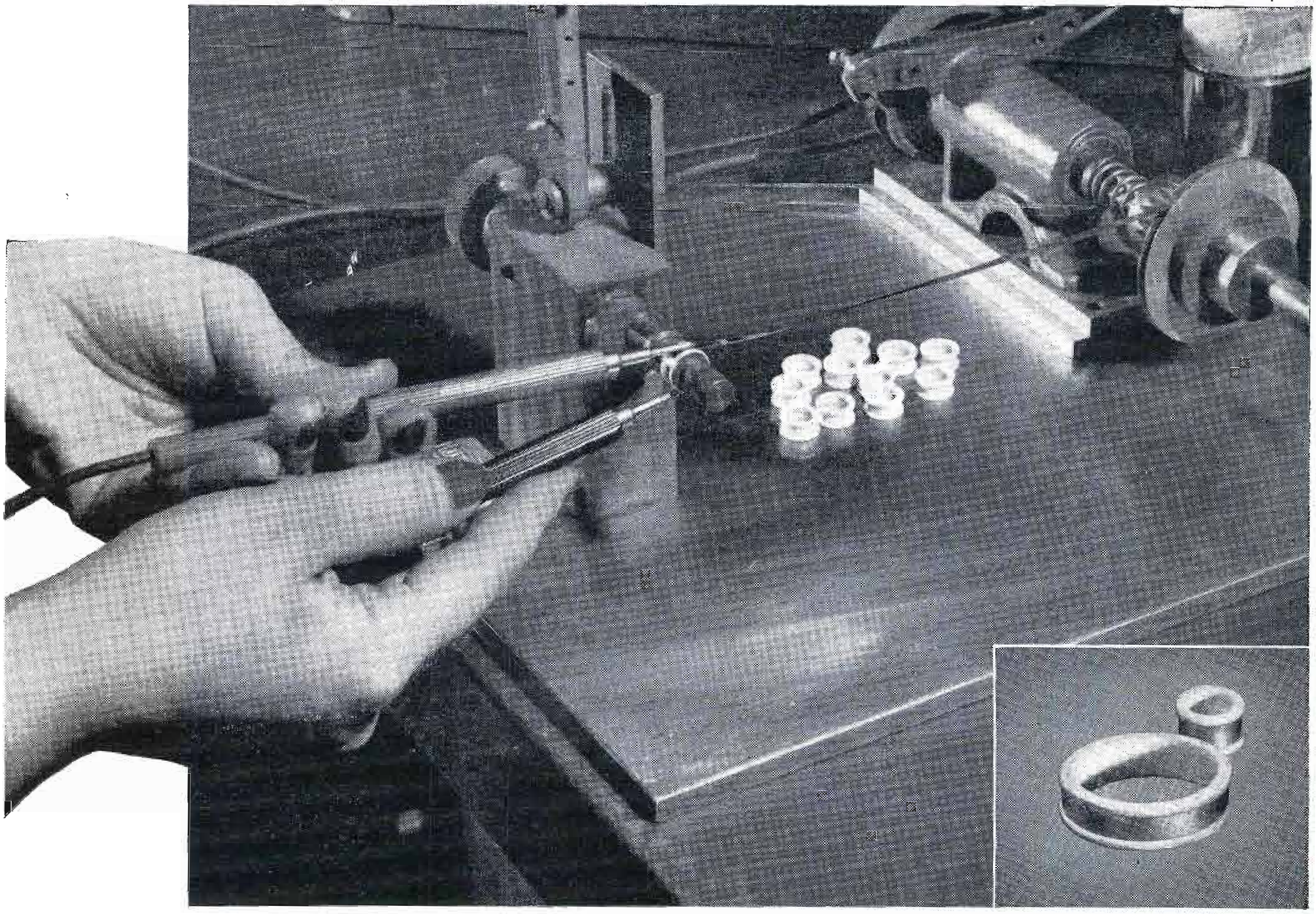
"Drop-outs" are a nuisance in recording for instrumentation purposes, where loss of a single pulse may upset the entire system. It has been found that drop-outs can result from lumps in the coating which cause a slight momentary separation between tape and head. Special tapes are now available which are so carefully made that drop-outs are practically nonexistent.

Future Developments

Many of the things considered in the last section as "problems" give a clue to "future developments" when the problems are solved. For example, high outputs, narrower tracks, lower speeds, and better response are in the offing, not necessarily as spectacular sudden developments, but as evolution of present trends.

New heads now in the experimental stage, are made of magnetic ferrite materials. They can be used at very high frequencies, and are so

(*Continued on page* 136)



Hiperthin* Cores . . .
newest approach to electronic circuit designs

New circuit designs, often making it possible to replace tubes in amplifiers, computers, modulators and similar electronic equipment, are being developed through the use of Westinghouse Hiperthin Cores.

An entirely new, thin magnetic material, capable of retaining its desirable qualities even when rolled as thin as 1/8 mil, is the reason.

Compounded of grain-oriented silicon or nickel-iron alloys, it combines the fast response, high permeability and low coercive force needed in vhf circuits. Non-deteriorating, it eliminates the periodic replacement problem encountered with tubes, assuring sustained and accurate performance.

To manufacture the new core economically, Westinghouse engineers devised new production methods. The illustration above shows a core being subjected to an electronically controlled spot weld, after being wound. New techniques have also been developed for effectively insulating the turns, and for annealing the metal on a ceramic form as a unit to insure permanent stability.

All your core requirements . . . whether they're for electrical or special electronic applications . . . can be met best by engineers who know and understand your problems. For further information write for reprint No. 4866, *Progress in Core Material for Small Transformers.* Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70676

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hard that they are virtually wear-proof.

Binaural and stereophonic sound, which reach their highest state of perfection in magnetic recording, are logical adjuncts to three dimensional movies that have been introduced lately.

Video recording, with present standards requires frequencies about 100 to 1000 times as high as the upper limit of conventional recorders. One system now being developed is a multiplexer that extends the response by using a number of parallel channels. Video recording on a tape ½ to 1 in. wide, running at 100 ips is promised.

Alternative Methods

Alternative methods for recording intelligence are FM, carrier currents, pulse width and pulse time modulation, etc. All of these have been uneconomical for audio use in view of the limited channel width available in magnetic recording. However they are quite practical for instrumentation, and are widely used. Now that magnetic recorders with a channel width of 100 KC or more are available, we can expect further uses for these newer forms of modulation.

Magnetic recording is also ideal for memory devices in computers and for business machines because of its rapid response, permanence, and erasibility. The field is developing so fast that it is difficult to keep track of all the new applications.

Motion picture film carrying a narrow magnetic stripe is now beginning to be used for the sound track on films ranging from the 35 mm professional class to the 8 mm amateur.

As magnetic recording becomes more widespread, there is a demand for pre-recorded music, and for duplicating methods. Duplication by magnetic contact printing is a rapid and economical process.

Among the most recent developments are magnetic playback heads which respond directly to the magnetic flux of the recording, rather than to its rate of change. Such heads give faithful reproductions of waveforms at very slow speeds; in fact the tape can be stopped at any part of a recorded cycle and the amplitude of that point can be read. They also give outputs in the order of volts, rather than millivolts, so that our ideas about amplification and equalization will have to be revised.

From all of these considerations we can conclude that magnetic recording is changing more rapidly than ever, and we can look forward to many new and interesting developments in the future.

LETTERS...

Compatible Line Sequential TV

Editors TELE-TECH:

I notice in the July issue of TELE-TECH that you have published Dr. Baker's remarks on the subject of the future of Color Television. These remarks are based on the assumption that there is only one possible compatible system which is a "dot sequential" system. Inasmuch as this is not true, I thought you might be interested in a presentation based on the other possibility, a compatible "line sequential" system, which has merits of simplicity and economy.

DANA A. GRIFFIN
President
Communication Measurements Lab., Inc.
350 Leland Ave.
Plainfield, N. J.

Editors' Note: Mr. Griffin enclosed an extremely interesting manuscript entitled "Color Television—Just Another Man's Considered Opinion," copies of which he will gladly make available to readers writing in and requesting same.

Binaural Listening in 1881!

Editors, TELE-TECH:

Old files of *L'Electricien,* Paris, report that on April 19, 1881, a group of French dignitaries including the minister of posts and telegraphs, the minister of public works, and the director of *l'Académie nationale de musique* gathered in an office at some distance from *l'Opéra* to hear a transmission of Meyerbeer's *Les Huguenots.* The results, *"véritablement remarquables,"* of this test led to an installation in *l'Exposition Internationale d'Electricité* which opened in Paris on September 15, 1881 of some permanent telephone lines between *l'Opéra* and *l'Exposition* over which music flowed to an appreciative audience whenever opera was being performed.

The music was picked up by ten microphones designed by M. Clément Ader and placed behind the footlights. (These latter were gas lights directed downward; the first general electric lighting of *l'Opéra* took place on October 15, 1881.) Power was furnished by ten liquid batteries each of which was automatically replaced each quarter hour.

To secure auditive perspective each listener had two telephone receivers; that for the right ear was connected to a microphone on the right side of the stage; the other was connected to one on the left. The ten transmitters fed eighty telephones, and thus accommodated forty listeners, twenty in each of two rooms.

The entire installation supplied 160 telephones in four rooms. While forty people enjoyed two minutes of an opera, another forty were taking over some dead telephones to await their two minutes.

George A. Whetstone,
Associate Professor,
Texas Technological College,
Lubbock, Texas.

Color TV Sharpness and Chromaticity

Editors, Tele-Tech:

In the August, 1953, issue of Tele-Tech, on page 168, there is a letter to the editor on the question of red, green, and blue detail in color television. In his reply, the editor states that he has been unable to find any published articles by Bell Laboratories to supplement the statements made on the witness stand in a FCC Hearing by W. H. Doherty, Director, Electronic and Television Research, Bell Telephone Laboratories.

May I respectfully call your attention to an article published in the Color-Television issue of the IRE Proceedings: M. W. Baldwin, Jr., "Subjective Sharpness of Additive Color Pictures," Proceedings of the IRE 39,1173 (October, 1951).

The editor concludes his reply with some statements about the acuity of the eye under lights of different colors. Many articles have been published on this topic (see Chapter 5 of "The Science of Color," Thomas Y. Crowell Co. New York, 1953); and some of them, at least, indicate that when chromaticity is the only variable, its influence on visual acuity is relatively minor.

Millard W. Baldwin, Jr.
Bell Telephone Laboratories
Murray Hill, N. J.

Trans-Atlantic TV in 1930

Editors, Tele Tech:

In your issue of March, 1953, Douglas Walters, London, stated, that he received a TV program direct from the General Electric Station at Schenectady, N. Y., on Sept. 17th, 1930.

I want to confirm this statement by saying, that I saw these transmissions also. At that time I was a research associate of the German Reichspostzentralamt and in this capacity I was charged with the observation of the TV transmissions at the Overseas Receiving Station Beelitz near Berlin. The emission of these programmes was agreed upon between Dr. Alexanderson of the General Electric Company and my office (wave length, 20 m.).

In those days 30 lines' scanning was the German standard and a bandwidth of but a few kc/s was required for transmission of the pictures, so we could use the ordinary equipment employed for telephone reception in our station. But in spite of the use of large pine-tree arrays, reception was poor.

Prof. Dr.-Ing. F. Kirschstein
Fernmeldetechn. Zentralamt
Technische Hochschule
Lucasweg 15,
Darmstadt, Germany

Air Density

(*Continued from page 70*)

The density potentiometer may have any total resistance, but, from consideration of bridge sensitivity and potentiometer construction, a resistance of between 2,000 and 3,000 ohms is usually chosen to represent a range of D of about 0 to 1.2. A value of D = 1.2 is usually considered to be the greatest relative air density which the system will encounter. Usually the system is designed to compute densities as low as 0.01, which is essentially zero. In these cases, the zero resistance point of the potentiometer will represent D = 0. When the lowest density to be computed is in the order of 0.15 or greater, however, it is advantageous to make the zero resistance point of the potentiometer represent the low end of the RAD range, and to connect a fixed resistor in series to represent lower values. The value of this fixed resistor will be

$$R_{DF} = \frac{D_{min}}{D_{max} - D_{min}} \times R_{DV\,max} \quad (23)$$

where R_{DF} = Resistance of fixed resistor (ohms).

R_{DVmax} = Total resistance of density potentiometer (ohms).

D_{min} = Lowest value of D to be measured.

D_{max} = Highest value of D to be measured.

This may be written

$$R_{DF} = CD_{min}$$

where

$$C = R_{DV\,max}/(D_{max} - D_{min}) \quad (24)$$

As the total resistance of a pressure potentiometer is usually held to only ±5% of the nominal value, the value of R_{DF} will generally have to be computed individually for each potentiometer. An alternative in production equipment is to provide an adjustment which can be permanently locked.

The required value of the calibrating leg of the bridge can be calculated from the equation

$$F = R_D R_T / Rp \quad (25)$$

But $R_D = C \times D = 9.632\ Cp/T$

$R_T = 4.24T$

$R_p = Ap$

$$F = 40.84\ C/A \quad (26)$$

The value of C may be found from Eq. (24).

$$C = R_{DV\,max}/D_{max} - D_{min}$$

The greatest value of F will be

$$F_{max} = 40.84\ C_{max}/A_{min}$$

and the least will be

$$F_{min} = 40.84\ C_{min}/A_{max}$$

A combination of fixed and variable resistors may be connected in series to obtain this range of F.

The maximum bridge voltage for the RAD system is limited by the heat rise in the temperature bulb and should be in the order of 12 to 15 volts. The design of the follow-up for the density potentiometer will follow conventional servo practice.

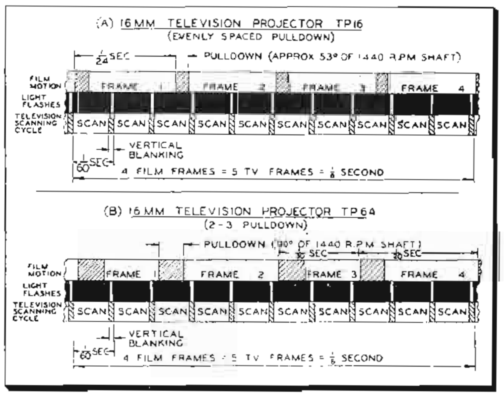
This system may be used at altitudes up to 50,000 feet and true air speeds up to 650 knots. It makes use of standard components, and is simple and reliable in operation. It will continue to supply useful data until extended ranges of air speed and altitude require the electromechanical true airspeed and density systems now under development.

---

16 mm TV Projector

RCA's new TP-6A TV projector contains several interesting design features. Included among these are an unequal pulldown spacing, and automatic lamp change assembly.

The 4/5 field-to-frame ratio of the TP-6A is the same as the TP-16. During one frame, two light flashes occur, and three during the next, in repetitive sequence. However, instead of having evenly spaced pulldown periods, the TP-6A's spacing is unequal in a 2/3 ratio, allowing a



(A) Evenly spaced pulldown periods. (B) Uneven pulldown ratio of 2/3 allows longer pull time

longer pulldown time and location anywhere between vertical retrace periods. The increased pulldown time results in increased life of the parts of the claw-type intermittent and of the film.

The automatic projection lamp change mechanism takes less than one second from the time of failure to replace a lamp. Two lamps are situated on a rotating mount above the blower. A relay coil is connected in series with lampfilament in use. When the circuit is broken by lamp failure, the relay actuates a motor driving the lamp assembly. A limit switch breaks the circuit and remakes when the rotation is complete, thereby preventing arcing. In its travel to the projection position, the new lamp passes under an additional set of contacts which preheat the lamp as it goes by.

Conductance Curves

(*Continued from page 71*)

not exceed 0.6%. The peak output voltage is approximately ±95 v. The 6SL7 tube is seen to have a large voltage gain and comparatively large voltage output with a small value of distortion.

For best operation with minimum phase shift, the reactance of the plate inductor should be at least twice the load resistance value at the lowest frequency to be transmitted. Selection of the proper value of inductance may be made from Eq. (2):

$$L = 2\,R_L / \omega = R_L / \pi f \qquad (2)$$

The inductance required for the problem at hand is approximately 300 henries with a static current of 2 ma.

As can be seen, the advantages of a supply voltage of approximately 450 v. may be obtained by the use of impedance coupling and a 250 v. supply. The power economy can be considerable.

The cathode resistor required for the 6SL7 tube has 1000 ohms resistance. If the cathode bipass capacitor for an audio amplifier is large enough that $G_M\ X_C$ is not greater than 0.1, adequate bypassing usually will result. For the present problem, where the frequency is 100 cycles, and G_M is about 1750 micromhos, a capacitance of 35 μf is adequate.

Pentode Transformer Coupled Amplifier

If a transformer coupled amplifier is required which provides high gain and small power input, use of a pentode amplifier tube might be practical. Assume, for example, that a 6BH6 pentode (Fig. 2) is chosen to be used as the amplifier tube. The input signal is ±0.5 v. Not more than 5% distortion can be permitted. The transformer may have a turns ratio of two, or an impedance ratio of four.

Examination of the characteristics of the 6BH6 with 75 v. on the screen shows that the distortion resulting from a grid bias change from zero to −1 v. bias will be slightly less than 4%. Consequently, choice of a screen voltage equal to 75 v. is reasonable. The static plate current at a bias of −0.5 v. on the control grid and 75 v. on the screen is 4.5 ma. If the resistance load for the secondary of the interstage transformer is chosen as 80,000 ohms, the reflected plate load is 20,000 ohms. The stage gain from grid to plate is 20,000 × 0.0043 = 86. The amplification to the grid of the following stage is 172. Since the design would be made to provide a plate voltage of 60 v. at zero bias, the required supply voltage would be 103 v. The peak signal output voltage across the grid winding of the interstage transformer is approximately 86 v., nearly as much as was obtained from the 6SL7 amplifier.

The average screen current of the 6BH6 tube operated under the above conditions is 40% of the plate current, or 1.8 ma. The total cathode current then is 6.3 ma. The cathode resistance required to provide 0.5 v. bias is 80 ohms. A 0.5 watt size is ample.

If, again, the minimum frequency to be amplified is 100 cycles, the transformer primary, with a static current of 4.5 ma, should have an inductance of at least 70 henries. The secondary inductance would be four

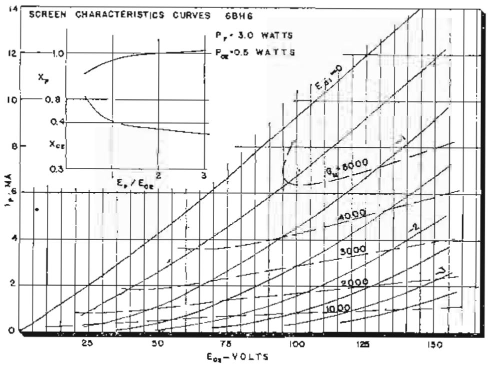


Fig. 2: Screen characteristic curves for 6BH6

times the primary inductance. The cathode bypass capacitor, to provide a frequency response to 100 cycles, should have a capacitance of 70 or more µf.

Push-Pull Pentode Output Amplifier Stage

Design of push-pull transformer coupled output amplifiers has the objective of providing a maximum power output with a minimum distortion. The provision of maximum power output is accomplished by adjustment of the tube screen voltage and the load impedance. The reduction of distortion is dependent on the proper choice of bias voltage.

From a power point of view, the maximum product of voltage change by current change is required in each tube. The design problem is to obtain the maximum product with a minimum distortion. The development of maximum power with minimum distortion may require, in some cases, the choice of a zero bias plate voltage less than 80% of the screen voltage. Use of a zero bias plate voltage to screen voltage ratio as low as 4/10 to 5/10 appears to be satisfactory with some pentode power amplifier tubes. The plate load impedance should be chosen to make full use of the current and voltage change values available. Then the bias is chosen to provide maximum linearity.

(*Continued on page* 144)

The adjustment of the grid bias is aided by preparation of a table of transconductances at typical bias voltages and several screen voltages. The sums of the transconductances of the two tubes at each value of bias excursion from several possible mean bias voltages should be tabulated. The preferred bias is the one which gives the most constant transconductance sum as a function of bias excursion.

Partition Distortion

Because of the radical variation of the total cathode current in the design of most push-pull power amplifiers, adequate bypassing of cathode bias resistors is extremely important. Lack of adequate bypassing increases the required input signal and introduces partition distortion into the output. This partition distortion is a result of the current division variation between the screen and the plate of the tube. The determination of the proper size of capacitor for bypassing the cathode bias resistor follows conventional techniques.

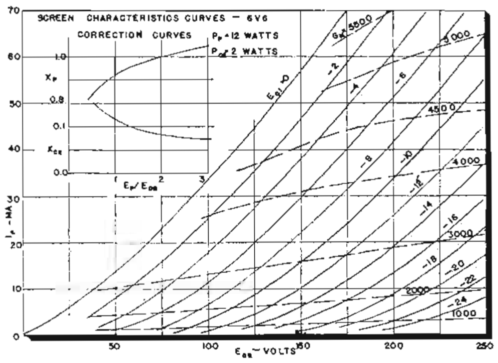


Fig. 3: Screen characteristic curves for 6V6

Transconductances Table

Assume that a push-pull power amplifier using 6V6 tubes (Fig. 3) is required. The available supply voltage is 250 v. The table of transconductances as a function of bias and screen voltage is included as Table I. Tabulating the small signal transconductance sums for different excursions about several mean bias values, and choosing those giving best overall uniformity gives (before correction) Table II.

The load impedances required for each screen voltage may be calculated from the data now available. They are summed in Table III.

The major contribution to the power output of a power amplifier operating in a nonlinear mode is obtained from the tube having minimum instantaneous bias. The prime effect of the second tube is to improve linearity. The power sum is made up of the positive excursion voltage and current change product and the negative excursion product. As can be seen, the power output rises as the tube screen voltage is raised from 150 to 200 v., then levels off. Since tube power input continues to increase as the screen voltage increases, choice of the lowest screen voltage providing required power yields best design.

Corrections to the plate current and transconductance values for the plate to screen voltage ratio variations may be made on the transconductance values of Table I as desired. The data in Table III include corrections on zero bias plate current. Making corrections is frequently desirable with power amplifiers. After the zero bias plate current and transconductance correction is chosen, the load impedance is determined. The corrected value of transconductance at each bias value may then be found and a new Table II prepared if it is required.

The transconductance sum table shows that the pentode push pull amplifier has an irregular variation of total amplification as a function of bias excursion. This variation indicates the presence of high order harmonics in the amplifier output. These harmonics undoubtedly contribute to the bad reputation of pentode amplifiers among high fidelity sound enthusiasts.

The lower the value of the plate voltage to screen voltage ratio (E_P/E_{C2}) which is accepted near zero bias with a given tube, the higher the output power which usually may be obtained. The increase in power output continues until the value of X_p becomes small enough that the product of X_p and the plate voltage change allowed from zero signal to zero bias begins to decrease as the value of the zero bias plate to screen voltage ratio is lowered. Consequently, when power output is of paramount importance, the optimum value of plate to screen voltage ratio for zero bias should be determined by calculating the product of X_p and the plate load voltage change from zero signal to zero bias.

Video Power Amplifier

As a final problem on the design of power amplifiers, assume that a video deflection amplifier is required for an oscilloscope. The tube chosen on the basis of examination of screen characteristics curves is the 6Y6 (Fig. 4). The basis for the choice is its high transconductance and wide bias range with a low screen voltage.

(*Continued on page* 146)

Since the video amplifier must have a limited size of load impedance to meet frequency response requirements, high transconductance is essential. Likewise since a large voltage output is essential, a large bias signal voltage range is required.

Assume that an amplifier capable of providing approximately 300 volts deflection voltage plate to plate with a load resistance of 200 ohms per tube is required. Table IV contains the tabulations of the transconductance sum data for different screen voltages.

When corrected for a minimum plate voltage of 6/10 of the screen voltage, the first three conditions in Table IV have adequate linearity. The current change for 75 v. on the screen is 80 ma; for 100 v., 124 ma; and for 125 v., 155 ma. With 2,000 ohms load, this 155 ma current change will provide the required

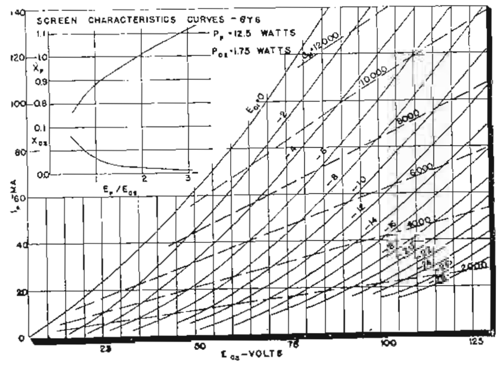


Fig. 4: Screen characteristic curves for 6Y6

300 v. deflection voltage. The plate supply voltage is 415 v. for the 125 v. screen voltage condition.

Checking the plate dissipation shows that the 6Y6 tube would be seriously overloaded if operated as just designed with 125 v. on its screen. To reduce the dissipation to within safe limits, the static plate current should be 40 ma or less. The required mean bias is then 24 v. In order to get best possible linearity, one may let the plate voltage at zero bias be approximately 40% of the screen voltage. Then X_p has a zero bias value of 0.7. The plate supply voltage required is 350 v. The amplifier can barely provide the required voltage output.

For a push-pull amplifier, the third harmonic distortion (assuming negligible second harmonic) is determined by

$$\text{Percent distortion} = 100\ (A_1 + A_2 - 2A_0)\ /\ 3(A_1 + A_2 + 6A_0) \quad (3)$$

A_1 and A_2 are the amplification sums at the excursion limits and A_0 is the amplification sum at the static bias. For a balanced push-pull amplifier, the amplification sums A_1 and A_2 are equal. Using Eq. (3) on the final video power amplifier design indicates that the amplifier will have about sixteen percent harmonic distortion.

The above problems are typical of the impedance coupled, transformer coupled, and power amplifier designs which can be solved by the conductance curve method. On all designs, distortion, practicallity of circuit components, and dissipation of circuit elements should be checked before final acceptance of the design. Check of power dissipation of all tube elements is particularly important, as was shown by the video amplifier design.

The effects of degeneration have been neglected in the problems so far considered. Since the use of degeneration is very important in the design of reliable circuits, the next article of this series (to be published in a forthcoming issue of TELE-TECH & ELECTRONIC INDUSTRIES) examines the design of circuits in which degeneration must be included.

AM and SSB

(*Continued from page* 66)

of white noise alone. "Awful" conditions are taken to represent those in which communications are limited by the combination of noise, severe selective fading and narrowband man-made interference. The vertical scale indicates the advantage of the single sideband system, with zero decibels taken to indicate equal total sideband power output of the AM and SSB transmitters.

The small circles indicate data which has been calculated or ob-

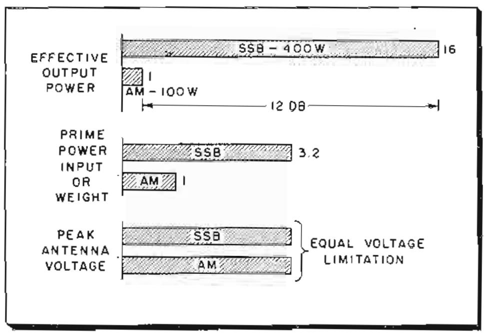


Fig. 6: Relative advantages of AM and SSB systems for given maximum antenna voltages

tained by experiment as described earlier. The experimental data obtained has been given the subjective "good" evaluation because most of the data was gathered under conditions yielding articulation scores around 50% over a 2000 mile link with transmitter power on the order of 1 to 5 watts. The dashed lines

(*Continued on page* 148)

are intended to indicate the observed trends rather than exact values.

The advantages of single sideband communications described above are not realized without cost, and this cost shows up in terms of increased complexity and difficulties of operation of the equipment. Single sideband techniques have been in use for well over 20 years, and it would appear that these factors have restricted wider application of the system.

Some of the most difficult problems of the SSB system lie in the required frequency stability of the transmitter and receiver and in the receiver automatic frequency control system required to compensate for frequency control inaccuracy and instability. In modern airborne communications, the additional requirements of completely automatic operation of numbers of equipments over wide frequency ranges and under rigorous conditions greatly increase the problem of development of a practical equipment.

In view of the SSB requirement for excellent stability and the operational requirement for large numbers of channels, it is very probable that crystal-saving techniques such as the frequency synthesizer or the stabilized master oscillator will be required. These methods require one or a very few carefully controlled crystal oscillators to stabilize any practical number of desired channel frequencies. The receiver AFC problem varies inversely with the state of the art of crystal manufacture. The Bell Telephone Labs. have recently indicated that there is no major obstacle toward substantial improvement in crystal aging and stability characteristics within the next few years.

There are three general methods of approaching the receiver frequency control problem. The first—completely independent control of receiver and transmitter—requires a substantial improvement in crystals and crystal oscillators. The second method involves excellent crystal control of receiver and transmitter plus elementary AFC provision in the receiver. This and other AFC methods require that full carrier be radiated from the transmitter at every opportunity, such as short initial periods and pauses in modulation and that the carrier be suppressed during modulation. The third approach, which might use existing crystals for frequency control and which would operate over the entire HF range, would require an

AFC system having wide correction range. In order to be practical, such an AFC system must be essentially free from capture by interfering signals that are not strong enough to jam the voice channel completely.

Any possible future conversion of a large communications system from AM to SSB will constitute a serious economic and operational problem. A possible interim system which would appear to offer maximum overall acceptability is based on the following factors:

1. A single sideband receiver can receive AM transmissions, provided the frequency accuracy and stability of the AM transmitter meets the minimum requirements of the SSB system. In fact, the performance of a SSB receiver may be substantially better than that of an AM receiver under difficult conditions in spite of the fact that one of the two sidebands is not used.

2. A conventional AM receiver will not receive SSB signals in a satisfactory manner without extensive modification or the use of a special adapter.

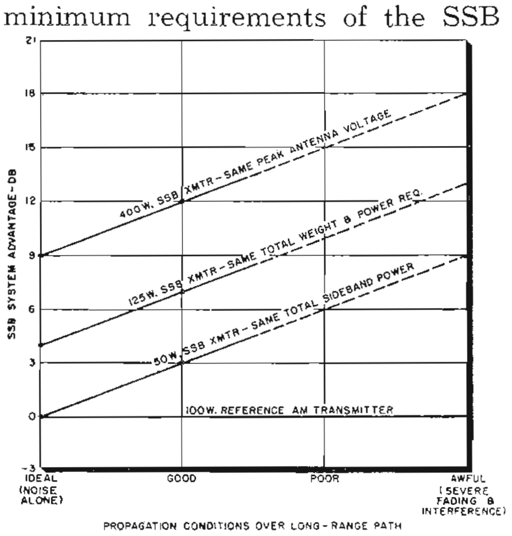


Fig. 7: Relative advantages of SSB for limiting propagation conditions over long range

Thus, ground stations equipped with AM transmitters (existing equipment), modified, if necessary, to provide good stability at the operating frequencies, can transmit to aircraft equipped with either AM or SSB equipment. The ground station receiving equipment would be supplemented by SSB receivers or AM receiver SSB adapters, thereby providing reception of either AM or SSB signals.

Air-to-air communications between planes having different types of equipment would not be possible without extensive modification of either or both equipments. This would not appear to be a definitive disadvantage, however, in view of the fact that standard operating procedures for high-frequency communications require very little of this type of communications.

This paper was presented at the National Conference on Airborne Electronics at Dayton, Ohio, May 11-13, 1953.

NEC Technical Program

The National Electronics Conference for 1953 will take place in Chicago's Hotel Sherman on Sept. 28-30, 1953. The technical paper program is as follows:

MONDAY, SEPT. 28

1. Circuits I

"Continued Fraction Analysis of Tandem Networks"—D. L. Finn—Georgia Inst. of Technology.
"Parallel-T Discriminator Design Techniques"—Paul T. Stine—Naval Research Lab.
"Synthesis of RC-Ladder Networks for Minimization of Flat Loss"—H. Smead—Purdue Univ.
"Synthesis of Constant-Time-Delay Networks"—M. S. Corrington and R. W. Sonnenfeldt—RCA Victor Div.

2. Magnetic Amplifiers

"The Application of Transistors to the Control of Magnetic Amplifiers"—G. F. Pittman, Jr.—Westinghouse Electric Corp.
"Industrial Applications of Transductors"—R. J. Radus—Westinghouse Electric Corp.
"Magnetic Frequency Conversion"—L. C. Harriott—General Electric Co.
"A Magnetic Amplifier for Temperature Detection and Control"—R. I. Van Nice—Westinghouse Electric Corp.
"Applying Magnetic Amplifiers"—L. W. Buechler—Vickers Electric Div.

3. Audio and Microphonics

"The 'Vagabond' Wireless Microphone System"—T. W. Phinney—Shure Brothers, Inc.
"Some Engineering Considerations of High-Fidelity Sound Reproduction"—S. A. Caldwell—RCA Victor Div.
"A Method of Analyzing the Microphonic Output of a Tube and a Description of the CK 6247"—W. H. Hunter—Raytheon Mfg. Co.
"Audio-Frequency Impulse Noise and Microphonism"—R. J. Wohl, S. Winkler, L. N. Heynick, and M. Schnee—New York Naval Shipyard.

4. Circuits II

"Directional Coupling with Transmission Lines"—W. L. Firestone—Motorola, Inc.
"A Broad-Band Hybrid Junction for VHF and UHF"—R. E. Grantham and J. W. Dorsett, Jr.—Naval Ordance Lab.
"Self Compensated Multilayer Distributed Constant Delay Lines"—W. S. Carley—Naval Ordance Lab.
"A Transmission Line Oscillatory Pulse Generator"—M. W. Hellar, Jr. and W. G. Holter—General Electric Co.
"Multiple Resonance Effects in Oscillators"—W. A. Edson—Stanford Univ.

5. Servomechanisms

"Some Design Considerations of a Saturating Servomechanism"—P. E. Kendall and J. F. Marquardt—Cook Research Labs.
"Switching Errors in an Optimum Relay Servomechanism"—T. M. Stout—Univ. of Washington.
"Transient Power Flow Studies of Elementary Servomechanisms"—J. P. Magnin and J. R. Burnett—Purdue Univ.
"The Magnetic Modulator in A.C. Servo Corrective Networks"—C. Volz—Pennsylvania State College.
"Possibilities of a Two Time Scale Computing System for Control and Simulation of Dynamic Systems"—H. Ziebolz—Askania Regulator Co., and H. M. Paynter—M.I.T.

6. Ultrasonics

"Ultrasonics and Industry"—O. Mattiat—Clevite-Brush Development Co.
"Ultrasonics and Medicine"—J. F. Herrick—Mayo Clinic.
"A Non-Contact Microdisplacement Meter"—H. M. Sharaf—Lab. for Electronics.
"A Temperature Controlled Ultrasonic Solid Acoustic Delay Line"—E. S. Pennell—Bell Telephone Labs.
"Characteristics of Ultrasonic Delay Lines Using Quartz and Barium Titanate Ceramic Transducers"—J. E. May—Bell Telephone Labs.

7. Materials and Components

"Magnetic Shielding Effects"—R. D. Teasdale and A. W. Friend—Magnetic Metals Co.
"Ferrites and Their Properties at Radio Frequencies"—R. L. Harvey—Radio Corp. of America.
"The Application of High Frequency Satur-

able Reactors"—G. H. DeWitz—C.G.S. Labs.
"Thermoplastic Insulated Tri-Axial Pulse Cables"—M. Tenzer and J. Spergel—Signal Corps Engineering Labs.
"Development of a High Speed Relay"—A. F. Bischoff—General Electric Co.

TUESDAY, SEPT. 29

8. Filters I

"An Introduction to Modern Filter Theory"—E. A. Guillemin—M.I.T.
"RC Filter of Novel Design"—J. Linvill—Bell Telephone Labs.
"Low Frequency Electro-Mechanical Filters"—S. P. Lapin—Motorola Inc.
"Geometric Aspects of Least Squares Smoothing"—A. A. Houser—Sperry Gyroscope Corp.

9. Television I

"A Continuous All-Eectronic Scanner for 16 mm Color Film"—V. Graziano and K. Schlesinger—Motorola Inc.
"A New Television Film Scanner"—F. J. Bingley—Philco Corp.
"Vidicon Film Reproduction Cameras"—H. N. Kozanowski—RCA Victor Div.
"Alignment of a Monochrome TV Transmitter for Broadcasting NTSC Color Signals"—J. F. Fisher—Philco Corp.

10. Electron Tubes I

"Improved Instrument Cathode Ray Tube Design"—K. A. Hoagland and H. Grossbohlin—Allen B. Du Mont Labs.
"Space-Charge Behavior in Backward Space-Harmonic-Beam Oscilators"—W. G. Dow—Univ. of Michigan.
"A Voltage-Tuned High-Power Microwave Oscillator"—E. C. Dench—Raytheon Mfg. Co.
"An RF Amplifier Tube for Airborne Communications Receivers"—R. E. Moe—General Electric Co.
"A High-Power CW Magnetron"—D. E. Nelson—Radio Corp. of America.

11. Nucleonics

"Electronics for a Synchrocyclotron"—L. Kornblith, Jr.—Univ. of Chicago.
"Nuclear Counting on the Chicago Synchrocyclotron"—M. Glicksman, H. L. Anderson, and R. Martin—Univ. of Chicago.
"A Ten Millimicrosecond Scaler"—J. Fischer and J. Marshall—Univ. of Chicago.
"Instrumentation for Nucleonics and Attendant Accuracy Problems"—R. H. Delgado—Nuclear Instrument and Chemical Corp.

12. Filters II

"The Role of Non-Linear Filters in Electronic Systems"—W. D. White—Airborne Instrument Labs.
"Time Filtering of Impulses"—A. A. Gerlach—Cook Research Labs.
"Computational Techniques which Correlate Steady State and Transient Response of Filters"—E. A. Guillemin—M.I.T.
"Use of Sampling Functions to Design for Transient Response"—W. K. Linvill—M.I.T.
"Potential Analog Methods of Solving the Approximation Problem of Network Synthesis"—R. E. Scott—M.I.T.

13. Television II

"Transition Effects in Compatible Color Television"—J. B. Chatten and R. C. Moore—Philco Corp.
"Aperture Compensation for Television Pick-up Equipment"—R. C. Dennison—RCA Victor Div.
"An Automatic Television Overload Elimination Circuit"—C. Masucci, J. R. Peltz, and W. B. Whalley—Sylvania Electric Products, Inc.

14. Electron Tubes II

"A Reflex Klystron Designed for Rapid Mechanical Tuning"—R. C. Hargenrother and H. W. Cockrill—Raytheon Mfg. Co.
"A Medium Power Developmental Traveling-Wave Tube for Microwave Relay Service at 2000 MC"—W. W. Siekanowicz—Radio Corp. of America.
"Long Line Effect with Pulsed and Frequency Modulated Magnetrons"—W. M. Hall—Raytheon Mfg. Co.
"The Influence of Vacuum Tube Component Temperatures on Characteristics and Life"—I. E. Levy—Raytheon Mfg. Co.
"The Transient Conduction of Current in a Hot Cathode Gas Diode"—J. Schuder—Purdue Univ.

15. Computers

"The Design of Computer Circuits to Operate at Extremely High Temperatures"—J. F. Koch, Jr. and G. C. Hand, Jr.—Technitrol Engineering Co.
"A Data Handling System for General Instrumentation"—M. E. Frank—Calif. Institute of Technology.
"The Application of Pulse Position Modula-

(*Continued on page* 152)

tion to Digital Computers"—C. B. Kinne—Raytheon Mfg. Co.
"Magnetic Core Ring Counter"—S. Guterman and R. D. Kodis—Raytheon Mfg. Co.
"Criteria for the Selection of Analog-to-Digital Converters"—G. L. Hollander—M.I.T.

WEDNESDAY, SEPT. 30

16. Network Synthesis

"Formulation of the Approximation Problem"—N. Balbanian—Syracuse Univ.
"The Role of Conformal Transformations in Network Synthesis"—W. R. LePage—Syracuse Univ.
"The Role of Analytic Continuation in Network Synthesis"—S. Seely—Syracuse Univ.
"Synthesis of RC Shunted High-Pass Networks"—C. F. White—Naval Research Lab.

17. Transistors

"Transistor Amplifiers Applied to Delay Lines"—A. H. Schooley—Naval Research Lab.
"Automatic Gain Control of Junction Transistor Amplifiers"—F. H. Blecher—Bell Telephone Labs.
"Transistor Feedback Amplifiers"—S. K. Ghandhi—General Electric Co.
"Stability Analysis of a Basic Transistor Switching Circuit"—T. R. Bashkow—Bell Telephone Labs.
"An Amplitude-Stabilized Transistor Oscillator"—E. R. Kretzmer—Bell Telephone Labs.

18. Instrumentation I

"Millimicrosecond Timer Utilizing a Spiral Sweep Cathode Ray Oscillograph"—Warren Slie, R. H. Stresau, and C. Goode—U. S. Naval Ordnance Lab.
"A Multi-Exposure Microsecond Photographic System"—L. D. Findley, E. S. Kennedy, and J. H. Van Horn—Midwest Research Institute.
"The Generation of Precisely Known Phase Relationships"—J. M. Looney—Technology Instrument Corp.
"High Input Impedance Metering Circuit Employing Precision Zero Suppression for Extending Input Range"—A. D. Ehrenfried—M.I.T.

19. Microwaves

"A High Power Microwave Coupler Design"—G. I. Cohn and G. T. Flesher—Illinois Inst. of Technology.
"Wideband Waveguide to Coaxial Line Adapters Using Stepped Ridge Transformers"—L. Swern—Sperry Gyroscope Co.
"Electromagnetic Propagation Trough Waveguides of Curtate-Sector Cross-Section"—La Plante and T. J. Higgins—Univ. of Wisconsin.
"Determination of the Design Constants of Dielectric and Metal-Plate U.H.F. Lenses by Use of Physical Analogy"—W. B. Swift and T. J. Higgins—Univ. of Wisconsin.
"Measurement of Microwave Local Oscillator Noise"—G. C. Dalman and E. Ortiz—Sperry Gyroscope Co.

20. Engineering Management

"Statistical Methods in Experimental Design Serve the Electronics Industry"—F. Caplan, Jr.—General Electric Co.
"Control of Cost of Research and Development Projects"—H. J. Finison—Armour Research Foundation.
"Staff Engineer's Part in Control of Design and Development Costs"—H. G. Purinton—Bendix Radio Co.
"An Engineering Incentive Problem"—H. Goldberg—National Bureau of Standards.
"The Engineer and his Customer"—C. A. Maynard—Indiana Steel Products Co.

21. Instrumentation II

"The Scintillation Counter as a Low Voltage X-Ray Detector"—H. Berger—General Electric Co.
"Counter Technique in Interference Analysis"—M. M. Newman, R. C. Schwantes, and J. R. Stahmann—Lightning and Transients Research Institute.
"Conclusive Voltage Calibration of High-Frequency Signals"—W. K. Volkers—Millivac Instrument Corp.
"The Crystal Constant in Microwave Measurements"—G. T. Flesher—Illinois Inst. of Technology.
"Void Detector for Sheet Insulating Materials"—R. E. Anderson—General Electric Co.

22. Communication

"Accuracy and Speed on Short-Wave Teleprinter Services"—J. B. Moore—RCA Communications, Inc.
"Transatlantic Telephone Communications"—J. R. Rae, A. T. & T.
"The Application of Wideband Radio-Relay Methods in International Telecommunication Services, Including Trans-Atlantic Television"—W. S. Halstead—Unitel, Inc.
"Design of a Commercial Facsimile System"—H. P. Corwith, Western Union Telegraph Co.

Printed Resistors

(*Continued from page* 80)

cylinders with Schrader flow valves and Skinner electric solenoid valve units. It derives its electrical time control through simple RC delays achieved by capacitive shunted relays. It derives its position information from high sensitivity Micro-Switch units. It does not utilize a single servo-motor or gear train assembly and is free from the usual heavy design time and maintenance aspects of this type of equipment.

Many different forms of "Autobrader" are possible, all design forms being dependent on the work piece involved. The chute system was selected for this design for many reasons. A large rotating drum with many work stations on its periphery must wait until the longest abrading time for any single resistor has elapsed before indexing. The chute device averages out time delays, due to the reserve supply capacity of the feed chute of each station. Resistors are on both sides of the particular work piece processed by this design, and both sides are readily worked on in alternate fashion, due to the flip-over action of plates passing through the unit. A rotating machine is limited to a fixed number of stations; the cascade unit may be as large as desired or as small. By means of interchangeable gun and contact assemblies, any number of resistors may be handled by repeat processing by a few stations. The three station unit shown does 15 different resistors by repeat cycling. Gun and contact assemblies are changed and plates run through again.

Removing Used Abrasive

One of the major problems in items using the newly developed Airbrasive units is removal of used abrasive. A vacuum duct, shown in Fig. 4, is placed directly in back of the work position and coupled with periodic hand vacuuming manages to remove excessive abrasive. The entire unit is built around a single aluminum alloy casting which forms the front panel. Side braces act to link this front panel to the air chassis and the electrical chassis directly beneath the air chassis. A disconnect between the front panel and rear chassis units provides for maintenance ease.

The flow valves, used to regulate cylinder travel speed, are placed at the rear and side of the station. These valves, coupled with the relay "count" adjustment and abrading

(*Continued on page* 154)

time control, are the only adjustments used to control the cycling.

No vacuum tubes other than a voltage regulator are used in the "Autobrader." 110 volt ac relays in combination with 16,000 ohm dc relays are used for all controlling actions. The dc relays are all of snap-action type eliminating hesitation and uncertain closures. All solenoid valves are operated by 110 v. ac, and are of types identified in the schematic.

The use of air cylinders as opposed to solenoids results in great simplification mechanically and electrically. The ability to control speed of operation precisely, with only a series flow control valve, renders the additional complication of solenoid valves of small consequence in the overall picture, due to the elimination of many complicated electrical and electronic time control circuits.

The schematic of the controlling circuitry (Fig. 6) shows an interesting combination of electrical and pneumatic elements. Where possible, design approaches best suited to utilize advantages afforded by this type of controlling system were used. An analysis of the controlling unit follows.

Controlling Unit

The "Autobrader" is controlled by an electrical resistance limit bridge. This device, using electrical resistance standards switched into it by the "Autobrader," will close a relay whenever the unknown, also supplied by the "Autobrader," is lower in electrical resistance than the standard. The limit bridge, a Clippard Resistance Comparator, is connected to a socket, the connecting elements of which are identified as 1, 2, 3, 4, 5, and 6 on the schematic. The standard input to the bridge is connected to terminals 1 and 2. The unknown on the plate to be worked on is connected by means of moving contacts in the "Autobrader" to terminals 3 and 4, thus, to the limit bridge. The output reaction of the limit bridge, a result of comparing standard and unknown, an opening or closing of its relay, is returned to terminals 5 and 6, thereby controlling the actions of the "Autobrader."

Assuming the "Autobrader" to be at the start of an operating cycle, on-off toggle switch S closed, V-4-14-A overload switch closed, and V-4-14-C load checking switch closed:

V-4-14-B sensing switch is in its down position, due to lack of a plate in the work position. This causes ac voltage to appear across terminal board connections 6 and 8, causing the changer solenoid valve to open, admitting air through a flow valve to the changer cylinder. This causes the cylinder, which has a spring-load return, to move forward stripping the bottom plate from the supply stack and causing it to drop down the chute into the work position. The presence of a plate in this position moves V-4-14-B to the up position, thus, cutting off the supply of air to the changer cylinder, causing it to return to its at-rest position, ready to recycle.

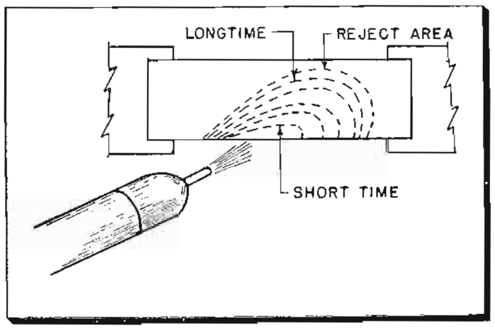


Fig. 7: Increased time of abrasion cuts away more conductive coating to increase resistance

The presence of V-4-14-B in the up position causes ac to appear across terminal board connections 2 and 5. This actuates the contact solenoid valve and thusly the contact cylinder which causes the contacts R and S to move into contact with the unknown resistor on the plate and the abrader nozzle into abrading position. The value of the unknown resistor is now compared to the low standard resistor, composed of the high standard plus a shunt resistor connected to section A of relay DC-I. Two courses of action are now open to the "Autobrader," dependent on the signal received from the limit bridge.

Unknown Lower Than Low Standard: If the limit bridge relay, closes, relay AC-IV, a protective relay preventing overload of the bridge relay, will close indicating that the resistive unknown is lower than the low standard and that abrasion is required. The closing of AC-IV causes AC-I to move its contacts to the down position, thus, removing d.c. voltage from DC-I and DC-II preventing their closure. (They do not close immediately, due to capacitive time delay shown.) The a.c. voltage on AC-I also goes to terminal board numbers 4 and 5, causing the abrading device to deliver abrasive under air pressure; thus, abrading the resistor and removing resistor material, thereby raising its value.

Following completion of abrading

(*Continued on page* 156)

action described above, the limit bridge relay will open as the unknown value because higher than the standard. This causes the action described next to take place.

Unknown Higher Than Low Standard: When the unknown is higher than the low standard, the bridge relay will not close, or will open, if previously closed. After the capacitive delay has passed DC-I will close, moving its contacts to the down position. This causes the shunting resistor on section A of DC-I to be removed from the circuit and the unknown is now compared to the high standard.

If unknown is of lower value, it will be passed by the pass cylinder; if of higher value, it will be rejected by the reject cylinder.

(1) If the value of the unknown is less than the high standard, the limit bridge relay is closed. With DC-I in down position and AC-IV in down position, AC-I will be in the up position; this allows AC-III to close, as DC-II is in up position, since closure of AC-III removed the

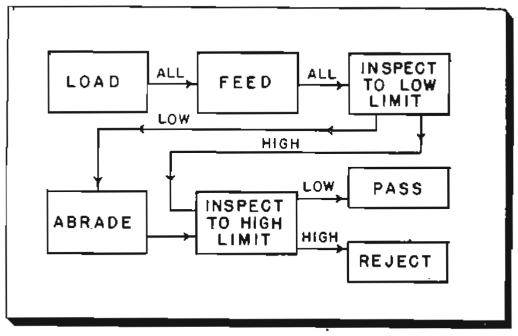


Fig. 8: Abrasion-inspection flow diagram

d.c. voltage from DC-II, preventing it from closing. The voltage across AC-III appears on terminal board numbers 1 and 3 and actuates the pass-on solenoid valve, removing the stop pin from the chute, allowing the plate to fall into the feed chute of the next station. Closing of the pass solenoid valve also removes the air supply from the contact cylinder, air supply for the contact cylinder coming through the pass-on valve; and this causes the contacts to move back. The absence of a plate then causes the changer to deliver a new plate starting a new cycle.

(2) If the valve of the unknown is higher than the high standard, the limit bridge relay will not close. This allows DC-II to close, after its time delay, actuating the reject solenoid valve and cylinder. This closure of DC-II removes a.c. from terminal board 2, thus, deenergizing contact solenoid, retracting the contacts and allowing the reject cylinder to push the plate out of the machine. The

(*Continued on page 158*)

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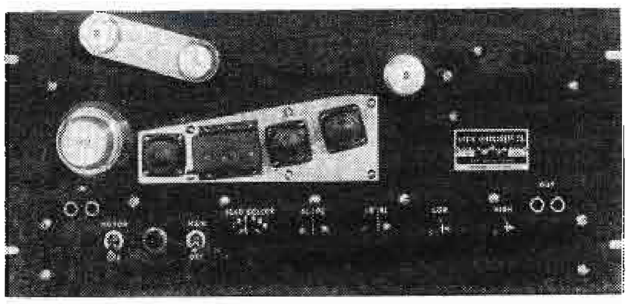

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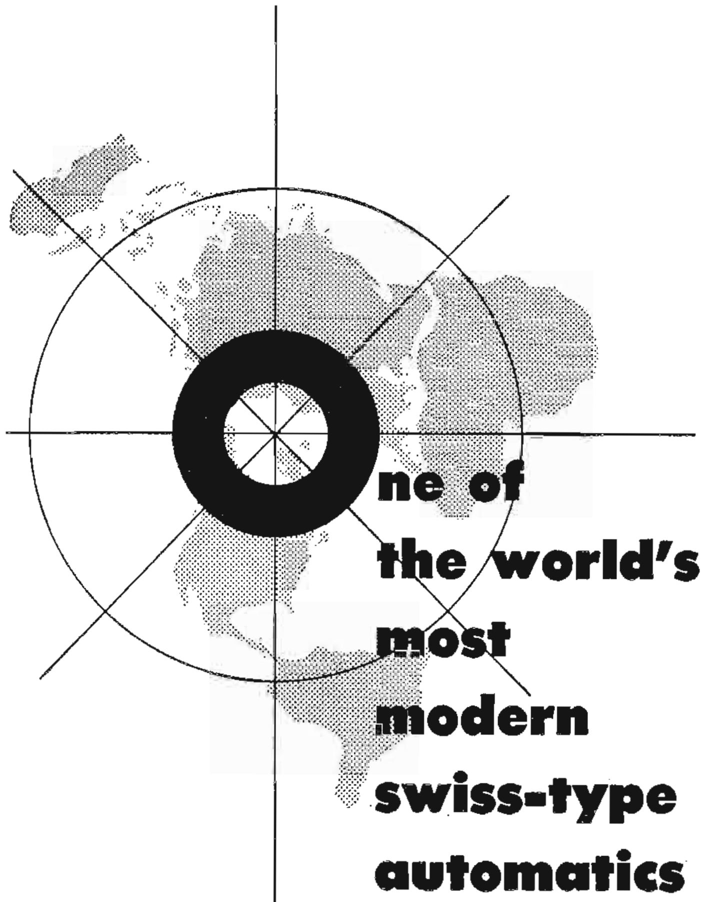

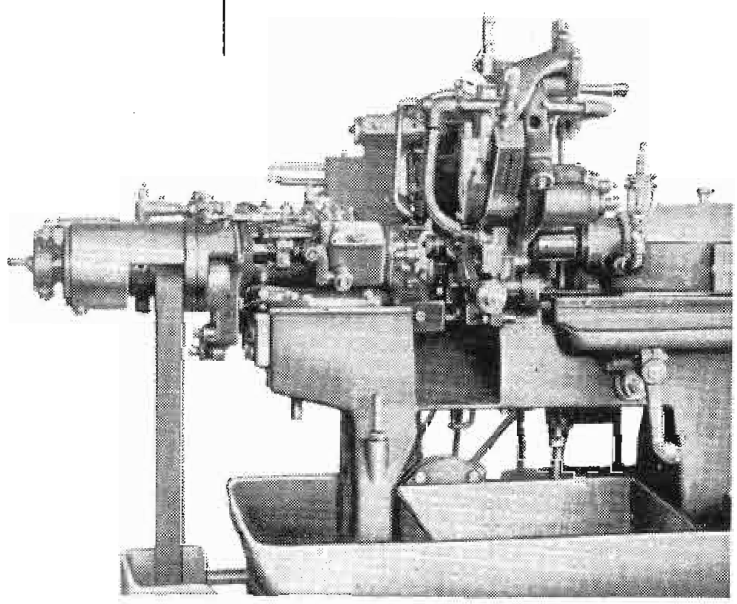

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absence of a plate causes the charger to operate, starting a new cycle.

Overtime Abrasion: If the abrading operation continues for a time period considered excessive, the heater coil of #304 Advance relay causes its contacts to close. This causes DC-II to close actuating the reject circuit.

Slow Following Station Action: In the event the next station runs slowly, thus, causing its feed chute to fill, a finger extending from V-4-14-A switch into the feed chute is moved shutting down this station This station will restart when the following station catches up.

No Plates in Chute: In the event that less than two plates are in position in the feed chute, a switch, V-4-14-C, prevents the machine from operating, thus, preventing a locked feed system requiring manual recycling to start.

Bridge Standards Control: Relay DC-I by means of switching section A creates the low standard when desired by shunting the high standard with that valve resistor necessary to create the low standard. This is done to prevent the limit bridge from seeing an open circuit on its standard terminals at any time and to keep its electrical circuits constantly in the same operating areas. This form of circuitry prevents erratic bridge action.

The inherent flexibility of the basic "Autobrader" circuitry has already led to exploration of its use for modification of capacitive and inductive printed circuit components. Being readily constructed from standard commercial units, new applications are easily investigated. The freedom from heavy design time usually accompanying a unit of this nature should lead to more and more application of this form of automation.

The model work on the Autobrader was done by Messrs: J. Arthur Bienvenue, Henry Peppin and John Caglione. Photo accompanying this article by Peter Petrucelli.

Bill Makes RR Radio Mandatory

The Senate has passed and sent to the House a bill sponsored by the late Sen. Charles Tobey, which would authorize the Interstate Commerce Commission to order installation of radio and electronic safety devices on railroads. The bill has been opposed by the carriers on the grounds that many such devices are costly and in the experimental stage. It was introduced soon after a wreck in Washington's Union Station early this year.

Superconductivity

(*Continued from page 83*)

of other metals, including some which are poor conductors at ordinary temperatures, their resistance vanishes completely at some critical temperature above Absolute Zero. The electrical resistance of practically all metals has been investigated down to about 1° K or lower, and in all, about 20 metals so far have been found to be superconductive. For the most part these lie in a well-defined region in the Periodic Table and include among others mercury, tin, lead, aluminum and zinc. It is interesting that the intermetallic compounds of bismuth and nickel and of gold and bismuth become perfect electrical conductors although the components themselves are not superconductors. The highest temperature at which superconductivity has been found is 15° K with columbium nitride.

Bolometer Applications

Although superconductivity is not fully understood theoretically, it has already found application in bolometers, that is as a detector of radiant energy. Briefly, the sensitive element is a superconducting strip of metal maintained in the transition range between normal and superconductivity where a slight change of temperature will cause an enormous change in electrical resistance. Further, low-temperature operation guarantees rapid response by virtue of the low heat capacity, and also a low ultimate limit of detectability because of the low level of noise due to statistical fluctuations.

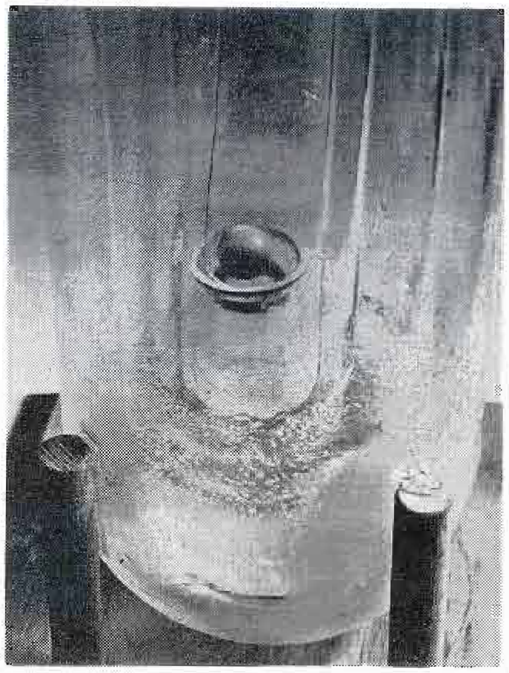
Many bolometers using columbium nitride as the sensitive element have been studied. An improvement in speed by a factor of a hundred over bolometers operating at room temperatures has been realized in practice, and it has been found possible with such bolometers to detect changes in temperature as small as 0.0000001° C.

Dr. Andrews at Johns Hopkins Univ., who has done considerable research on superconducting bolometers, suggested a number of possible applications. For example, when used with an oscillating scanning mirror, the bolometer can pick up images of objects by their own thermal radiation and present crude pictures of the objects on a TV screen. Similarly any temperature difference, even as little as a few degrees, developed by spontaneous combustion could be detected and shown on TV screen at some distant point.

A superconducting bolometer was also found to be a detector of radio signals, necessarily superior to other types of radio receivers operating at room temperature in its signal-to-noise ratio. More practical interest is being attached to the fact that the superconductive bolometer can be used as an alpha particle detector which not only counts the particles but gives an indication of their energy.

Magnetic Properties

The magnetic properties of superconductors are fully as important and unexpected as are the electrical properties. The magnetic permeability of a metal in the superconductive state is zero. in other words, a



Resistanceless lead sphere floats in liquid helium (−452°F), supported by magnetic field induced by the superconducting lead rings

superconductor is perfectly diamagnetic. Thus superconductors become among other things, excellent magnetic shields.

Superconductivity also offers a means of constructing magnetometers of high sensitivity and low noise. High Q resonators are available in the form of cavities fabricated from superconducting material. Q's in range of millions have been reached. Because the metals have vanishing expansion coefficients at low temperatures and become exceedingly stiff and rigid, the mechanical stability of these resonators is great. Electrical filters composed of elements made of superconducting metals would possess properties unattainable by other means.

Another subject of interest is the temperature dependence of electrical noise. The ordinary noise found

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in metallic resistors, referred to as Johnson or thermal noise, is known to decrease in direct proportion to the temperature and to increase with the value of the resistance used. Thus when thermal noise in a resistor is of great importance, a considerable increase in the signal-to-noise ratio can be expected by making it of metal and lowering the temperature.

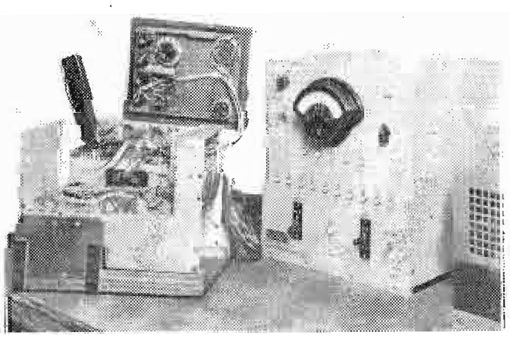
The electronic industry in already familiar with the use of refrigerated traps for vacuum work. Vapors may be pumped faster by exposing them to a cold surface than by a mechanical or diffusion pump. At liquid helium temperatures all substances except helium itself are solids with completely negligible vapor pressures. A liquid helium trap may therefore serve as a vacuum pump for all gases with the single exception of helium.

Insulators Hold Charge

Insulators become so nearly perfect at these low temperatures that they may hold a charge for unusually long periods. This may be useful, for example, in a storage tube for computers.

The field of semiconductors may also benefit from low-temperature measurements of processes. Admixtures of alloying materials markedly affect the conductivity of germanium, and the effect is different at very low temperatures than at room temperatures. It is felt that additional data obtained in extreme cold should help explain germanium's conductive mechanisms and thus improve semiconducting devices such as germanium diodes and transistors. Perhaps a material as yet undiscovered, may show semiconducting properties at liquid helium temperature and be useful as a low noise transistor.

AUTOMATIC CIRCUIT CHECKER



High-speed automatic checker for locating wiring discrepancies has been developed by Federal Telephone & Radio Corp., an IT & T associate. Shown in position for production testing of Signal Corps equipment, device can check 44 complex circuits in less than three minutes, using unskilled personnel. Unit under test is at left, checker at center, and bridge at right

News of MANUFACTURERS' REPS

I. E. Robinson Co., 702 Mattison Ave., Asbury Park, N. J., and 222 Long Lane, Phila. (Upper Darby, Pa.; **R. M. C. Associates,** 103 Lafayette St., New York 13, N. Y. and 114 East Main St., Bogota, N. J.; **Yewell Associates,** 270 Commonwealth Ave., Boston 16, Mass. and 1101 East Main St., Bridgeport, Conn.; **Horman Associates,** 2017 S. Street, N.W., Washington 9, D. C.; and **J. D. Ryerson,** 712 State Tower Bldg., Syracuse 2, N. Y. were appointed as of July 1, 1953 to handle Hewlett-Packard electronic instruments in the northwestern and New England states formerly covered by Burlingame Associates.

Hornbrush Associates, Pine Grove Circle, Scotch Plains, N. J. have been given additional territory in New York State by American Gas Furnace Co., Elizabeth, N. J.

Eric Gompertz has been appointed Caribbean sales representative for the International Div., Allen B. DuMont Laboratories, Inc. to sell all divisional products in Cuba, Puerto Rico, Santo Domingo, Panama, Central America, Venezuela, and Columbia. His headquarters will be DuMont's Florida offices, 7000 North East 4th Court.

A-N-B Specialties Co., West Richfield, Ohio, has been appointed factory representative for Stephens Mfg. Corp. for loud speakers, condensers, and wireless microphones in Kentucky, Ohio, West Virginia, Western Pennsylvania, and Michigan.

Wm. Rambo has joined the J. T. Hill Sales Co., Los Angeles representatives, to work on component sales to manufacturers. Formerly, he was associated with D. H. Loukota Co. in the same capacity.

Jack Carter, former sales manager of Walter L. Scott, Los Angeles, has joined John B. Tubergen Co., Los Angeles electronic representatives. Mr. Carter and Robert L. Bray will become associates in the organization.

Arthur A. Gustafson, who has been appointed representative of America Silver Co., Flushing, N. Y., will have his office at 2580 University Ave., St. Paul 4, Minn.

Clark R. Gibb has been appointed representative for Bud Radio, Inc., to handle electric components and sheet metal products in Minnesota, North Dakota, and South Dakota. His office is at 1409 Hennepin Ave., Minneapolis 3, Minn.

Ash M. Wood Co., El Monte, Calif., will handle sales for the entire H. H. Buggie, Inc. line of electronic components and parts in California, Arizona, and Nevada. **Lowry-Dietrich Co.,** 1404 Swantek St., Pittsburgh, Pa., will represent the client company in western Pennsylvania and West Virginia.

BULLETINS

Aircraft Products

The 32-page photographically illustrated, installation instruction manual, Technical Bulletin 53Y1, covering the aircraft products of Burndy Engineering Co., Inc., Norwalk, Conn., shows how to use tools; gives inspection procedure and instructions covering Hydent compression terminals and links, terminal blocks, current limiters, and solderless shielded wire terminations. The literature is free.

Coaxial Cables

Federal Telephone and Radio Corp. Selenium-Intelin Div., 100 Kingsland Rd., Clifton, N.J., has published an informative 24-page illustrated booklet that is replete with graphic and tabular engineering information covering coaxial cables and TV lead-ins.

Vacuum Machines

Hild Floor Machine Co., 740 Washington Blvd., Chicago 6, Ill., has released a color circular which illustrates and describes Models 115 and 155 heavy-duty wet or dry vacuum machines made by the company.

Plating Solutions

Bulletin IC 2, published by Ward Leonard Electric Co., Industrial Chrome Div., Mount Vernon, N.Y., gives the deposit characteristics of Chromasol concentrated plating solutions Nos. 1 and 2.

Tower Lighting

"Tower Lighting," a 20-page booklet (381-F), describes methods and materials necessary for the installation of obstruction lighting equipment on radio, TV, and microwave relay towers. Included drawings and bills of material for lighting towers of all heights meet F.C.C. and C.A.A. requirements. Issued by Crouse-Hinds Company, Syracuse 10, N.Y.

Temperature Test Chamber

Stratham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif., have issued a four-page folder which presents specifications and operating and maintenance instructions covering the Model TC-1 temperature test chamber.

CR Tubes

Vacuum Tube Products, 506 South Cleveland St., Oceanside, Calif., have released new data sheets for the company's cathode ray tube catalog covering types 5AB, 5R, and 5X.

Extruded Plastics

"Extruded Plastics," 1954 edition, just published by Anchor Plastics Co., Inc., 33-36 36th St., Long Island City 6, N.Y., shows 12 pages of technical data and the latest applications of thermoplastic rods, tubes and shapes. Special sections deal with the size and range of extrusions.

DC Power Supplies

A new eleven-page catalog released by Rapid Electric Co., 2881 Middletown Rd., New York 61, N.Y., describes and illustrates a line of direct current power supplies, and presents information on rectifiers with technical data on controls and periodic reversing equipment.

Sheet Metal Fabricator

The first edition of Catalog 10-AA is an 8-page loose-leaf folder in color which illustrates and presents drawings and performance data covering the Wales sheet metal fabricator produced by Wales-Strippit Corp., North Tonawanda, N.Y.

TV Film Scanner

Philco Corp. Government & Industrial Div., Philadelphia 4, Pa., has sent an illustrated folder and two specification and data sheets to broadcasters which discuss and describe the company's new studio-to-transmitter link and new TV film scanner.

BULLETINS

(Continued)

Resistors

Bulletin No. 1, a four-page folder released by Arnold Ceramics Inc., 1 East 57th St., New York 22, N.Y., discusses chemo-carbon resistors and presents styles, dimensions, and tabular and graphic technical data.

Capacitors

Astron Sales Corp., 255 Grant Ave., East Newark, N.J., have prepared a new catalog supplement, AC-3A, which gives numbers, capacitance and voltage ratings, case sizes, and prices of its line of twist-prong capacitors.

Resistance Welders

"Weld-It," a four-page folder published by Taylor-Winfield Corp., Warren, Ohio, illustrates and describes various types of bench resistance welders.

Belt Splicer

Bulletin No. 310, distributed by Aget-Detroit Co., Ann Arbor, Michigan, presents the features and operation of the Econ-away Abrasive Belt Splicer.

Conveyor

A two-page loose leaf sheet released by Miskella Infra-Red Co., East 73rd and Grand Ave., Cleveland 4, Ohio, presents illustrations, dimensions, specifications, and performance data covering the Miskella Heli-Veyor conveyor.

Humidity Test Units

Bulletin Rh-550-2, a four-page color loose-leaf folder, presents engineering data and illustrates the H-series relative humidity testing units produced by Bowser Technical Refrigeration Div., Bowser, Inc., Terryville, Conn.

Transformers

The 24-page Stancor Transformer 1953 catalog, which carries complete electrical and physical specifications for nearly 500 transformers for electronic applications, is being placed in the hands of the company's distributors by the Standard Div., Chicago Standard Transformer Corp., Addison & Elsten, Chicago 18, Ill.

Plastics Components

A new four-page brochure describing and illustrating various types of plastics components is offered by the Tri-Point Mfg. and Developing Co., 401 Grand St., Brooklyn 11, N.Y.

Glass-Bonded Mica

A comprehensive 23-page, illustrated reference and operating manual on the machining of glass-bonded mica has been issued by Mycalex Corp. of America, Clifton, N.J.

Tape Erasure

"Sound Talk," Bulletin No. 24, issued by the Minnesota Mining and Mfg. Co., St. Paul, Minn., discusses the theory and practice of AC magnetic tape erasure, covering such points as orientation, speed, and pass numbers.

Kudos to Mr. Kallas

Readers who enjoyed the delightful sketch "Workings of the Engineering Mind" on page 112 of our August issue, should know that this is the work of J. L. Kallas, who is under exclusive contract to the "Council Compass" of the Council of Western Electric Technical Employees, of which Arthur M. Marin is national chairman.

INDUSTRY NEWS

Frank White has resigned as president of the National Broadcasting Co. Brigadier General David Sarnoff, Chairman of the Board of NBC, has assumed the presidency, in addition to his office as Chairman, pending the election of a new president. The resignation, which went into effect August 7, 1953, was dictated by health considerations.

John H. Ganzenhuber, formerly manager of government contracts division, Hoffma Laboratories, Inc., Los Angeles, has been elected vice-president and general manager of Hughey & Phillips, Tower Lighting Div., 3300 N. San Fernando Blvd., Burbank, Calif. where he will make his headquarters. Mr. Ganzenhuber, at one time, was manager of broadcast sales and assistant manager of government sales for Western Electric Co.

John H. Ganzenhuber

Edward J. Meehan, Jr., has rejoined the broadcast marketing division as sales coordinator of AM and FM radio transmitters and broadcast audio equipment of Engineering Products Dept., RCA Victor Div., Radio Corp. of America.

Frank Freimann, president of Magnavox Co. recently announced the election of John A. Rankin and John S. Sturgeon as vice-presidents of the company.

Russell K. Soderquist has been appointed general manager of Industrial Tubes, Inc., Geneva, Ill. Mr. Soderquist began his engineering career with Continental Electric Co., Geneva, and subsequently held responsible positions with Ross Mfg. Co., Burlington, Iowa, and National Electronics, Inc., also at Geneva, Ill. He joined his present company in 1952.