ELECTRONIC INDUSTRIES &

TELE-TECH

A Caldwell-Clements Publication

FEBRUARY, 1953

SECTION ONE:

FRONT COVER: A PREVIEW OF THE MANY ANTENNA TYPES that will be appearing on house roof-tops in 1953. Shown (l to r) are stacked V, stacked dipoles and reflectors, corner reflector, stacked fan dipoles, fan dipole or bow tie, Yagi, helical, parabolic reflector, sheet reflector, rhombic and slotted line type antennas. (See page 38, Tele-Tech, Dec. 1951.) As of Jan. 1 the number of TV stations authorized totaled 283. Of the 175 post-freeze grants included in this figure, 127 are for UHF operation. Post-freeze VHF and UHF grants made during 1952 will bring TV service to 112 additional cities—making a total of 177 cities in 43 states, the District of Columbia, Puerto Rico and Hawaii now having or slated to have TV stations. (See also Timetable of New TV Stations Coming on the Air, page 93, this issue)

DEPARTMENTS

SECTION TWO:

TELE-TECH, Vol. 12, No. 2, February, 1953. 75 cents a copy. Acceptance under Section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00; All Other Countries $10.00. Please give title, position and company connection when subscribing. Copyright by Caldwell-Clements, Inc., 1953. Printed in U.S.A.
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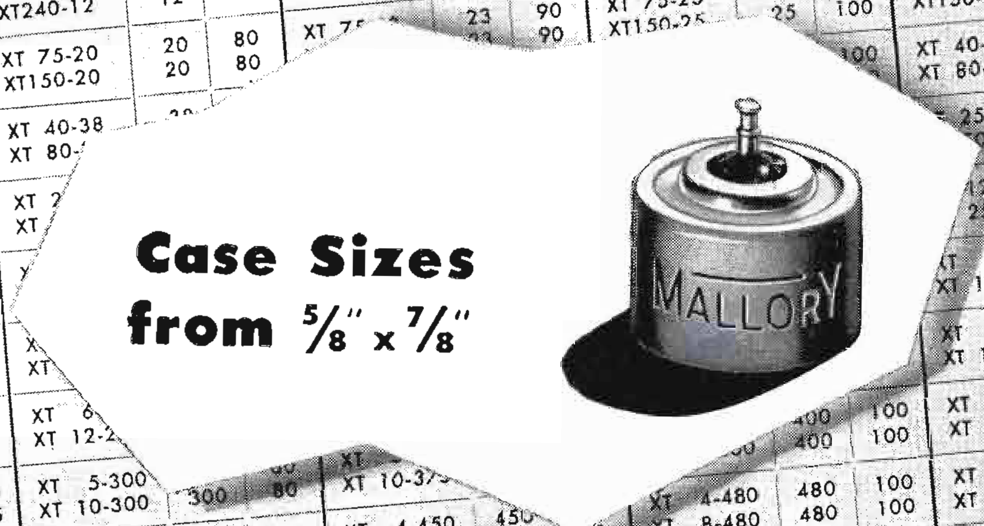
MALLORY TYPE XT
TANTALUM ELECTROLYTIC CAPACITORS

MFD	SIZE D	SIZE H	SIZE C	OHMS	200°C MAX. Type No.	DCV	μA	150°C MAX. Type No.	DCV	μA	125°C MAX. Type No.	DCV	μA	85°C MAX. Type No.	DCV	μA
120 240	7/8 1 1/8	1/2 9/16	1 1	2.5 2.5	XT120-12 XT240-12	12 12	80 80	XT120-14 XT240-14	14 14	90 90	XT120-15 XT240-15	15 15	100 100	XT120-18 XT240-18	18 18	125 125
75 150	7/8 1 1/8	1/2 9/16	1 1	2.5 2.5	XT 75-20 XT150-20	20 20	80 80	XT 7[illegible]	23 [illegible]	90 90	XT 75-25 XT150-25	25 25	100 100	XT 75-30 XT150-30	30 30	125 125
40 80	7/8 1 1/8	1/2 9/16	1 1	2.5 2.5	XT 40-38 XT 80-[illegible]								100	XT 40-60 XT 80-60	60 60	125 125
25 50	7/8 1 1/8	1/2 9/16	1 1	2.5 2.5	XT 2[illegible] XT[illegible]									[illegible]25-100 [illegible]0-100	100 100	125 125
12 25	7/8 1 1/8	27/32 15/16	2 2	5. 5.										[illegible]12-180 25-180	180 180	125 125
8 16	7/8 1 1/8	1 3/16 1 5/16	3 3	7.5 7.5	X[illegible] XT[illegible]									XT 8-270 XT 16-270	270 270	125 125
6 12	7/8 1 1/8	1 17/32 1 21/32	4 4	10. 10.	XT 6[illegible] XT 12-2[illegible]									XT 6-360 XT 12-360	360 360	125 125
5 10	7/8 1 1/8	1 29/32 2 1/32	5 5	12.5 12.5	XT 5-300 XT 10-300	300	80	XT[illegible] XT 10-37[illegible]				400 400	100 100	XT 5-450 XT 10-450	450 450	125 125
4 8	7/8 1 1/8	2 1/4 2 3/8	6 6	15. 15.	XT 4-360 XT 8-360	360 360	80 80	XT 4-450 XT 8-450	450 450	90	XT 4-480 XT 8-480	480 480	100 100	XT 4-540 XT 8-540	540 540	125 125
3.5 7.	7/8 1 1/8	2 19/32 2 3/4	7 7	17.5 17.5	XT 3.5-420 XT 7-420	420 420	80 80	XT 3.5-525 XT 7-525	525 525	90 90	XT 3.5-560 XT 7-560	560 560	100 100	XT 3.5-630 XT 7-630	630 630	125 125



The Mallory Tantalum Capacitor shown is but one of the complete range of sizes and ratings indicated in the table. Note the following advantages:

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- High resistance to shock and vibration
- Proof against thermal shock from −60° C. to +200° C. without damage
- Double sealing for absolute protection under all operating conditions.

Originally developed for the Armed Forces subminiaturization program, Mallory Tantalum Capacitors are now available in quantity. If you are redesigning your equipment, don't hesitate to call on us for help in any problem involving the application of capacitors, the development of special types or the simplification of related circuits.

For Complete Information...

The above table is part of our new Technical Bulletin 4-3. Write for your copy today. It is complete with sizes, mounting arrangements, surge voltages and performance curves.

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Broadcast Stations in U. S.

	AM	FM	TV
Stations Air	2377	612	120 VHF 5 UHF
Under Construction (CPs)	139	36	46 VHF 119 UHF 10 Educational
Applications Pending	232	8	463 VHF 294 UHF

FM Station Changes

FCC Chairman Walker at year-end reported 722 FM stations on the air, including 98 educational outlets. During the first 10 months of 1952, he said, 28 FM stations went off the air and 24 new ones went on the air. He added that 18 FM stations were under construction and 11 applications for construction permits were pending.

Amateur Licenses

Licensed ham stations at end of '52	117,069
Licensed ham stations at end of World War II .... (Increase 67%)	70,000
Licenses in new Novice class, authorized July 17, 1951	12,730
Licenses in new Technician class, authorized July 17, 1951	3,601

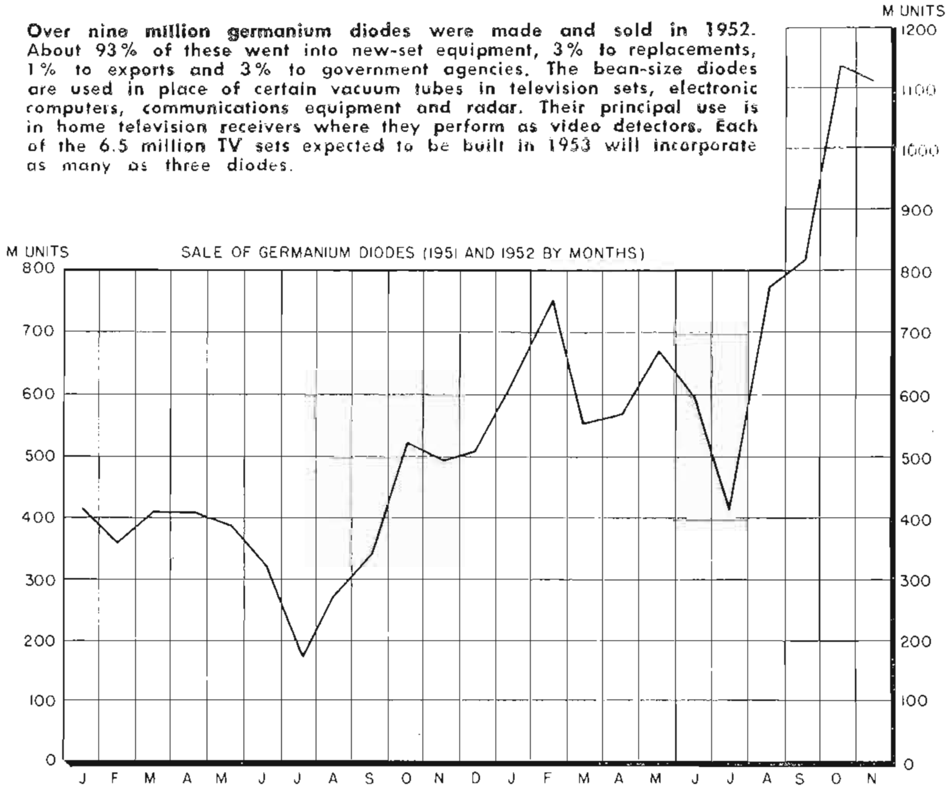
(Figures supplied by FCC Commissioner George E. Sterling.)

TV Abroad, 2,400,000 Sets

The U. S. State Department reports that TV stations are now operating in 21 countries on four continents, with two additional nations to begin TV service shortly, and three others in 1953. By the close of the present year, 28 may have TV.

TV sets in use abroad rose from 1,680,000 in October 1951 to 2,400,000 at close of '52. The latter figure does not include an estimated 77,000 sets in use in Russia. The report estimates the regular TV viewing audience outside the Iron Curtain and USA at 24,450,000 persons.

Over nine million germanium diodes were made and sold in 1952. About 93% of these went into new-set equipment, 3% to replacements, 1% to exports and 3% to government agencies. The bean-size diodes are used in place of certain vacuum tubes in television sets, electronic computers, communications equipment and radar. Their principal use is in home television receivers where they perform as video detectors. Each of the 6.5 million TV sets expected to be built in 1953 will incorporate as many as three diodes.



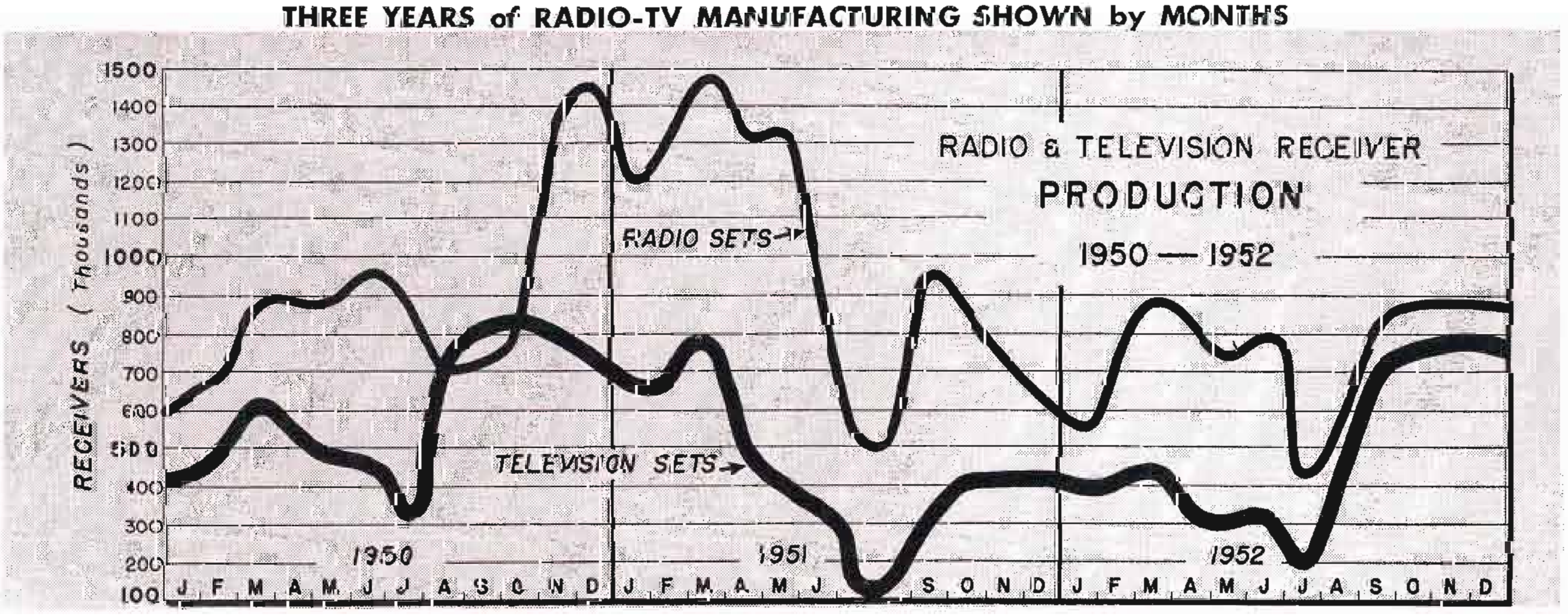
TV and Radio Receiver Production by Months, 1952

	Television	Home Radios	Portables	Auto	Clock	Rotal Radio
January	404,933	288,723	68,433	195,147	80,152	632,455
February	409,337	312,705	72,866	267,779	106,103	759,453
March (5 weeks)	510,561	357,689	99,720	343,314	175,169	975,892
April	322,878	286,164	110,529	275,250	176,003	847,946
May	309,375	288,927	128,351	215,478	115,588	748,344
June (5 weeks)	361,152	297,669	205,186	246,909	124,489	874,253
July	198,921	203,868	81,353	95,220	61,295	441,736
August	397,769	235,728	105,006	94,315	108,753	543,802
September (5 weeks)	755,665	324,786	126,666	230,706	183,496	865,654
October	724,117	314,459	113,552	163,494	180,841	772,346
November	780,486	389,853	153,503	195,200	185,639	924,195
December	760,000	370,000	153,500	185,000	180,000	888,500
1952, year	5,935,194	3,670,571	1,418,665	2,507,812	1,677,528	9,274,576
1951, year	5,562,000					12,895,000
1950, year	7,520,000					14,630,000

1952 FM Production - Home sets with FM facilities totaled 33,200 units in November and 32,000 units (estimated in December, bringing the 12-month 1952 total to 387,249 FM sets.

In addition, 7,603 television sets with FM circuits were produced in November and 6500 (estimated) in December, bringing the 12-month 1952 total to 93,781 TV sets with standard (100-mc band) FM output.

THREE YEARS of RADIO-TV MANUFACTURING SHOWN by MONTHS



See also Caldwell-Clements Statistics in World Almanac, Encyclopaedia Britannica, National Conference Board Economic Almanac, and "Information Please" Almanac

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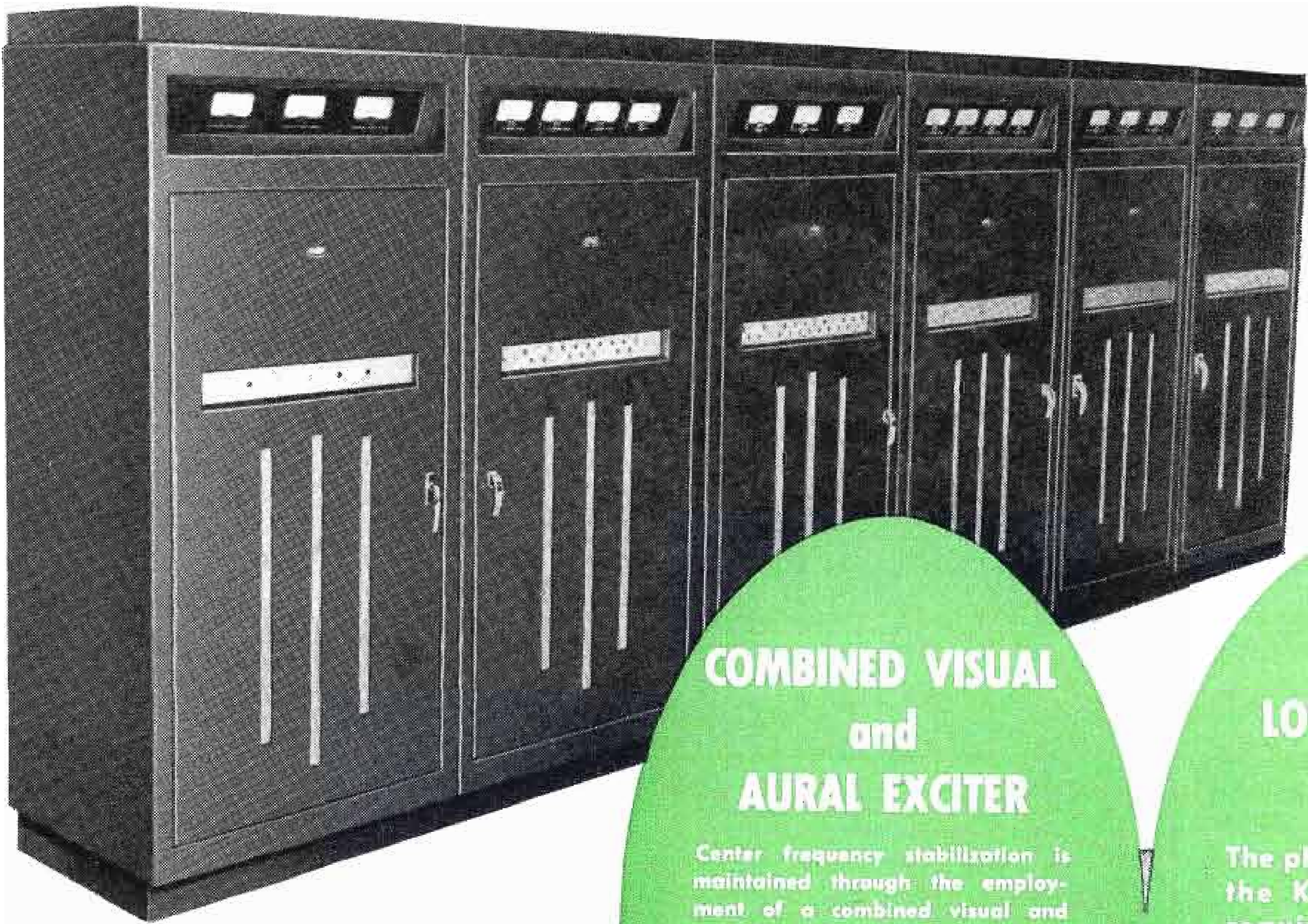
the new DuMont 5kw

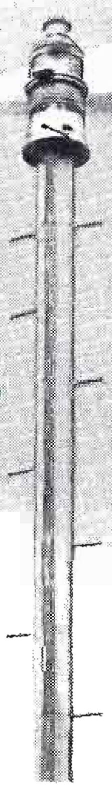


COMBINED VISUAL and AURAL EXCITER

Center frequency stabilization is maintained through the employment of a combined visual and aural exciter. One crystal controls the center frequency of both the aural and visual transmitters. The 4.5 megacycle difference frequency is thus maintained to positive accuracy. This Du Mont development results in clean, simple circuitry that means easier maintenance, trouble-free operation.

LOW DRIVING POWER

The phenomenal gain of the Klystron amplifier requires only nominal driving power. The driver unit is a simple, low-maintenance unit employing few tubes. Utmost dependability and performance are realized with this design.



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The perfect UHF antenna custom-fitted to your needs by Du Mont's staff of leading propagation experts assures the success of your installation. The new Du Mont antenna is a rugged, simple, reliable design. Power gain 14 to 25, beam width 2.1° to 4.2°, vertical nulls filled in and beam tilted to meet terrain requirements. VSWR less than 1.1 to 1. Will handle up to 50 KW power.

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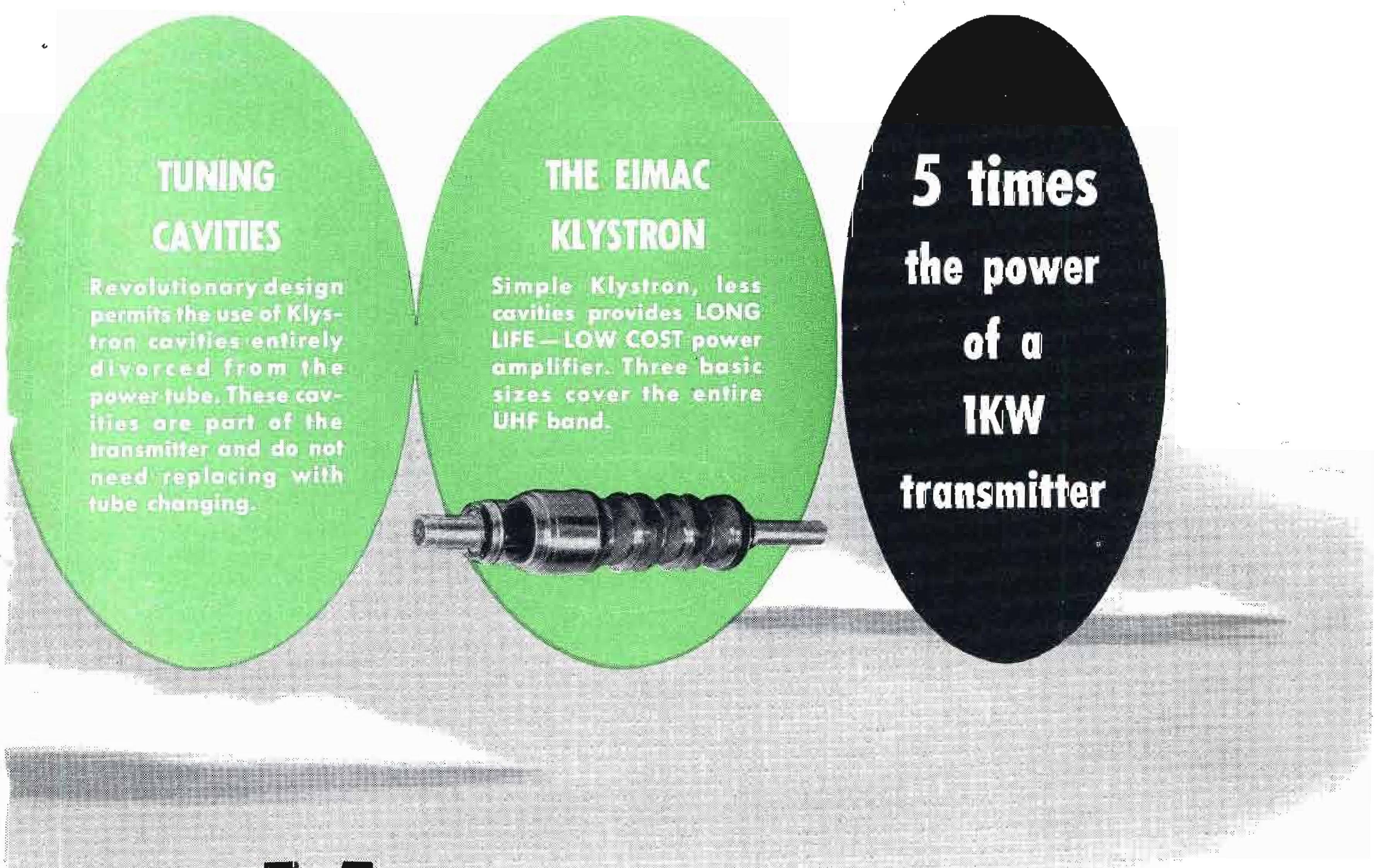
The new Du Mont 5KW UHF transmitter represents an entirely new concept in transmitter design. Its simplicity in circuitry establishes new standards in operating economies, dependability and performance. All inherent limitations of previous UHF designs have been eliminated with result that now the UHF broadcaster can be completely competitive with the VHF broadcaster.



DU MONT

TELEVISION TRANSMITTER DIVISION
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TELE-TECH* 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 in the telecommunications and electronic fields, with emphasis on subjects of engineering import and timeliness. Special attention is given to the following fields:

MANUFACTURING—Design and production of end products, components and accessories for:
—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, timing, counting, computing.
—Military equipment including radar, sonar, field sets, guided missiles, gunfire controls.
—TV-FM-AM receivers, phonographs, recorders, reproducers, amplifiers.
OPERATION—Installation, operation and maintenance of:
—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, lighting, acoustics.
—Military, civilian and scientific electronic computing and control systems and equipment.

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West Coast Symposium Scheduled

The 1953 Electronic Components Symposium, the fourth in a series of national annual meetings of this type, is scheduled to be held on April 29, 30 and May 1 at the Shakespeare Club in Pasadena, Calif., Dr. A. M. Zarem, Chairman of the Executive Committee, announced recently. Sponsored by the AIEE, IRE, RTMA and the West Coast Electronic Manufacturers Assoc., the forthcoming symposium is expected to attract over 1,000 scientists, engineers, technical workers and executives. Sessions will follow the general pattern of previous national meetings on electronic components held in Washington, D. C., and Los Angeles. Headquarters for the Electronic Components Symposium have been established at the Stanford Research Institute, Suite 1011, 621 S. Hope St., Los Angeles 17, Calif.

Radio Union to Meet April 27-30

As in the past, the U.S.A. National Committee of the International Scientific Radio Union (U.R.S.I.) is sponsoring a Spring Technical Meeting jointly with the IRE Professional Group on Antennas and Propagation. This meeting will be held on April 27, 28, 29, 30, 1953 at the National Bureau of Standards in Washington, D. C.

Sessions will be held by Commissions I, II, III, IV, V, VI, and VII. The U.R.S.I. Commissions and their Chairmen are as follows:

I—Radio Measurement Methods and Standards, Mr. F. J. Gaffney, Polytechnic Research and Development Co.

II—Tropospheric Radio Propagation, Dr. A. W. Straiton, Elec. Eng. Res. Lab., Austin, Texas.

III—Ionospheric Radio Propagation, Dr. H. G. Booker, School of Electrical Engineering, Cornell U.

IV—Terrestrial Radio Noise, H. E. Dinger, Naval Research Lab.

V—Radio Astronomy, A. H. Shapley, National Bureau of Standards.

VI—Radio Waves and Circuits Including General Theory and Antennas, Dr. S. Silver, Div. of Electrical Engineering, U. of California.

VII—Electronics, J. A. Morton, Bell Tel. Labs.

Those interested in submitting papers on the above topics should send their titles with 200 word abstracts and 1,500 word condensations for the program on or before Feb. 16, 1953, to the relevant Commission Chairman.

- Outside diameter of tubes and rods as small as .062" diameter centerless ground to tolerance of ±.0001".
- Rods free of camber for precision shafts.
- Rods and tubes centerless polished to 5 micro inch RMS finish $5\surd$.
- Cylindrical parts ground both inside and outside to diameter tolerance of ±.0005" with concentricity of .001" TIR. Sizes up to 8½" O.D. by 24" long are available.
- Holes as small as .187" diameter can be economically lapped to tolerance of ±.001".
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All-TV IRE Conference

The Seventh Annual Spring Technical Conference, sponsored by the Cincinnati Section of IRE, to be held in Cincinnati, Ohio, on April 18, 1953 will be entirely devoted to television. Advance registration for the conference, including hotel, luncheon and banquet reservations, should be directed to Mr. Anthony C. Wahl, c/o A. C. Wahl Co., P.O. Box 8, Green Hills 18, Ohio.

Among the technical papers and speakers scheduled for the morning session are: "Television and the Bell System"; "A High Powered UHF-TV Broadcast System," F. J. Bias, GE; "The Design of TV Receivers Utilizing Non-Synchronous Power," G. D. Hulst, Dumont Labs.; "Approach to Mechanized Assembly of Electronic Equipment Applicable to TV Receivers," L. K. Lee, Stanford Research.

For the afternoon session: "The Selection and Amplification of UHF Television Signals," W. Boothroyd and J. Waring, Philco; "Transient Considerations in the NTSC Color System," B. S. Parmet, Motorola; "A Four-Gun Tube for Color Television Receivers," J. Rennick and C. Heuer, Zenith; Latest NTSC Color System," R. D. Kell and A. C. Schoeder, RCA Labs.

Research Fellowships Available

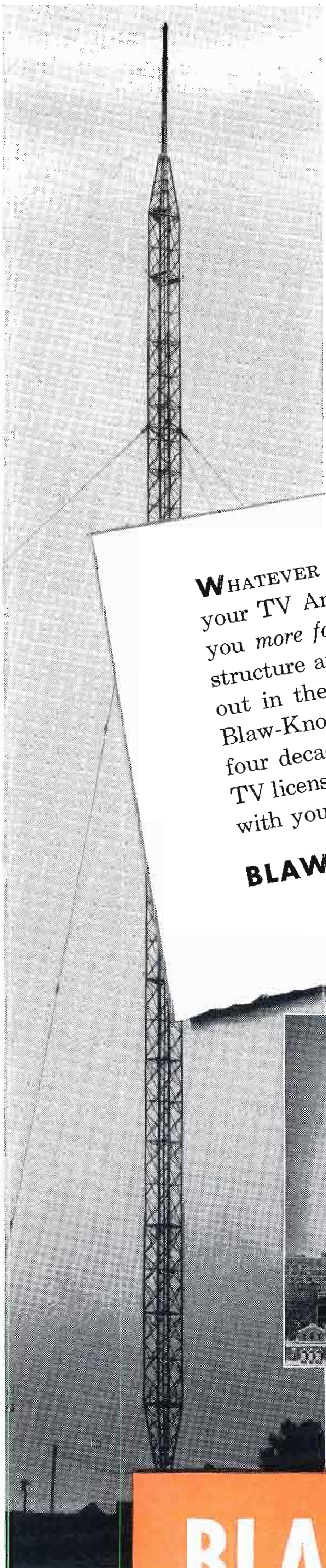
A number of industrial research fellowships in physics, chemistry and chemical engineering, metallurgy, ceramics and minerals, engineering mechanics and electrical engineering are being offered by Armour Research Foundation of Illinois Institute of Technology. Research fellows will attend Illinois Institute of Technology half-time and work in the Research Foundation half-time in a graduate program leading to advanced academic degrees.

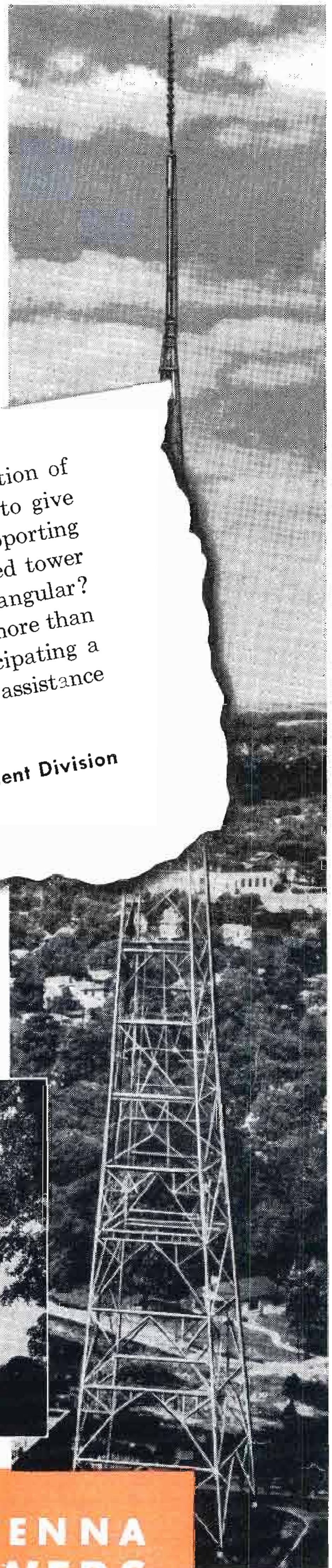
The Foundation awarded nine fellowships in 1952, and plans to award about 15 in 1953. Awards are made on a competitive basis to U.S. citizens under 28 years of age holding a bachelor's degree from an accredited engineering or scientific school or a liberal arts college with a major in the sciences. Application forms may be obtained from the Office of Admissions, Graduate School of Illinois Institute of Technology.

RTMA Group to Study Subscription TV

A 10-man committee has been formed by RTMA to study subscription TV. Paul V. Galvin, president of Motorola, has been named chairman of the committee, which is composed of members of the RTMA Board of Directors. The other group members include: W. R. G. Baker, GE; Max F. Balcom, Sylvania; H. C. Bonfig, Zenith; John W. Craig, Crosley; Allen B. DuMont; J. B. Elliott, RCA; Larry F. Hardy, Philco; H. Leslie Hoffman, Hoffman Radio; and Leslie F. Muter, The Muter Co.

Designs Unlimited





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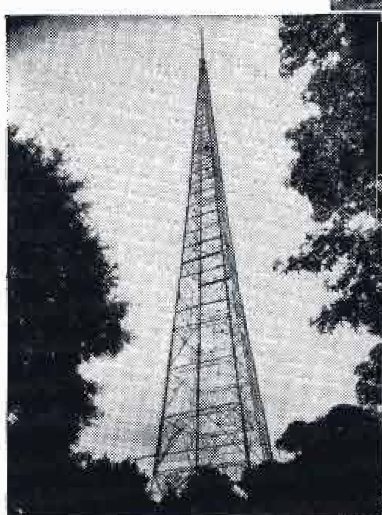

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BLAW-KNOX ANTENNA TOWERS

TELE-TIPS

(Continued from page 25)

tives of the Video Corporation of America, developer of the radar camera, say the company is working on a further refinement that will record the exact speed of a vehicle on the same frame of film that pictures the auto license plate.

DIATHERMY RULES — The FCC has postponed the effective date of its rules applicable to diathermy and industrial heating equipment to June 30, 1953. Part 18 of the rules was amended to read: "18.51 Existing equipment—The provisions of this Part shall not be applicable until June 30, 1953 to diathermy equipment and industrial heating equipment, the manufacture and assembly of which was completed prior to July 1, 1947, nor shall they be applicable until April 30, 1953 to miscellaneous equipment, the manufacture and assembly of which was completed prior to April 30, 1948; Provided that the foregoing provisions of this section shall be applicable only if such steps as may be necessary are promptly taken to eliminate interference to authorized radio services resulting from the operation of equipment manufactured prior to the respective dates hereinabove set forth."

HOT CHASSIS! Is it enough that a TV set carries a notice of *warning* that *severe shock* may result from contact with the chassis? We feel that set manufacturers, with economy in mind, are putting unnecessary and unfair hindrances in the path of the serviceman, who has a difficult enough task as it is, servicing a TV set, without being forced to keep in mind that the chassis is at or above line potential. Some set manufacturers who have availed themselves of the advantages of selenium rectifiers have built in isolation transformers to protect servicemen and meddlesome owners. Why not all?

"ALPHA, BRAVO" instead of "Able, Baker" is the start of the new international phonetic alphabet system which many radio users and pilots oppose, although the new system was devised to lessen the chances for misunderstanding in the pronunciation of letters that sound alike. The Air Force ordered the new system into effect last summer. The original alphabet code was: Able, Baker, Charlie, Dog, Easy, Fox, George, How, Item, Jig, King, Love, Mike, Nan, Oboe, Peter, Queen,

(*Continued on page 44*)

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If you're *not* using Presto discs at present, then it's time for a change. The reason, in one word . . . quality! From the meticulous preparation of the aluminum base in the Presto plant to the final play-back in the studio, quality is the byword . . . your assurance of consistent performance, unmatched fidelity of reproduction, long service. That's why Presto is the proven leader in the professional disc field . . . a leader that merits your consideration when you decide that it's time for a change . . . right now.

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WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

TELE-TIPS

(*Continued from page 30*)
Roger, Sugar, Tare, Uncle, Victor, William, X-Ray, Yoke, Zebra. The new one: Alpha, Bravo, Coca, Delta, Echo, Foxtrot, Golf, Hotel, India, Juliet, Kilo, Lima, Metro, Nectar, Oscar, Papa, Quebec, Romeo, Sierra, Tango, Union, Victor, Whiskey, Extra, Yankee, Zulu. Civilian pilots have complained that the new alphabet has some dangerously similar words, pointing to Nectar for N, confusable with Victor, and such sound-alikes as Echo for E, Kilo for K, Metro for M, and Zulu for Z. An Aeronautics Administration official said that almost the only word in the new system to which no one has objected is Whiskey for W.

"MEXICAN PRISONER" letters (an old international swindle) have recently been received by a number of radio engineers. Datelined Mexico City, the letter explains that the writer is in a Mexican prison but has $450,000 in U. S. currency in a trunk in a U. S. custom house. If the radio recipient will come to Mexico and pay off restraining fines releasing a suitcase which contains the baggage check for the $450,000 trunk, the "prisoner" offers one-third as reward to the guileless radio engineer advancing the costs involved.

RECORDS DOOMED?—Tomorrow's music record shop may look like an automat where you'll drop a spool of magnetic wire into a slot and get it back with the latest song hits recorded on it. This possibility is envisioned by Chicago's Marvin Camras, now senior physicist with Armour Research Foundation. When the songs' popularity has waned, the spool would be magnetically erased and the coin-in-the-slot vending machine would again electronically imprint the current favorites. The inventor believes the idea of using the same spools would save money and prevent accumulation of dead reels in the home collection. Camras also sees the day when spools might be sent mail-order to a central headquarters for re-recording.

ENGINEER ESSENTIALS—The discussion on "Qualities Essential for Engineering Success" appearing on page 63 of this issue, was abstracted from a report by J. K. Salisbury, Division Engineer, Thermal Power Systems Division, General Engineering Laboratory at Schenectady, N. Y., and presented in a recent number of the General Electric Company's magazine, *G. E. Review.*

ANY BUSINESS or profession that has no room for radical changes and improvements is dead.—L. R. WHITAKER.

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Diameter.........3/16" to 1-1/4"
Length..............9/16" to 10"
Current: half-wave..1.5 ma to 60 ma
Voltage: DC output......20 volts to 4,000 volts

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Diameter...............1/8" to 1"
Length................1/2" to 12"
Current: half-wave..1.5 ma to 60 ma
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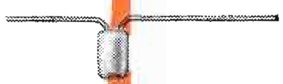
Output Current...200 ua to 1.5 ma
Temperature Range −50°C to 100°C



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LETTERS . . .

Simple Method for Determining Q

Editors, TELE-TECH:

Your article by Raymond Lafferty in the November issue is helpful to the engineer desiring to know the "true" Q of a coil, but a simpler method exists to determine the "true" inductance if the engineer has access to a Q-Meter having a calibrated Inductance Scale, such as the L-C Dial used by Boonton Radio Corp. on their model 160-A Q Meters. This method is in fairly widespread use, but is offered here for those who may not know of it.

1) Determine the distributed capacity of the coil.

2) Resonate the coil at the proper reference frequency, (79 KC, 250 KC, 790 KC, etc.) using the L-C Dial of the Q-Meter with the vernier capacity dial at zero.

3) Add the distributed capacity to the capacity indicated for reasonance, and reset the L-C Dial to the capacity.

4) Read the "true" inductance on the Inductance Scale of the L-C Dial.

The writer does not know who originated this method, and therefore cannot give credit to the proper source.

RAYMOND F. GEGENHEIMER,
Chief Engineer
Anchor Electronic, Inc.
717 Sip St., Union City, N. J.

Ferroxcube Materials

Editors, TELE-TECH:

The article on "Improved Horizontal TV Sweep Circuits," by Mr. B. M. Cole, which appears on page 92 of the September issue of TELE-TECH is incomplete and gives rise to the wrong impression concerning the production of Ferroxcube materials in this country. Ferroxcube materials, particularly Ferroxcube 3, were first made in the United States by the North American Philips Co. All technical qeuipment and key personnel engaged in Ferroxcube manufacture were later transferred to the Ferroxcube Corporation of America, a company jointly owned by Philips Industries, Inc., and the Sprague Electric Company, and which is under the active management of Sprague.

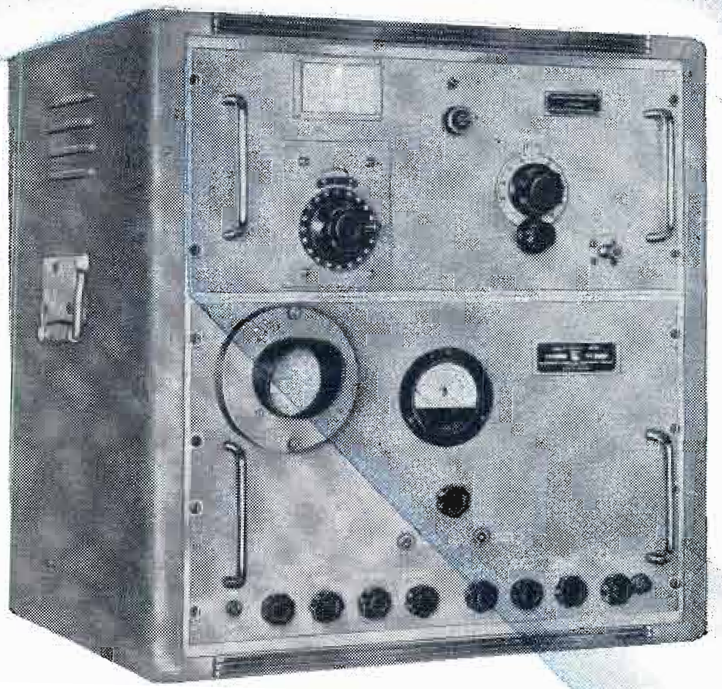
The Ferroxcube plant at Saugerties, New York, is daily turning out thousands of Ferroxcube 3 and 3C cores of various types.

As far as we know, Ferroxcube 3 and 3C, as made by Ferroxcube, are the only manganese zinc ferrite materials in production in the United States at the present time. Other materials which we have analyzed still have remnants of nickel in the mand can be classified as being modifications of the Ferroxcube 4 series. They are not quite as efficient for horizontal output transformers as Mr. Cole points out.

S. L. CHERTOK
Ferroxcube Corp. of America
97 Marshall St., North Adams, Mass.

(*Continued on Page* 52)

FOR X-BAND OR S-BAND



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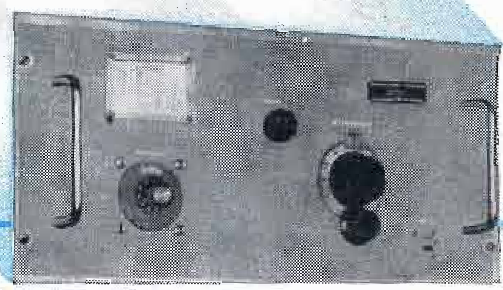

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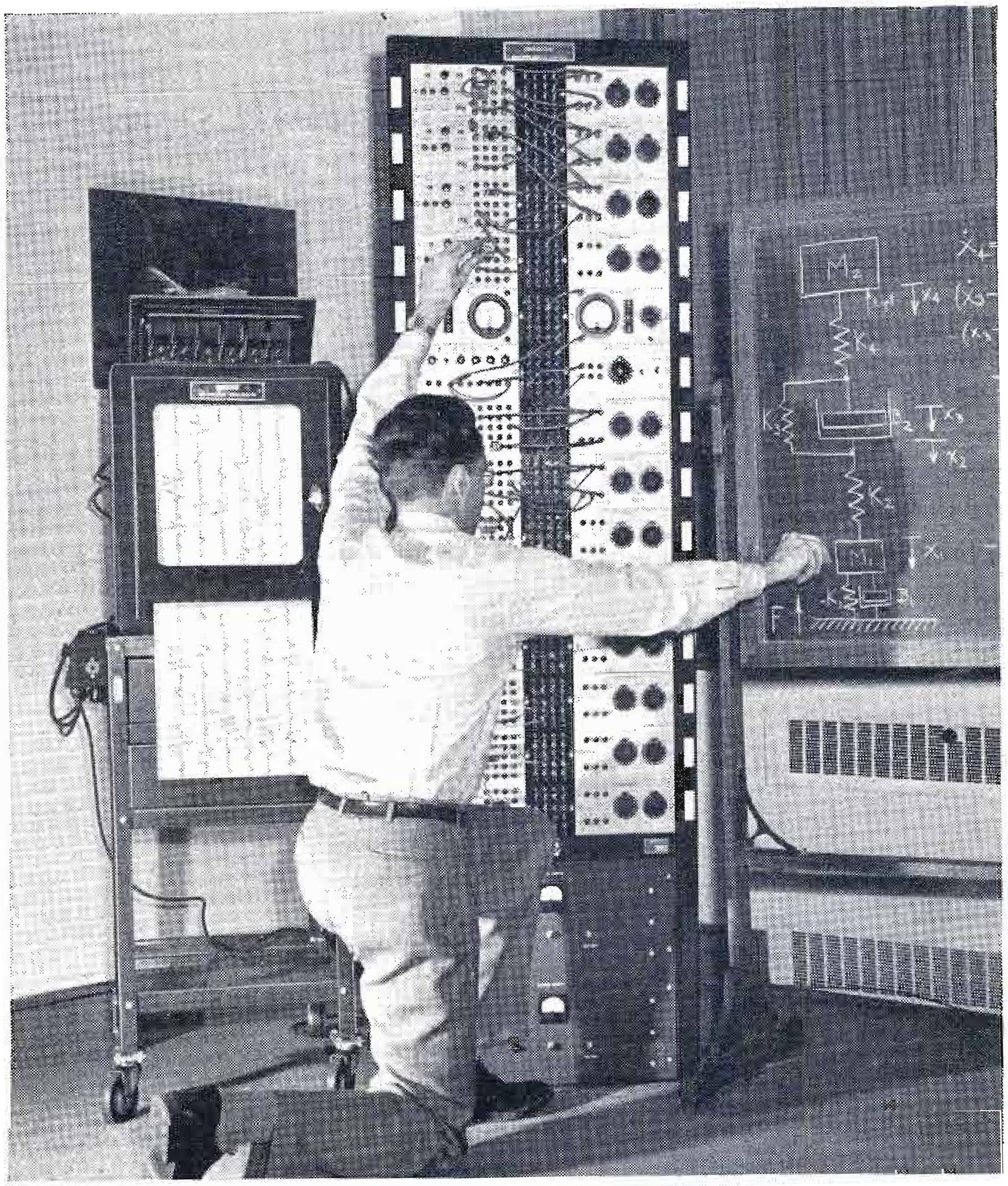

LETTERS—

(*Continued from page* 48)

"All-Vue" to Cover VHF & UHF

Editors, TELE-TECH

One of the lesser problems the television industry now faces is that at present there is no single word that adequately describes an antenna (or booster) that covers both VHF and UHF.

The all-inclusive phrases "broadband" and "all-channel" have become synonymous with VHF, and a new word is now needed to include UHF also. Channel Master Corporation suggests the term *"All-VU"* (all "view"; all *V*HF, all *U*HF).

We are at this time offering "All-VU" in the hope that one standard term will avoid the rise of a whole group of miscellaneous terms whose only purpose will be to confuse dealers later on.

Duso Advertising, Ellenville, N. Y. — DANIEL S. ROHER, President

Effect of Filament Voltage on Tube Characteristics

Editors, TELE-TECH:

In the September 1952 issue of your magazine, you published an article titled "Effect of Filament Voltage on Vacuum Tube Characteristics" by Mr. Arthur J. Winter. Because some of the ideas and implications presented in this article are in conflict with the practices normally recommended by tube manufacturers, we would like to call several factors to your attention.

The article states "Incerases of 1.5 in voltage amplification have been measured by operating at approximately one half rated filament supply voltage." While we do not question that a single 6C4 can actually give an improved voltage amplification at reduced heater power when operated at a relatively low current level and into a load resistance which is sufficiently large as to minimize the effect of the plate resistance on circuit performance, we definitely question the implication that this fact can be applied to a mass production piece of equipment or to a wide range of applications.

The applications where increased amplification at reduced heater power can be realized must be limited to stages of voltage amplification and not power amplification. Furthermore, the advantages are only available where the tube is working into a large load impedence and where the resulting decrease in plate current is not detrimental. Actually the vast majority of circuits in use today employ relatively low load impedances and consequently require tubes with high levels of transconductance and high ratios of transconductance to plate current. Hence the use of this reduced heater voltage concept is restricted to a very narrow range of applications.

In these relatively few classes of service where improved performance is possible, such practice would involve serious disadvantages. The tube characteristics vary widely from tube to

(*Continued on page* 58)

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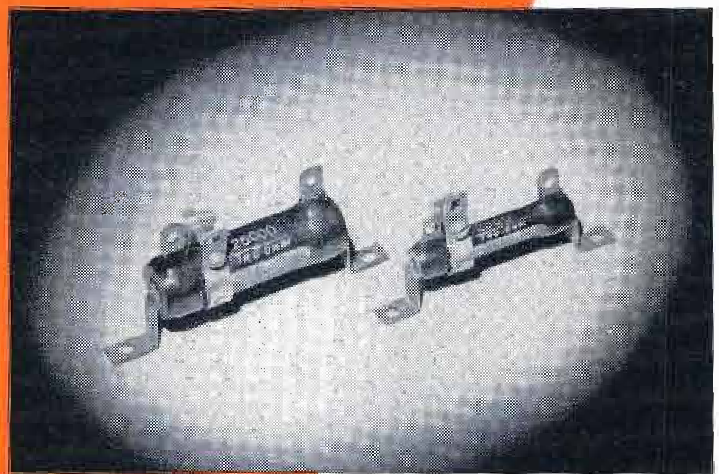

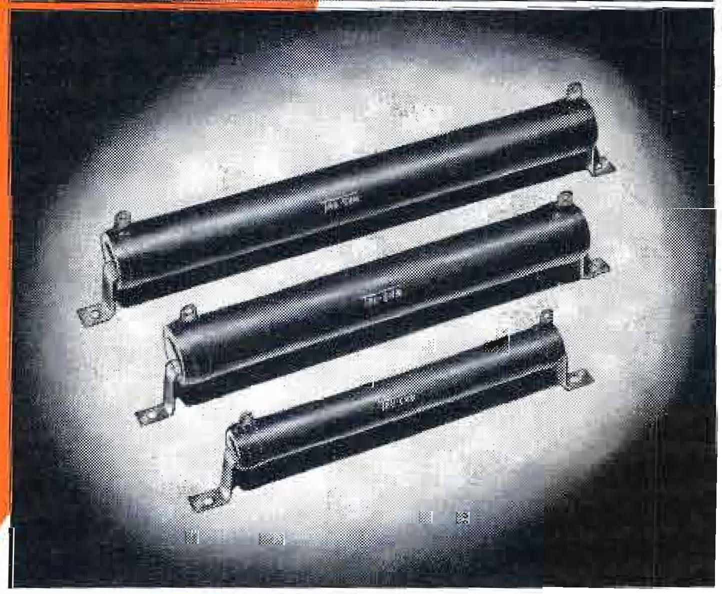

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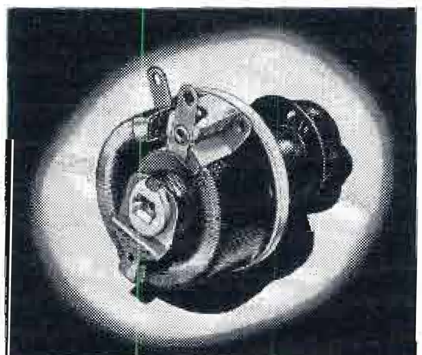

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LETTERS—

(*Continued from page 52*)

tube at a heater voltage of one half the rated value. This divergence is further exaggerated among tubes manufactured by different companies. As a result, a severe interchangeability problem would develop as equipments employing these circuits began to require tube replacements in the field. At this time, no tube manufacturer makes any claims or guarantees of characteristics at these reduced heater voltages.

Another problem which should be considered is that the tube characteristics are extremely sensitive to small changes in heater voltage at these low heater power levels. Consequently, a very close regulation of the heater supply would be required if any degree of uniformity of performance is to be achieved. These factors would indicate that the circuit designer would be faced with an almost impossible design problem if normal production performance limits of the equipment are to be maintained.

The author further expresses an opinion that improved tube life, drift, and stability of dynamic characteristics could be gained although no substantiating data are presented. Although the heater would probably enjoy improved life, it would be expected that the tube characteristics would deteriorate at an accelerated rate at the reduced cathode temperature yielding an actual decrease in tub life. The degradation of tube characteristics would certainly affect the drift and stability characteristics.

Although we take no exception to the interesting theoretical discussion which develops the reasons for the characteristic shift with reduced heater voltage, we do object to the implication that widespread practical circuit advantages and increased tube life result. TELE-TECH reaches a large and influential audience; it is not inconceivable that this article could result in improper tube usage in the vital equipments being designed for the Armed Services.

GEORGE H. GAGE
General Electric Co.
Owensboro, Ky.

No Future for Subscription-TV

Editors TELE-TECH:

It is my considered opinion that subscription-TV or pay-as-you-go television has no major future in our industry.

I belong to the very large schoool of thought which believes that the economics of our industry is predicated on volume advertising and that we will continue to exist on that basis. Parenthetically, I also feel that there will be a real and continuing reluctance on the part of television-set owners to pay for every program they see, when they know that it is their privilege to see these same programs free.

LOUIS D. SHADER
National President
National Society of Television Producers
7063 Sunset Blvd., Hollywood 28, Calif.

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

Five Qualities Essential for ENGINEERING SUCCESS

A large engineering organization has been making a study of the characteristics underlying greatest usefulness and individual success on the part of its engineering executives. In a statement put before its engineer personnel, the following five qualities are cited as indispensable:

1. TECHNICAL ABILITY, although developed formally in a college engineering course, usually is also the product of one's environment, hobbies, and natural inclinations. It can be divided into two major subdivisions: creativeness and ingenuity; and analytical ability. Only rarely does an engineer of high technical ability possess both to an outstanding degree.

One normally tends to catalog engineers as either analyzers or as synthesizers—the analyzers are the appraisers and evaluators; the synthesizers are those who are creative and ingenious in devising new ways of doing things.

2. AGGRESSIVENESS must accompany technical ability. One must, for example, have the energy, the vigor of intellect, and the spark to exercise his technical ability, or it avails him nothing. He must have the will to win.

Every engineer with experience in industry has encountered the person of superb technical competence, but incapable of initiating the accomplishment of any useful objective.

These people tend to sit in a corner and wait for their problems to come to them. They perform beautifully when given a specific assignment and a date on which it must be completed.

On the other hand, all of us have known people with mediocre technical ability who are continually thinking about the job, and who perform assigned work expeditiously to the full extent of their somewhat limited abilities.

These are the aggressive ones—the ones who are outstanding performers when used within the limits of their technical abilities. They move swiftly and surely. Things happen when they are around. Often such people have a high degree of intelligence and horse sense but are not naturally gifted in technical matters. They recognize their limitations, and it is the problem of management to make available for their assistance others who excel them in purely technical matters. Thus is formed a team that has more capacity than the sum of the capacities of the individuals.

3. UNDERSTANDING OF HUMAN RELATIONS is vital in the business world. The aggressive engineer who does not comprehend through his understanding of human relations the effect of his aggressiveness on his associates is likely to incur their serious displeasure, and as a result fail to obtain their co-operation.

Skill in human relations implies an innate personal kindness—a tolerance toward the shortcomings of others. Above all, it requires fairness in dealing with people and a generosity of spirit. In a supervisor it requires a comprehension of the things that motivate the individual, a recognition of his merits, and a knowledge of his weaknesses.

4. RESPONSIBILITY is the fourth indispensable characteristic. The successful engineer must have high personal and company standards of responsibility. He must be willing to accept responsibility even though it is not specifically thrust upon him. He must assume that he is personally responsible for the success of the endeavors in which he is engaged. He must accept responsibility for failures like a man, and he may also, though modestly, take unto himself responsibility for successes.

5. PERSONAL INTEGRITY, the fifth indispensable quality, may also be called high-mindedness. It is the all-consuming insistence of the engineer that he do what is right at all times. It is character. Personal integrity implies an intrinsic honesty, an intellectual fairness in all things, and good judgment. It is sincerity. It is the quality that speeds transaction of the day's business. It is identified by promises that are kept, though made in a word or two, even when forgetfulness might provide a plausible excuse. It eliminates the need for written instructions, and for confirming memoranda.

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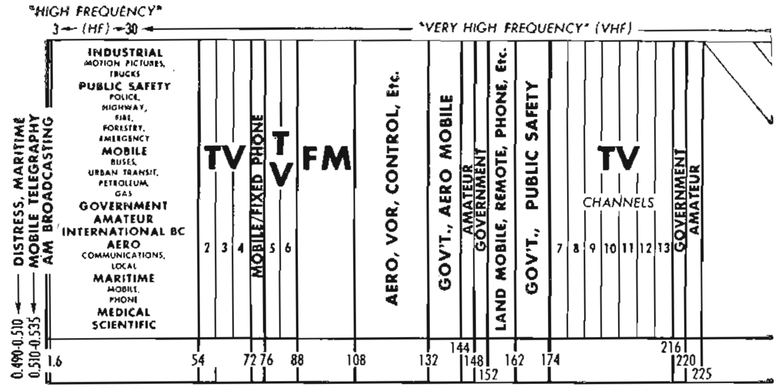
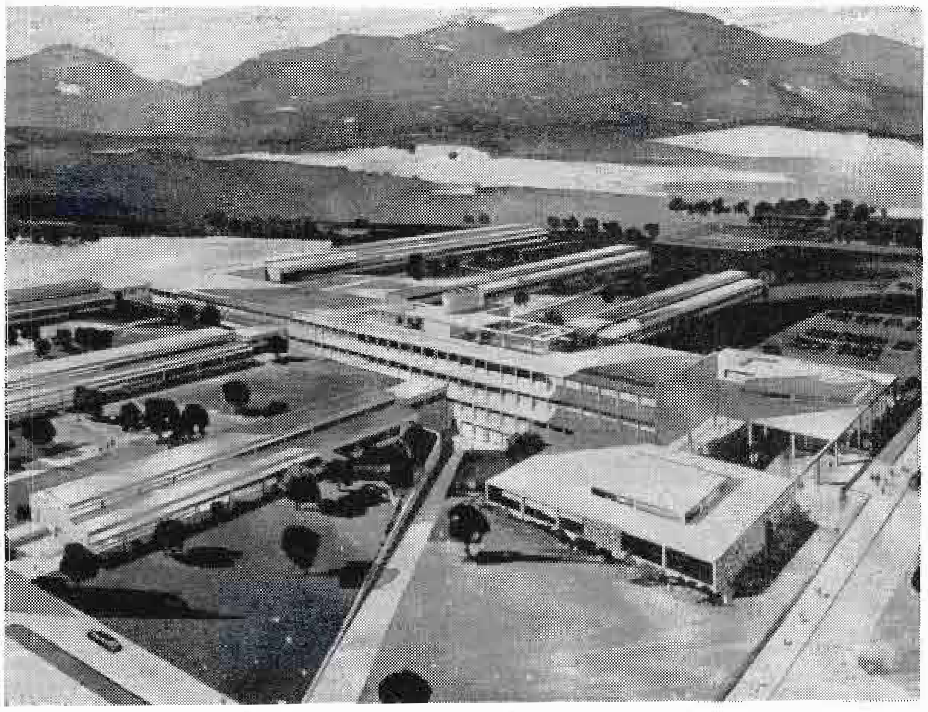


UHF-TV

OF THE 56 NEW TV STATIONS scheduled to start broadcasting during 1953, 43 will be UHF-TV stations. This number, added to the 9 UHF stations scheduled to be on the air by Jan. 1, indicates that by the end of 1953 approximately 25% of all TV stations will be on UHF. Because transmission of higher powers is more difficult to obtain at UHF than at VHF, and since present UHF receivers require minimum signal strengths that are 3 to 4 times that of VHF, it is obvious that engineering effort will be directed toward the development of higher power transmitters and more sensitive tuners. Costs and/or distribution problems associated with converters and with replacement strip type tuners make the development of sensitive low-noise combination UHF & VHF tuners important. Special new receiving tube types such as planar triodes for use in such tuners is imminent. Receivers with built-in antennas will be appearing in greater numbers again since reports indicate that the built-in antenna does work on UHF.

AVIATION

TOWER HAZARDS—Although the end of high towers has been freely forecast by the aviation industry's prophets of doom, a recent survey of pending television applications shows that very few such applications request towers even as high as 1000 feet. Inasmuch as most towers will presumably be located either on natural high spots, or in existing hazard areas such as cities, where there are normally high buildings, and the tendency is for television broadcasters to use a common tower for mounting all the antennas at a given market, it is possible that aviation hazards may be decreased rather than increased by the new television stations.



Construction has begun on this $4,500,000 laboratory of the National Bureau of Standards at Boulder, Col. The new building will house the Bureau's Central Radio Propagation Laboratory on a 210-acre site, near the campus of the University of Colorado. Complete facilities are to be provided for research on the propagation of radio waves and on the expanded utilization of the radio spectrum for FM, television, facsimile, and radar.

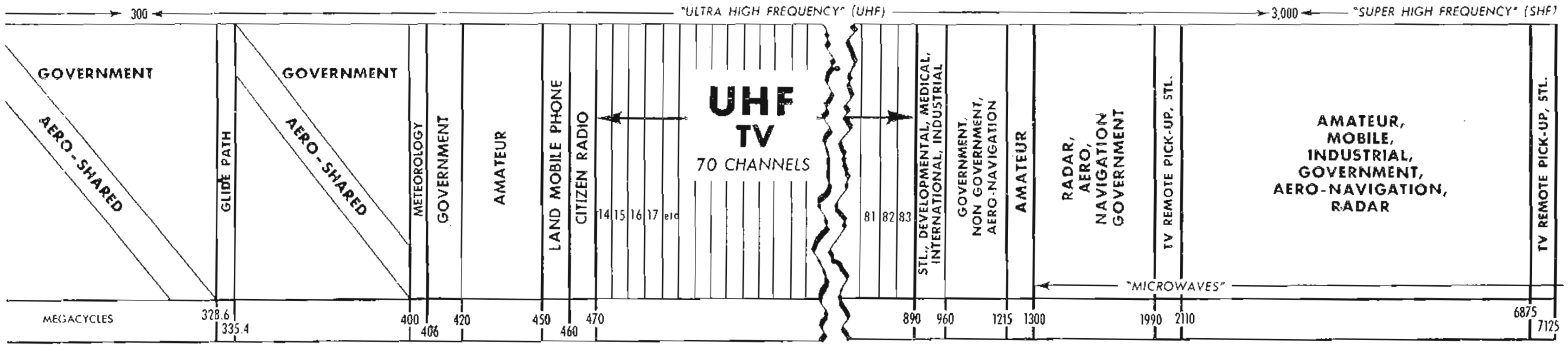
INTERNATIONAL

THE BBC AND RTF (Radiodiffusion Télévision Française) in July of last year operated the largest international television link to date. It consisted of four transmitters in Britain, two in Paris, and one in Lille. The original video signal used the 819 line standard of France and was broadcast, using that frequency, in Paris and Lille. Conversion to the BBC system of 405 lines was accomplished by displaying the incoming signal on a monitor screen and re-transmitting it by means of a camera focused on the screen. An interesting point is that long-resistance phosphors were needed on the monitor tube so that the decay time would be comparable to that required to scan a single frame of a television image. Complicated as the relay may seem, it marks the first true international television broadcast and as such should lead the way to closer international understanding.

AUDIO

STEREOPHONIC SOUND is becoming more popular as a means of giving depth and movement to speech and music—in broadcasting, theatre TV and motion pictures. Basic idea of the system is the use of two or more microphones and loudspeakers strategically located to reproduce the sound in a manner similar to the way the ears would normally hear the originating source. In one system of binaural radio broadcasting, an FM and AM transmitter is used, each fed by a separate sound pick-up located at different vantage points in the studio. In the home, an FM and AM receiver, properly spaced within the room (preferably in adjoining corners) will produce sounds which give depth effect. Among the stations which have made such experimental broadcasts are: KOMO, Seattle; WGN, Chicago; WDRC, Hartford; and WQXR, New York.

In theatre TV, the Eidophor system (see August 1952 TELE-TECH, p. 57) used three sets of two microphones located at left, right and center of the stage and orchestra. The microphone outputs, including an additional one for choral pick-up, were fed through equalizers, telephone lines and amplifiers to three speakers. A



three-dimensional aural illusion is created in the new motion picture technique Cinerama (see Nov. 1952 TELE-TECH, p. 84) by recording the pick-ups of six strategically placed microphones on a single strip of magnetic film containing siz sound tracks. As the action moves, the sound comes out of different speakers located around the theatre.

MATERIALS

GERMANIUM—believing that coals in the Appalachian region contain germanium, the "new" magic mineral, in commercial quantities, the Pennsylvania Coal & Coke Co. of Fairmount, W. Va., has announced plans for an exhaustive cooperative investigation of all mines and coal seams in the region. Germanium, which ranks with titanium and uranium as a rare but highly essential mineral, is a grayish white, scarce element of crystal structure and in pure-metal form is worth about $350 a pound. Concentrations of germanium are found, investigations reveal, in the organic matter of coals, generally in the top and bottom five inches of the seam. The West Virginia Geological Survey's investigation disclosed the presence of the metal in appreciable quantities in several of the coal seams of that state. Similar findings are hoped for elsewhere in the coal-producing states of the Appalachian region, where 70% of the nation's soft coal is found. Thus far, germanium has been recovered from chimney stacks in England where the coal burned has a high content of the element, and from the flues of metallurgical smelters in this country. It is freed from the coal as a part of the inherent ash and not in the usual manner of extracting by-products.

EDUCATIONAL

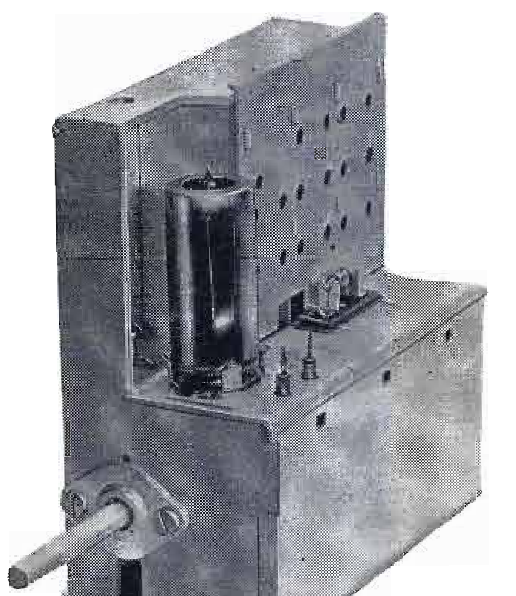
TV MICROSCOPE—Cornell University students will get some of their basic physics from the television screen beginning this year. The main lecture room in Rockefeller Hall has been outfitted for the project, in which RCA is cooperating. Experiments will be televised from the instructor's desk to viewing screens visible from all corners of the room. The television setup will make it easier to show the "Brownian movement"—the jittering dance of molecules in a fluid, a phenomenon invisible to the naked eye. Ordinarily, students would wait their turns at microscopes. Now, with the television camera trained into one microscope, the image will be magnified on the screens and visible to everyone.

The physics department plans to use the TV method to explain such other physical phenomena as light interference, surface tension and the behavior of high-energy particles in a cloud chamber.

MANPOWER

AIRFORCE ENGINEERS—One necessary source of drain on the engineering field today is the demand of the Air Forces on engineers formerly in the Inactive Reserve. Here is a whole crop of young men who signed up in what was called the Inactive Reserve when they completed their service at the end of World War II. A great majority of these men were part way through college and were talked into taking a five-year hitch in the Inactive Reserve. They were to be called only after the Active Reserve and the Guard had been called up by an act of Congress and in the event of war. There is hardly a one of them whose five years has not expired. They are now being called up by power given to the President several years ago by the Congress, before the Active Reserve, who have been paid, are being called. When these men were rendering their first service during World War II, they had not completed their college training. In the half-dozen years that have gone on since that time, many have completed their training and are getting well established in industry, in research and in similar places where their collegiate electronic training is of importance. There is no need, in a scarce field, for calling these people up as communications officers.

Capt. Henry J. Round, of England, receiving the prized Armstrong Medal from John Bose, President of the Radio Club of America. The Medal was awarded to Capt. Round in recognition of his pioneering work in radio, in the fields of radio direction and position finding, and the high amplification of short-wave signals.



Model 60
UHF-TV tuner

UHF Tuning Devices

A practical review of the electrical and mechanical design considerations involved in the development of "high-production" type tuners

By NORMAN G. ALTMAN & FRED M. BARR
General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J.

THE problems of designing a high production tuner to cover the new TV channels divide themselves roughly into two main groups.

First: There are the rather obvious electrical considerations. The unit *must* be capable of covering all the UHF channels simply and conveniently. Naturally, the noise factor and insertion loss should be as low as possible and the rejection to spurious signals be as high as possible. The oscillator should conform to standard industry practices and the tentative FCC regulations as far as the oscillator radiation, drift and shift are concerned and should also be substantially independent of tube changes. Linearity of tuning would be highly desirable. Since it is to be used in TV receivers we felt that the necessary modifications of receivers should be minimized. Also it is advantageous to have as low a power drain as is commensurate with satisfactory operation and to use B plus voltages available in present TV sets. In addition, we felt that if it were possible, the tuner should be designed to use high production tube types.

Second: The production problems had to be considered along with the electrical problems. We wanted this unit to be adaptable to very high rates of production. This means that it would be necessary to build the unit without depending on extremely close tolerances in parts and assemblies in order to maintain the electrical characteristics. As part of the same consideration, we wanted to avoid any complicated machined or formed parts and intricate assembly operations. This would seem to indicate that the unit would have to be built with a sufficient number of "handles" or adjustments so that the variations due to normal production tolerances would be "washed out" by simple alignment and calibration techniques that could be performed at high speed by production personnel.

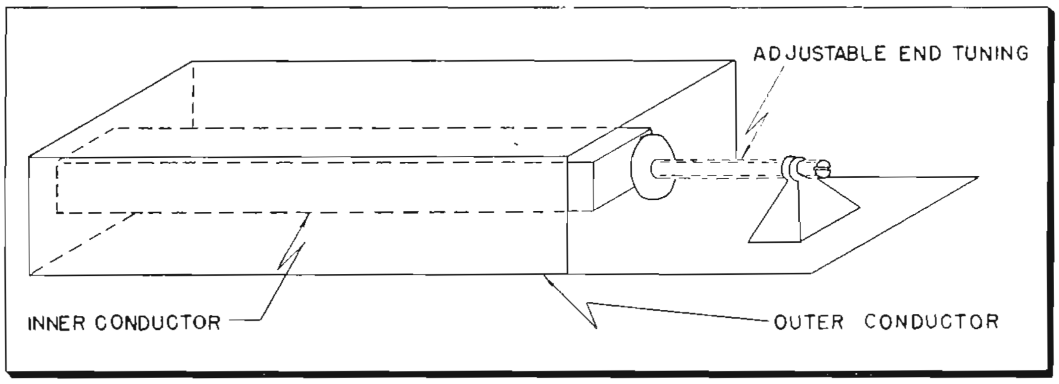
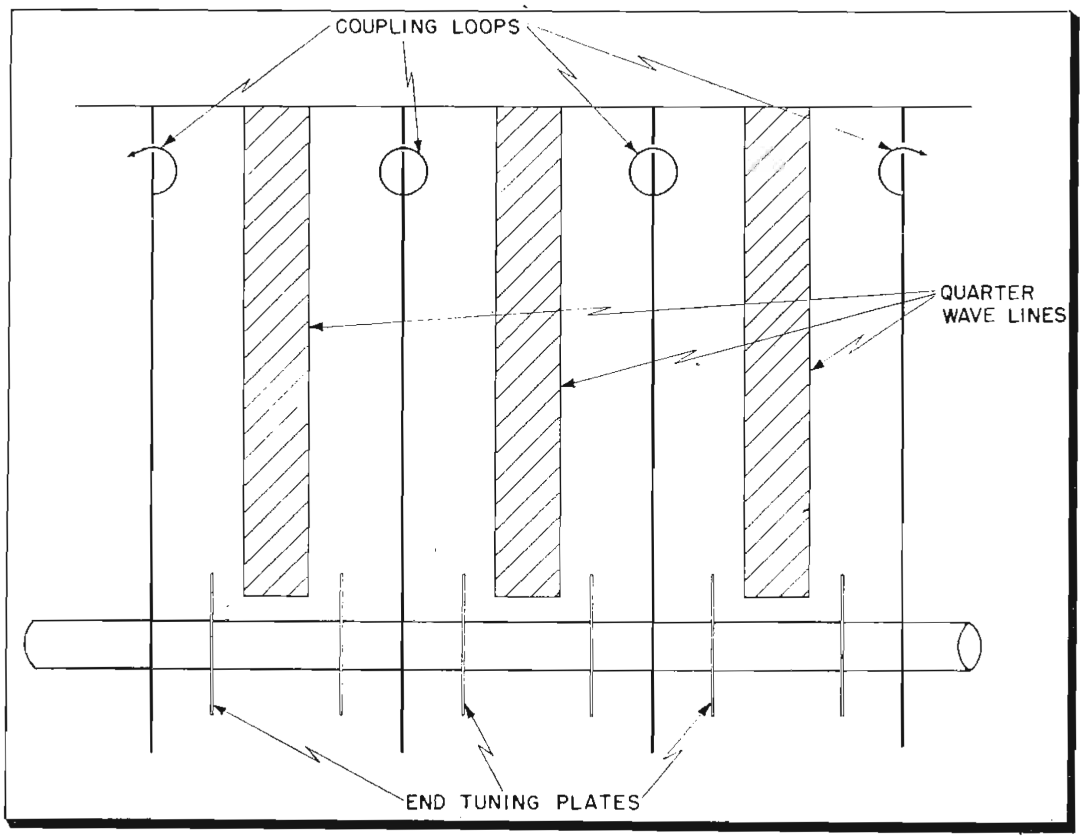


Fig. 1: Basic tuning element consists of a silver-plated end-tuned quarter-wave coaxial line

Fig. 2: Ganged tuning element with quarter-wave lines is constructed similar to capacitor



Single Knob Control

In addition, it was felt that a single knob UHF-VHF control with a straightforward tuning indication and an easily serviced drive should be either an integral part of the unit or easily incorporated in it. Also, in designing the unit, we tried to keep the serviceman in mind. We do *not* feel that the average serviceman will be capable of performing work of any major nature on a UHF tuner in the foreseeable future. Therefore, it seems necessary that any tuner designed for UHF should have an extremely long, service-free life.

The unit which we designed has as its basic tuning element a silver plated end-tuned quarter-wave coaxial line, one form of which is shown in Fig. 1.

The advantages of this configura-

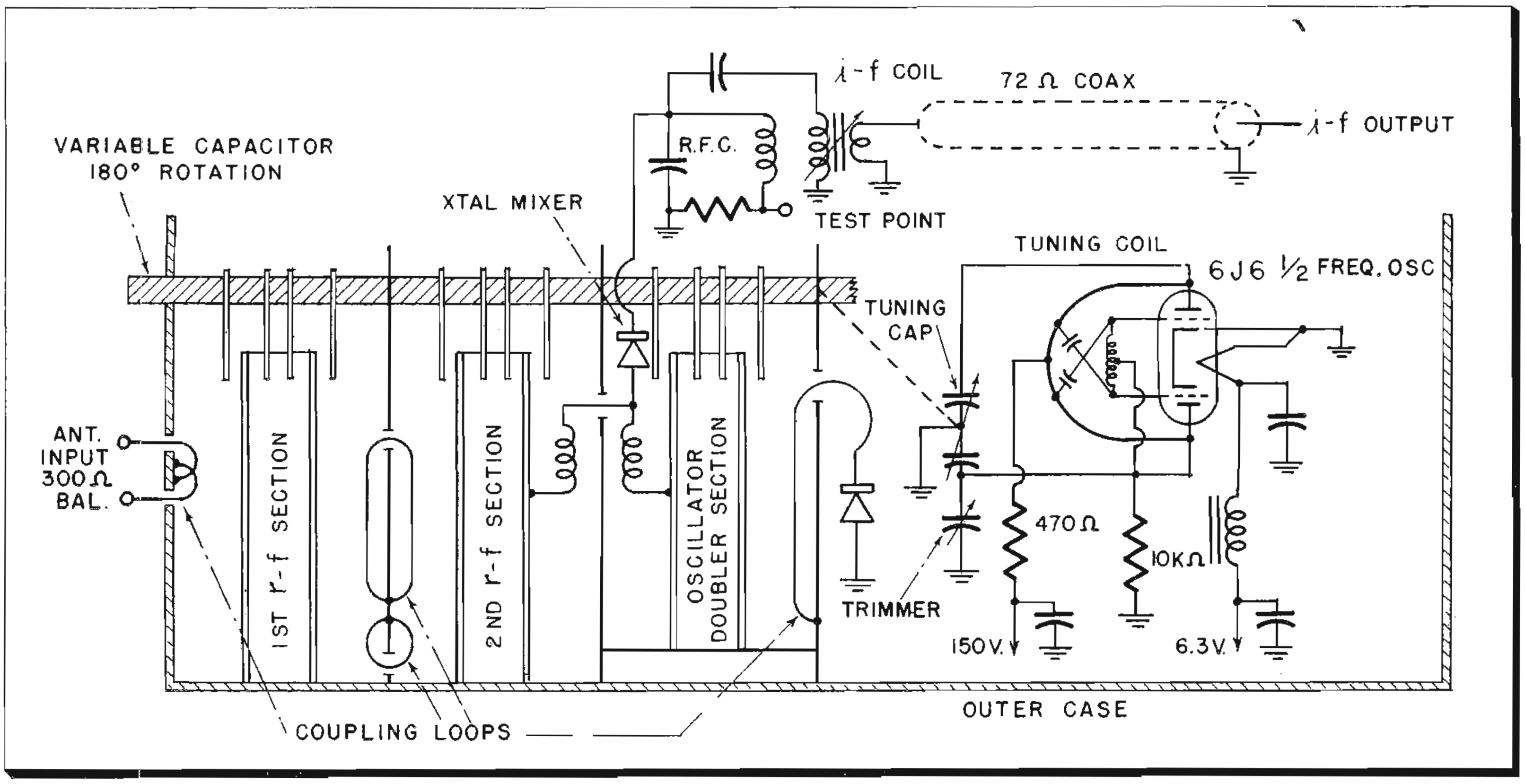


Fig. 3: Circuit of 470 to 890 mc tuner employs 6J6 half-frequency push-pull oscillator. Four plates are used to tune each line

tion are many. It retains most of the advantages of tuned stubs and still permits a two to one or greater tuning range. The unloaded Q to loaded Q ratio is very high, and it leads automatically to a low dissipation loss circuit. It avoids the use of any lumped elements in the r-f circuits. The Q of these end-tuned quarter-wave elements increases with an increase of frequency, whereas the Q of lumped element circuits normally decreases with an increase of frequency. This increase of Q with frequency permits the design of a tuner that has constant bandwidth and insertion loss over the whole band. Use of end-tuned quarter-wave lines leads directly to a simple, effective overall design that is straightforward to manufacture, and also leads to a ganged tuning element whose construction is very similar to that of a variable capacitor, as is shown in Fig. 2.

Consequently, we can shape the plates of the rotor so that we obtain a straight line tuning characteristic. Also, known techniques and known production equipment can be used in manufacturing. Tracking and aligning can be done in a manner similar to that employed in the manufacture of variable capacitors. This frees us of the necessity of depending only on piece-part and assembly tolerances for the electrical characteristics and for satisfactory tracking of the completed unit.

At the time we did our original development on this tuner, we could obtain no definite promises of production of a tube that could be used as a fundamental oscillator.

After considering many possible oscillator circuits, we settled on a half-frequency push-pull oscillator using a 6J6. The advantages are that it uses an inexpensive, well-debugged, high production tube. Standard, simple, well-known VHF tuner wiring and aligning techniques may be used with little change. The drift, shift, and radiation problems are also very similar to those encountered in VHF and the techniques for handling them are similar.

Designing Difficulties

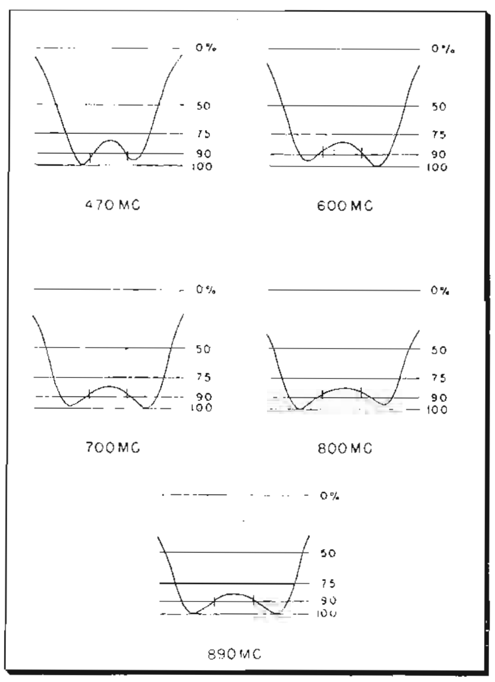
There was, of course, some trouble in designing even a half-frequency oscillator as there always is with any oscillator. At first, the output was not uniform enough to maintain the crystal injection within the limits required for best noise and gain. The grid inductor in the oscillator however, raises the amplitude at the lower frequencies, helping to maintain the proper injection current. Also, we found lead dress to be extremely critical. To increase the uniformity of lead dress, the plate inductor is a stamped piece mounted to the capacitor support with eyelets and attached to the tube socket with lugs which are an integral part of the stamping. The coupling capacitors are positioned by holes pierced in the loop itself. In this manner, we have been able to keep lead dress and oscillator characteristics "nailed down" almost automatically. Fig. 3 shows the complete schematic of the tuner.

For the r-f sections we have provided trimmers at the tuned end of each quarter-wave line in order to set the high frequency end and to compensate for the effects of normal production variations with the tuning rotor unmeshed. In this way the variations in the setting of the stop for the rotor, the slight variations in plate settings on the rotor shaft, and the slight variations in the settings of the inner conductors of the lines themselves have no effect on electrical characteristics.

Four plates are provided for tuning each line. The two outer plates are slotted to make point-by-point corrections of the passband characteristics and the two inner plates are solid and can be used to correct for general trends throughout the tuning range.

One of the major design problems

Fig. 4: R-F bandwidths with 4.5-mc markers



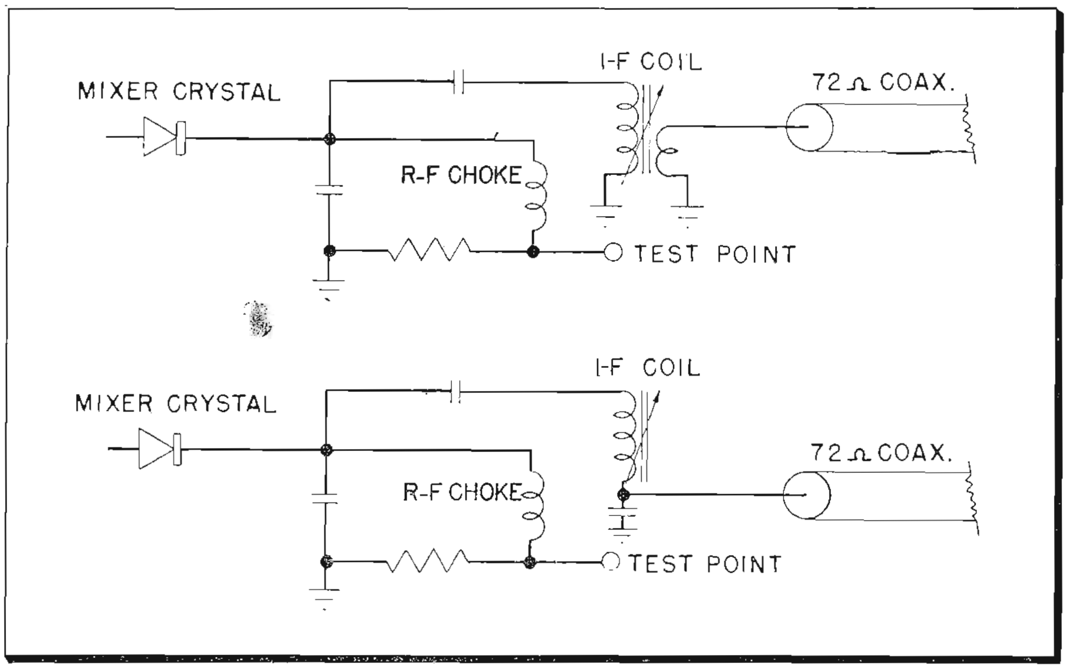


Fig. 5: Tuners are provided with either of two r-f outputs; link coupling as shown above, or low side capacity coupling as shown below

concerned the method of coupling that was to be used from the antenna to the first tuned circuit. At first a 50-ohm input was used. This required the use of a balun between the tuner and the 300-ohm line, which is what seems to be expected to be used at these frequencies. We found, however, that the use of a balun had many disadvantages; either price or size or performance or all three. It was therefore decided to try to make the input of the tuner 300 ohms balanced and to keep it reasonably matched over the entire range. After much trial, we eventually designed the present input circuit which conforms to the existing specifications for VHF tuners: that is, a reflection coefficient of less than 50% over the whole range.

The original coupling between the first and second r-f sections was a single loop, designed to be an optimum compromise, considering current distribution and natural unloaded Q of the lines. However, it turned out to be too large to use in circuitry of this sort. Various resonances and suck-outs were caused by it. The present interstage coupling system uses two loops, one for the high frequency coupling setting and one that is most effective at the lower frequencies. Neither of these loops is large enough to give objectionable resonances within the working range and the use of the two loops affords a great advantage production-wise. It is found that if the smaller loop is used to set the bandwidth at the high frequency end and the larger loop is used to set the low frequency end, a very satisfactory bandwidth is obtained over the entire range.

In coupling to the mixer crystal, the usual problems were encountered. That is, maintaining oscillator injection comparatively constant and at a proper level to give best conversion loss and noise without introducing a low impedance shunt path for the r-f signal. In addition, there is always the problem of proper impedance to the crystal. We are using, and find to be very satisfactory, an r-f choke coupling in which the chokes are tuned to self-resonate below the low end of the band.

Bandwidth Variation

Fig. 4 illustrates the r-f bandwidths of the tuner at various frequencies. On these curves you will note that the spacing between markers is 4.5 MC, and that the bandwidth increases from about 7.5 MC at the low end to about 11.5 MC at the high end. However, we feel that this variation in bandwidth is a problem that can be licked with just a normal amount of additional engineering investigation.

Fig. 7 shows averaged noise and gain figures obtained from ten production UHF tuners. The output of the UHF tuner is fed through a General Instrument Model 48 VHF tuner, acting as a 40 MC preamplifier. As a preamplifier, the Model 48 has a gain of 40 db and a noise figure of about 6 db.

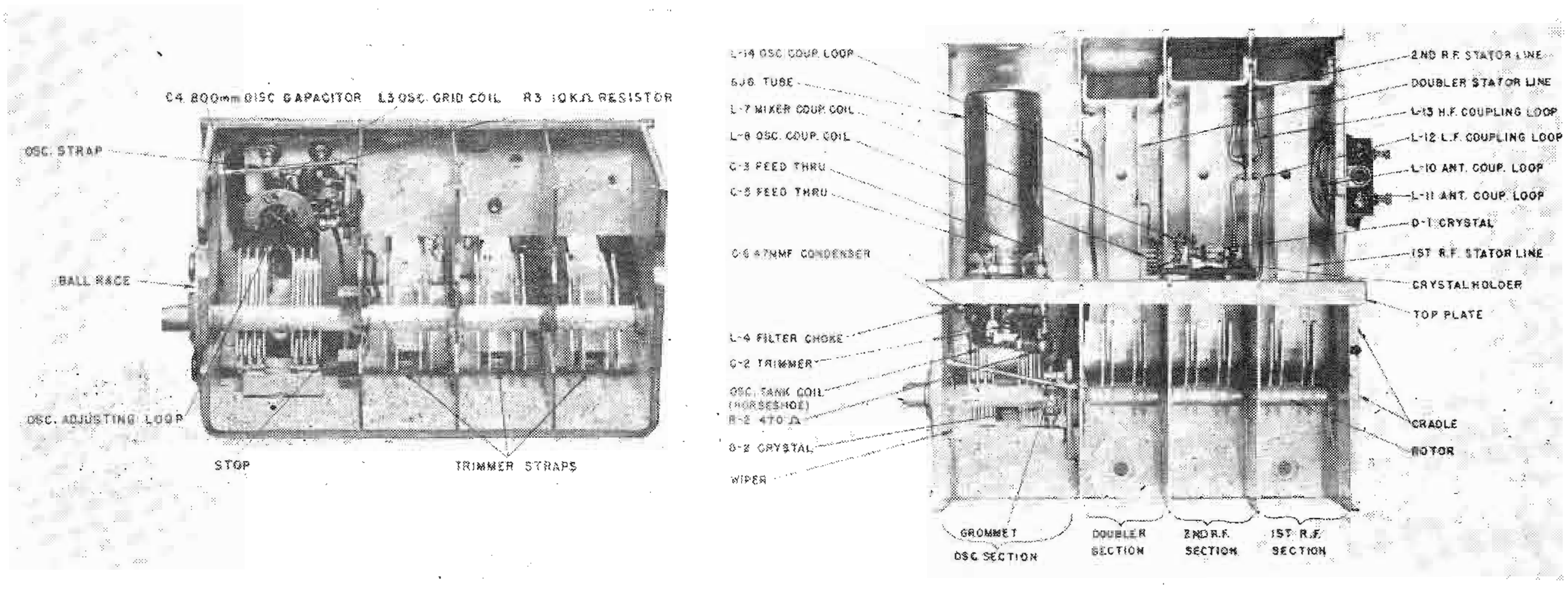
Equipment for Measurements

These measurements were taken using a 50-300 ohm tapered line balun to match the tuner to the 50 ohm output of the generator.

We are at present providing the tuner with either of the two i-f outputs shown in Fig. 5. Both of them bypass the crystal directly at the i-f point with a 33 μμf capacitor, and then provide a test or looker point. The testpoint serves two purposes. In production, the 47-ohm resistor is not soldered in until the oscillator and harmonic emphasizer have been set. This permits attaching a milliameter from the test point.

(*Continued on page* 149)

Fig. 6: Photos of tuner with cover removed to show identity and assembly of component parts



Powdered Magnetic Cores

Measurement techniques for magnetic materials aid research and improve manufacturing methods. Factors affecting loss and permeability analyzed

By
W. J. POLYDOROFF

Consulting Engineer
Carry Bldg.,
927 15th St. NW
Washington 5, D.C.

POWDERED compressed cores for high frequencies first appeared in the early thirties for "universal" use, but since then it was realized that better cores can be made for each individual frequency or application. Hence a great variety of powders and cores made of those powders appeared in the market so as to cover a very wide frequency spectrum from 2000 MC to 100 MC. Depending on their applications the cores vary in weight from one gram for a small "screw thread" to one kilogram for a loop antenna core and, according to a recent survey,[1] the total number of grades now offered is estimated to be close to 200. Such a variety creates a confusion in a choice of a grade and future replacements, while in actual practice a dozen of standardized grades could satisfy all the requirements both for frequency and for a desired application standpoint.

Multiplicity of Grades

Apart from economical considerations, it is felt proper to mention at least one cause of this multiplicity of "grades" if one considers that a given powder can be compressed to different densities, producing "different" cores with the same primary material. Fig. 1 illustrates this condition, where several carbonyl iron powders are compressed to different densities. One can easily see the difference in permeability obtainable by this method. In many cases higher pressure and permeability produce cores of higher losses, such practice often being used for permeability tuning cores, although in this case the cores really should have a "variable magnetic density," so that a softer end of the core enters into the coil first.[2]

This great variety of magnetic materials and cores creates a problem with manufacturers, which so far has been solved by making cores "according to a sample." This in turn necessitates creation and buildup of libraries with each manufacturer, where cores and coils are stored for future reference.

Some years ago, sample sets of coils were proposed for R.M.A. Each set of eight coils enables one to test standard size cores for their effective permeability and Q, the latter combining both Q of the coil and of the core. A score of such sets of coils now in use in this country constitutes about the only practical means of comparison of different grades of magnetic materials for their permeability and Q.

It has been realized that basic material classifications should be adapted for powdered magnetic materials and a great amount of work is going on in this country to arrive at common standards.

It is generally agreed that any material having magnetic properties can be recognized by its permeability, loss-factor at a given frequency and its stability. The "complex permeability" $\mu = \mu' - j\mu''$ sufficiently represents two characteristics of a core material, μ' being an inductive term of permeability manifesting the increase of inductance of an air coil L_0. The new increased inductance may be represented by L_i so that $\mu' = L_i/L_0$; μ'' representing the loss term$= R_i/\omega L_0$, where R_i is an equivalent series resistance due to the insertion of a magnetic material into the coil L_0. The ratio $\mu'/\mu'' = Q'\omega L_i/R_1$ may represent, by analogy with coils,

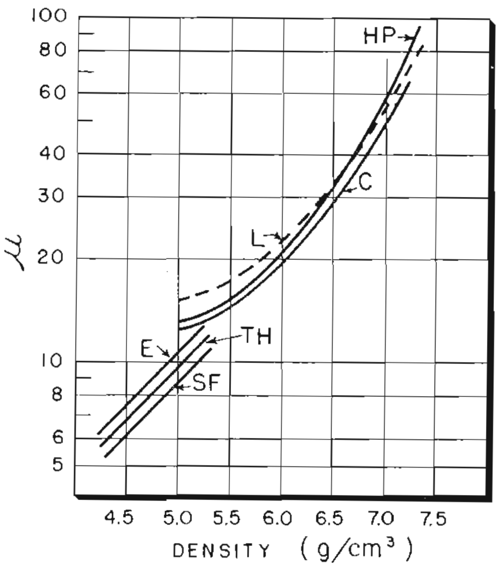
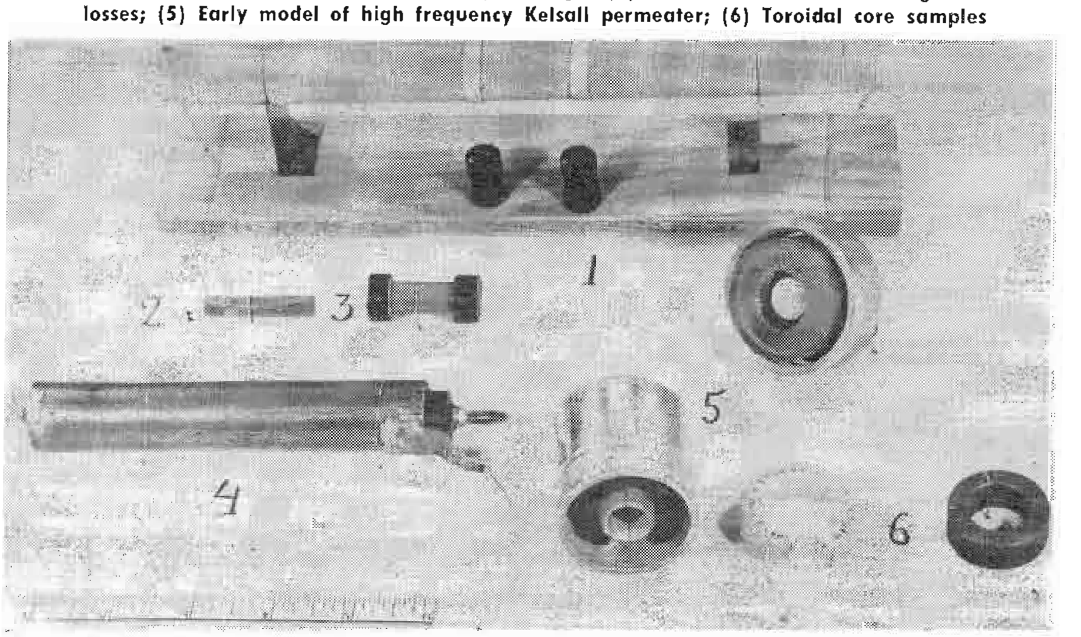


Fig. 1: Curves of initial permeability vs. density for carbonyl powder cores

a figure of merit of the core. Another expression. $\tan\delta = 1/Q' = \mu''/\mu'$ is often used and called "loss tangent" or dissipation constant.

There are other attempts to designate the materials by their figure of merit, of which the product $Q'\mu'$

Photo shows (1) Modified Cogniat coil for Q-meter measurements of permeability; (2) Test bar of magnetic material; (3) Carriage; (4) Coaxial line for measuring core losses; (5) Early model of high frequency Kelsall permeater; (6) Toroidal core samples



deserves a special attention, since it has been proven that for a given material and frequency this product remains constant if degree of utilization of magnetic material (effective permeability) is varied, e.g. decreased by an air gap, then the value of Q′ will increase. Apart from the validity of this expression later shown in analysis of losses, this is demonstrated by a simple experiment shown by Fig. 2, where effective permeability of a solenoid of low loss was varied by variable gaps and product $Q'\mu'$ plotted against μ. Since highest μ is always desirable together with highest Q, one can see that their product is a real figure of merit of a core.

Circuit Instability

Both μ' and μ'', or μ and Q′ of the material may change considerably with magnetization and with temperature, causing an instability in circuits which is of great concern in the equipments designed for high

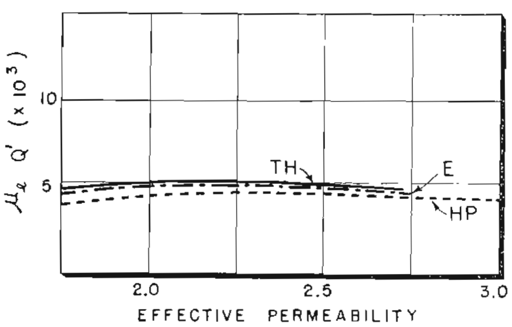


Fig. 2: Product $\mu_e Q'$ when μ_e is changed by variable air gap in a solenoid coil at 400 KC. Carbonyl powder cores "E," "TH," and "HP."

temperature operation, especially military equipment. Since measurements may involve the measure of permeability and core losses, a brief resume of common practice will be given first.

Measurements of Permeability

Very fortunately the powdered cores, having billions of gaps in their structure are hardly affected by magnetization. Unlike the ferrites, where H=0.1 oersted already produces change in μ, the powdered materials require hundreds times greater H to observe the change in permeability. In a majority of high frequency applications the fields are so weak that we may safely limit the observations to the initial region of permeability, which we call "initial permeability," μ_0. Without much regard to the field strength, we may measure a toroidal coil wound on a magnetic sample toroid on a 1000 cycle bridge for its inductance. We may make a similar toroid on a non-magnetic core and measure its L_0. Then the ratio $L_1/L_0=\mu_0$. Or, instead of second measurement we may compute L_0 from known formulae.[3] The only precaution necessary is to wind as many turns as to cover at least 60% of the surface of the core with copper to avoid the leakage of the flux through the air, especially noticeable in weak magnetic materials.

To avoid winding a toroid, one may use the Kelsall method[4] adapted first to high frequency measurements by H. Dressel[5] and presently developed by P. H. Haas as a secondary standard of the National Bureau of Standards.[6] By careful calibration, the instrument is capable of an accuracy of a few percent. Its simple principle and operation was recently described and it is believed the instrument, when accepted by the trade, may give a close correlation of permeability with other methods now in use.

Cogniat Method

There remains to describe one simple method originated in France and equally acceptable for quick determination of initial permeability in the samples of material under test made in the form of elongated cylinders or bars. The original Cogniat method[7] was intended for measurements of initial permeability of thin long laminations at relatively high frequencies in an instrument similar to the Q-meter. These laminations were placed in the central region of a solenoid one meter long. Assuming a uniform field in that region and the absence of demagnetization in very long thin samples Cogniat arrived at a very simple deduction for permeability:

$$\mu=(1+\Delta L/L)\ (V/v) \qquad (1)$$

where L is the inductance of his solenoid, ΔL is the increase of inductance due to the sample and V and v are respectively volumes of the coil and of the sample. The writer applied this method to the measurements of permeability on a Q-meter, using convenient sample bars of rectangular cross-section $0.2\times0.2\times1\frac{1}{2}$ in. long. The samples were made of the same mix and compressed to the same density as a corresponding set of toroids, which were separately measured for permeability. A solenoid 10 in. long and 3/4 in. diam. was uniformly wound with Litz wire (to assure high Q and

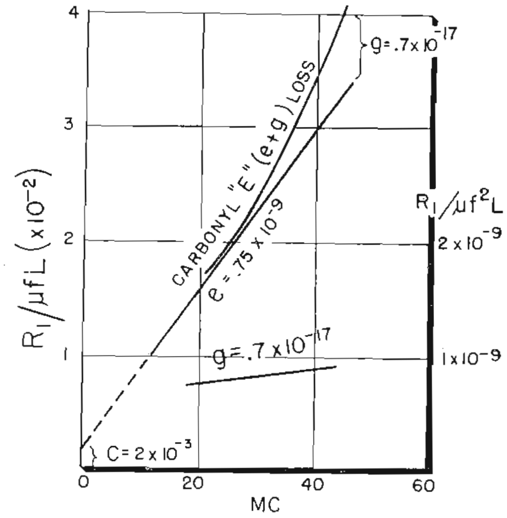


Fig. 3: Coaxial line core loss determination

hence accuracy of resonant point) to an inductance of 200 μH. Because our inductance of whole coil and of the region occupied by the sample were *not* proportional to their respective lengths (as was assumed in the original work) values should be corrected by Nagaoka constants which in the above example are: K=0.97 for the coil and k=0.82. Furthermore the field in the sample due to the demagnetization is reduced so that in effect we may substitute his permeability μ by an effective permeability:

$$\mu_e=\mu/[1+D(\mu-1)]$$

where D is demagnetization constant of an elongated bar, is a function of the length to diameter ratio and is given by Thompson.[8] Thus the final formula becomes:

$$\mu_e=(1+\Delta L/L)\ (V/v.\,K/k) \qquad (2)$$

For a given solenoid, its inductance L and volume V are the same for all tests, also K, and we may choose same dimension samples for all our tests in which case v,k and D remain the same so that $\mu_e=1\pm\Delta LA$; where A is a constant—in our case 0.43. Having determined μ_e we get, as first approximation

$$\mu=\mu_e/(1-D\mu_e) \qquad (3)$$

For the above core dimensions D = 0.03.

The writer has published curves of effective permeabilities as function of permeability and ratio of length to diameters, from which curves[9] one can easily read full permeability μ as the function of μ_e obtained from the modified formula (2) of Cogniat. These curves closely agree with the results obtainable by Thompson's demagnetization coefficients.

The measurement becomes extremely simple. The solenoid is resonated on the Q-meter and C reading observed. A test sample is inserted which causes a new setting of Q-meter condenser C′. Knowing C and C′ at a given frequency one can calculate L and ΔL. Applying all the corrections of modified formula (2) μ_e is found and corrected to μ either from the curves or by demagnetization formula (3). The results obtained with the test bars as above described were in complete agreement with toroidal measurements* made on similar materials.

Setting Q-meter at 60 kc the coil alone resonated at $C = 351\ \mu\mu F$. Insertion of carbonyl E bar changed the setting to $C' = 323\ \mu\mu f$. By simple calculation $\Delta L = 16.5\ \mu H$. Thus $\mu_e = 1 + .43 \times 16.5 = 8.1$; from (3) $\mu = 8.1/.76 = 10.6$. Measurements of same material in toroidal form yielded $\mu = 10.45$. Still closer agreement may be reached if D is better known. It can be determined from a bar of *known* permeability (carefully made of the same mix and same density as a test toroid), preferably of much higher permeability so as to emphasize effect of demagnetization.

Measuring Permeability

The National Bureau of Standards utilizes collapsible coaxial line[6] into closed end of which the test sample is inserted. This method together with precision bridge constitutes their primary standard method of measuring the permeability.

To determine the influence of temperature or other causes on the core losses one must consider the origin and nature of those losses. It is convenient for measurements and calculations to represent core losses as an equivalent series resistor introduced into an inductor by the insertion of the sample of a magnetic material, which also manifests itself by an effective permeability. The resistance due to the iron R_i is composed of several terms as represented by the formula

$$R_i = R_h + R_c + R_e + R_g \quad (4)$$

where R_h is hysteresis loss resistance

(*Continued on page* 112)

Improved Tri-Color TV Picture Tube

Chromatic Television Labs. has recently demonstrated an improved tri-color TV picture tube—the Chromatron—also known as the Lawrence tube. The tube's good resolution and excellent color fidelity proved to be comparable to, or better than, other types demonstrated to date. Unfortunately, facilities available for the demonstration limited the showing to standard color slides, which were made by Eastman Kodak for NTSC.

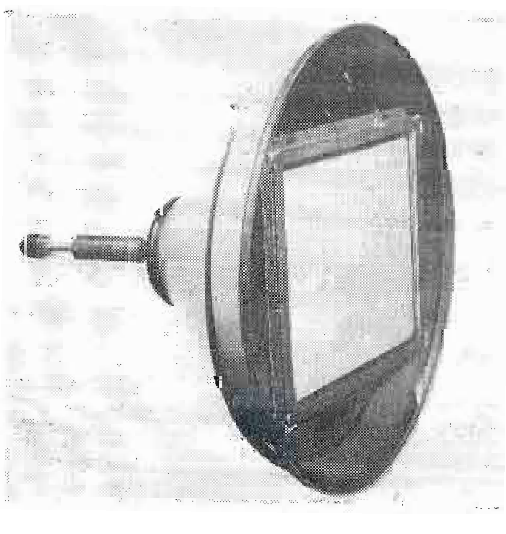
The single-gun, 22-in. tube, shown in Figs. 1 and 2, has a rectangular color face, 18.5 in. diagonally. Developmental work is also proceeding on a three-gun tube. In either case, dimensions, deflection components and deflection angle requirements of 70° to 90° are all similar to standard black-and-white tubes. Chromatic claims that the Chromatron utilizes 85% of the total electrons available, as compared to 14% possible with mask type units.

Cost for mass-produced tubes is expected to run about twice the amount for equivalent black-and-white types. On an individual sample basis, the metal-coned Chromatrons are presently being sold to laboratories for $500 each.

The recent demonstration of the single-gun tube employed the CBS color system, but it is not limited to any one system. It is possible to obtain very bright pictures with single-gun time-shared operation. Information received at press time indicates that further progress has been made in displaying NTSC signals on the single-gun tube using 3.6 MC switching and keying circuits for the color modulation. This advance is expected to be shown to the industry around the middle of Feb. 1953.

The tube of Fig. 1 contains 1000 vertical color phosphor strips with 500 grid wires. Still better performance should result from one developmental type which utilizes 1600 vertical strips, each 10 mils wide, and 20-mil wire spacing. One result of these narrow strips is a 300-line resolution.

Fig. 1: Front view shows 18.5-in. color face



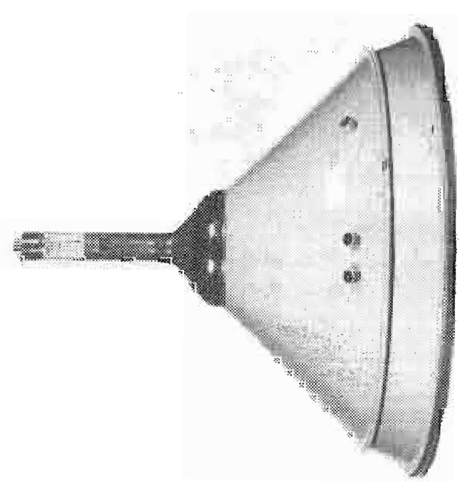


Fig. 2: Chromatron is built with metal cone

To review the operation of the Chromatron briefly, Fig. 3 shows how the electron beams in a three-gun tube pass through the color control grid and strike their respective red, green and blue phosphors. In the single-gun tube, Fig. 4, one electron beam passes through the double grid to strike the green phosphor strip. As the beam scans across one line, the potential on the grid wires is varied at proper time intervals in such a way that the electron beam is deflected slightly to impinge upon the red or blue strips, as desired.

It is of interest to note that the main horizontal deflection system (not shown) can cause the beam to scan across the wires and phosphor strips at any angle to the wires, and still produce an excellent picture. The only thing that changes as the scan is changed from perpendicular through parallel to the wires, is that the basic picture element structure changes from line- to diamond- to checkerboard-shape. Since preferred element shape is in large measure a subjective reaction, more extensive personal reaction tests are planned.

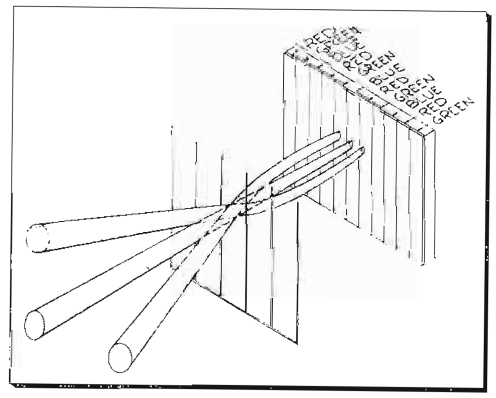
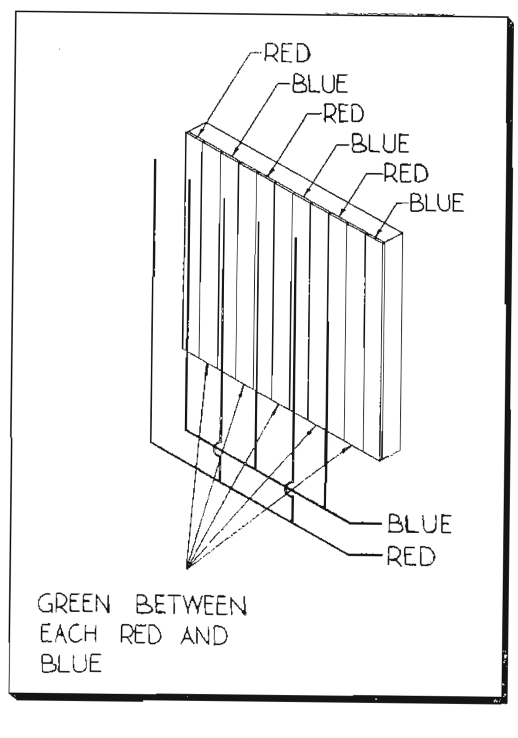
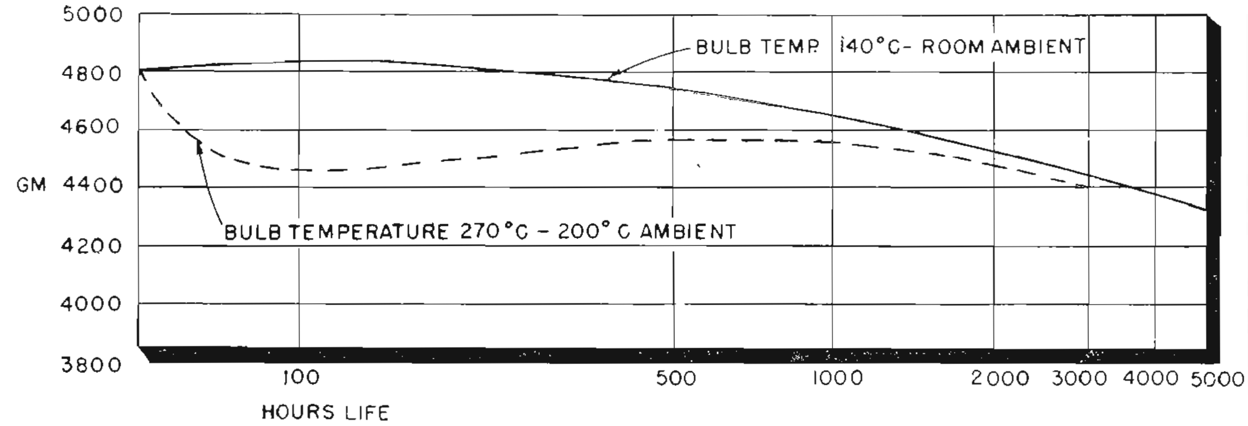


Fig. 3: Three-gun electron beams through grid

Fig. 4: Grid structure for single-gun tube





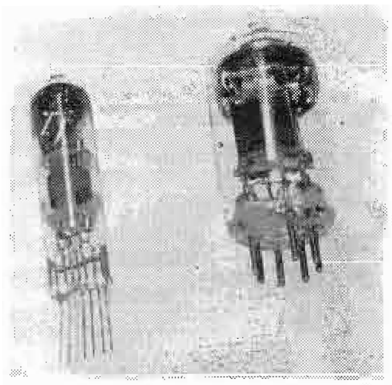


Fig. 1: (l) Effect of temperature on g_m of 5702 tube. Fig. 2: (r) Comparison of 5702 (left) and 6AKS.

Shielding and Mounting Effects on

Operation of miniature and subminiature tubes at high ambients require special shielding to keep bulb temperature well below critical 275°—300° range. New design illustrated

By IRVING E. LEVY
Raytheon Mfg. Co.
55 Chapel St.
Newton 58, Mass.

NEW requirements for both military and commercial applications necessitate the use of high ambient temperatures for tube operation. Glass envelope vacuum tubes were not originally designed to operate under the present day stringent requirements. Consequently, high operating ambient temperatures impose a difficult test for the present day tubes to meet. A limiting factor in the successful use of tubes operating at high ambient temperatures is electrolysis of the glass which takes place approximately between 275°C and 300°C.

Mechanisms of Heat Loss

Let us examine the three mechanisms of heat loss from the bulb and determine their applicability to the present problem of high ambient temperature tube operation.

1. *Radiation:* The bulb is an excellent absorber and radiator of heat in the wave lengths of radiant heat energy normally encountered in vacuum tube use. The heat lost by the bulb by radiation is expressed by the Stefan-Boltzmann relationship as follows:

$$H = \varepsilon K (T_2^4 - T_1^4)$$

H = rate of heat loss from bulb wall per unit area in watts/sq.cm.
K = 5.672×10^{-12} watts/cm² (°K)⁴.
ε = the emissivity or blackbody coefficient. This is approximately 0.9 for the case of glass in a heat radiating field normally set up by vacuum tube operation.
T_2 = bulb temperature, degrees Kelvin.
T_1 = ambient temperature, degrees Kelvin.

The radiation effect is expressed quantitatively to point out how important the ambient temperature is in influencing bulb temperature. This relationship points out that as the ambient temperature is increased, so will the bulb temperature be increased, because of the decreased rate of heat loss from the bulb.

2. *Conduction:* In the usual operating sense, heat loss by conduction from the bulb is a negligible quantity. There is virtually no heat loss except that which is conducted away from the bulb by the stem leads. In order to utilize conduction it is necessary to put some sort of heat conducting shield around the bulb and have this shield satisfactorily attached to a large chassis which will act as a heat sink. The details of this technique and the effect on bulb temperature will be discussed in a later section.

3. *Convection:* Tubes are normally mounted in chassis where there may be a great deal of free air space. Proper venting of the chassis will cause a displacement of the warm chassis air by the more dense cool air external to the chassis. Heat transfer will accompany this displacement, causing a lower ambient chassis temperature. This is called natural convection. If this air motion and displacement is produced mechanically it is called forced convection. Considerably more efficiency can be obtained by a careful analysis of the chassis components and design. An excellent treatment of convection studies with reference to heat transfer in electron tubes has been carried out by Buckland.[1]

The convection effect will not be measured or evaluated in this paper. Since the same insulated box was used in all the experiments, convec-

TABLE 1: Shield and Chassis Temperatures for Various 6AK5 and 5702 Mountings at Different Ambient Temperatures

(All temperatures in degrees centigrade)

Ambient Temperature	28	100	175	200
Shield Temperature				
6AK5 shield	50	122	175	230
5702 conventional shield—riveted	88	157	200	255
5702 conventional shield—soldered	65	131	183	237
5702 special Raytheon shield—soldered	53	130	191	241

Ambient Temperature	28	100	175	200
Chassis Temperature				
6AK5—no shield	29	130	151	205
6AK5—shield	36	108	158	212
5702—conventional shield riveted	42	113	160	220
5702—conventional shield soldered	41	118	165	220
5702—special Raytheon shield soldered	30	115	170	230

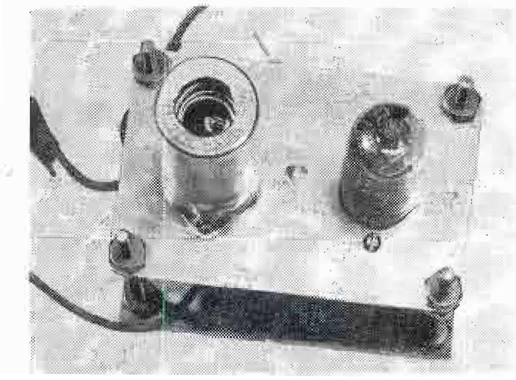


Fig. 3: Shielded and unshielded tube mountings

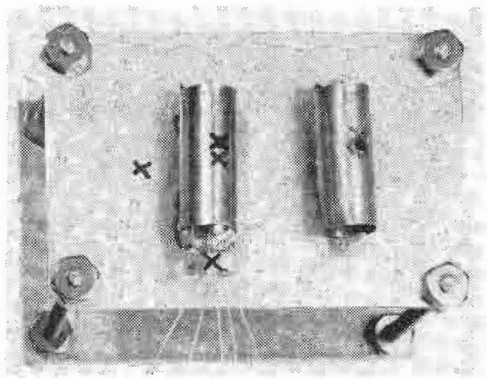


Fig. 4: Subminiature chassis and clip assembly

Tube Bulb Temperatures

tion will be considered a constant factor for this work. This paper will concern itself mainly with the radiation effect, and with methods of improving the heat conduction away from the bulb by means of various conducting shields and chassis mountings.

One of the main difficulties encountered in the operation of vacuum tubes at high ambient temperatures is that a deterioration of characteristics on life is often noted as a result of the high bulb temperatures which are reached. While there have been many theories to explain this, it seems logical to assume that gas given off from the bulb wall as a result of the higher bulb temperatures is in many cases sufficient to cause a poisoning of the oxide cathode and a resultant loss in emission characteristics. Fig. 1 shows a somewhat typical case of how the characteristics are affected on life when the tubes operate at a high ambient temperature. The type considered here is the subminiature 5702 in the unshielded condition. The 140°C bulb temperature resulted from operation at room temperature ambient. The 270°C bulb temperature resulted from operation at an ambient temperature of 200°C. The wattage input was kept constant for both cases. While results on this type indicate that the tube operates completely satisfactorily all through its life, there is a drop in transconductance at the higher bulb temperature between 200 and 500 hours. Although this is not serious on the 5702, it does indicate that high ambient temperature operation can cause emission characteristics to suffer.

Other tube types might be considerably more vulnerable to this type of operation and might actually fail early on life under these conditions.

P. T. Weeks[2] has pointed out the various specific features of the miniature and subminiature tubes as they are related to the factors which affect tube reliability. Some of these factors are operating temperature, emission stability, and life. While it is true that a reduction in size from a miniature to a subminiature introduces many problems in connection with the wattage rating and bulb temperature, it is the purpose of this paper to determine if the proper type of tube shielding and chassis mounting will result in subminiature bulb temperatures which are comparable to the miniature bulb temperatures.

Experimental Details

In all this work, a subminiature 5702 was compared to its miniature counterpart the 6AK5. Fig. 2 shows the comparison in size between these two types. The 6AK5 has the conventional T-5½ bulb while the subminiature 5702 has a T-3 bulb. These two tube types were combined with the following shield and chassis mounting arrangement:

1. 6AK5 mounted in a miniature tube socket bolted to the chassis. No shield around the tube.
2. 6AK5 mounted in a miniature tube socket bolted to the chassis with a conventional JAN-S28 high frequency shield around the tube. This shield was never intended for and does not make thermal contact with the bulb.
3. A 5702 tube with conventional subminiature clip shield around it riveted to the chassis. (Shield made by the National Electrical Machine Shops, drawing No. 6873-3).
4. A 5702 tube with a conventional subminiature clip shield around it soldered to the chassis.
5. A 5702 tube with a specially designed Raytheon Manufacturing Company subminiature clip shield soldered to the chassis. (Raytheon designation T-3 shield, No. 1).

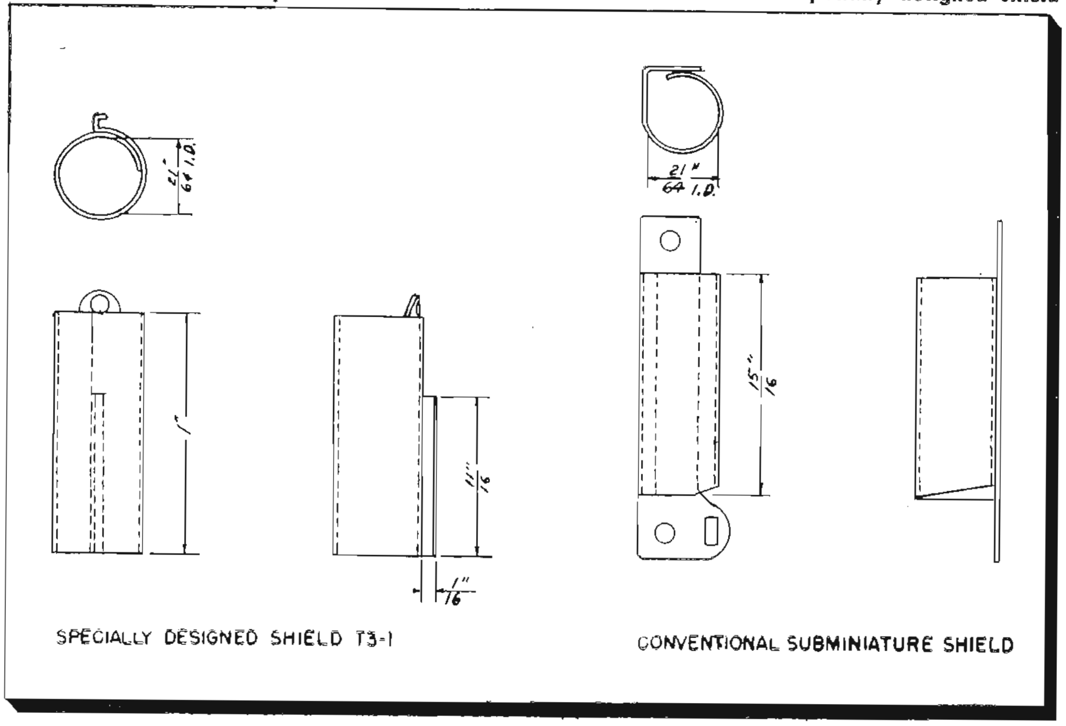
The miniature tube mountings with and without the shield are shown in detail in Fig. 3. The subminiature chassis and clip assembly are shown in detail in Fig. 4. Fig. 5 shows the detailed differences between the conventional subminiature clip shield and the specially designed Raytheon T-3 clip shield.

The special T-3 shield, which is cylindrical, was designed to fit the T-3 bulb contour more exactly than the conventional subminiature shield. This should insure better thermal contact and cooler bulb temperatures. The lip on this shield is provided for insertion into a chassis slot prior to soldering.

The special Raytheon T-3 shield was made out of 0.015-in. grade A phosphor bronze, finished in bright

(*Continued on page* 159)

Fig. 5: Constructional comparison of conventional subminiature shield and specially designed shield



Combination UHF & VHF

Immediate application of UHF tuners to present VHF Features include double conversion and automatic

By *H. F. RIETH*
Chief Engineer, Kingston Products Corp., Kokomo, Ind.

FOR several years the UHF television band has been under observation, and until recently was considered a rather intangible project. With the lifting of the freeze and the issuing of construction permits for new stations, serious consideration must be given to the building of a UHF TV receiver which is practical. This means that the manufacturer is faced with building a TV receiver with continuous UHF tuning, and without disrupting the present chassis and testing procedure too greatly. The increased costs must be as low as practical and the performance must be exceptionally high, in order to preserve the reputation of the manufacturer.

Considerable space has been devoted to UHF tuners in our technical periodicals, and these, of course, are the tools which are required to build a UHF TV receiver. The purpose of this article is primarily to consider the application of a UHF tuner to a present TV chassis. The process has been successfully applied to several chassis, and the results have been very gratifying. It is well to point out at this time that, although this process looks like the most attractive and realistic approach to the problem, it is possible that in several years one will find an altogether different arrangement having better performance and lower costs. The answer seems to resolve around tubes which are not presently available, and which there is little hope of obtaining in the very near future.

The first basic decision lies in the choice of single or double conversion in the front end or r-f section of the receiver. In this case double conversion was selected for the following reasons:

Double Conversion

Double conversion is superior on the basis of being able to secure greater sensitivity at UHF over other present methods. From the results of the VHF experience obtained, we know that a set must have the maximum sensitivity that is possible to obtain, in order to secure a satisfactory reaction from the public. The results of various UHF field tests indicate that maximum sensitivity is the most important consideration, provided a normal noise figure is secured.

Double conversion permits immediate factory changeover, which is necessary at this critical time, inasmuch as lengthy engineering time would retard production, and, together with the necessary tool changes, would certainly result in a lapse of production of UHF TV receivers. Double conversion utilizes the same testing equipment and procedures that are presently being used on VHF receivers, and with the UHF tuners fully aligned when it reaches the manufacturer, only a simple performance test need be applied to the completed set prior to shipping.

The following change could be instituted at any time in the schedule without changing the bill of material of the present VHF set, and the procurement problem would entail the addition only of a UHF tuner and the necessary changeover switch, in order to build a combination VHF-UHF receiver.

Less Shielding

A double conversion UHF TV receiver is far more stable from an i-f standpoint, requiring less shielding and freedom from overall feedback, particularly with the antenna lead in.

Fig. 1 illustrates the block diagram of this type of VHF-UHF set.

Fig. 1: Block diagram of combination UHF-VHF receiver

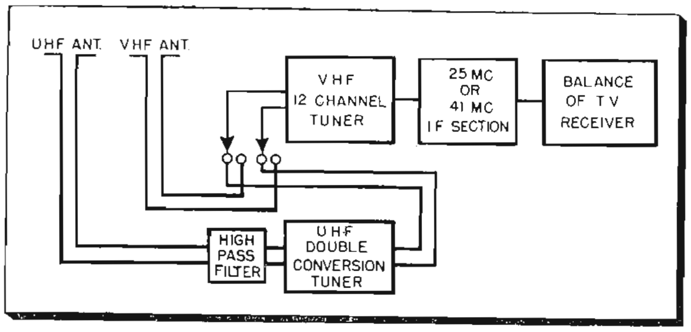


Fig. 3: High-pass filter frequency-loss characteristic

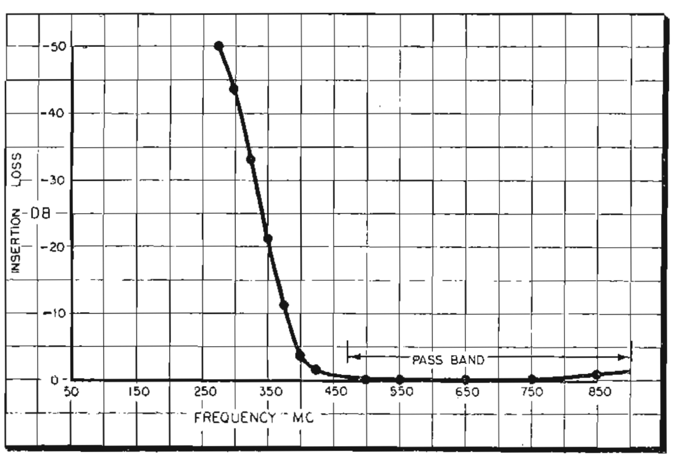
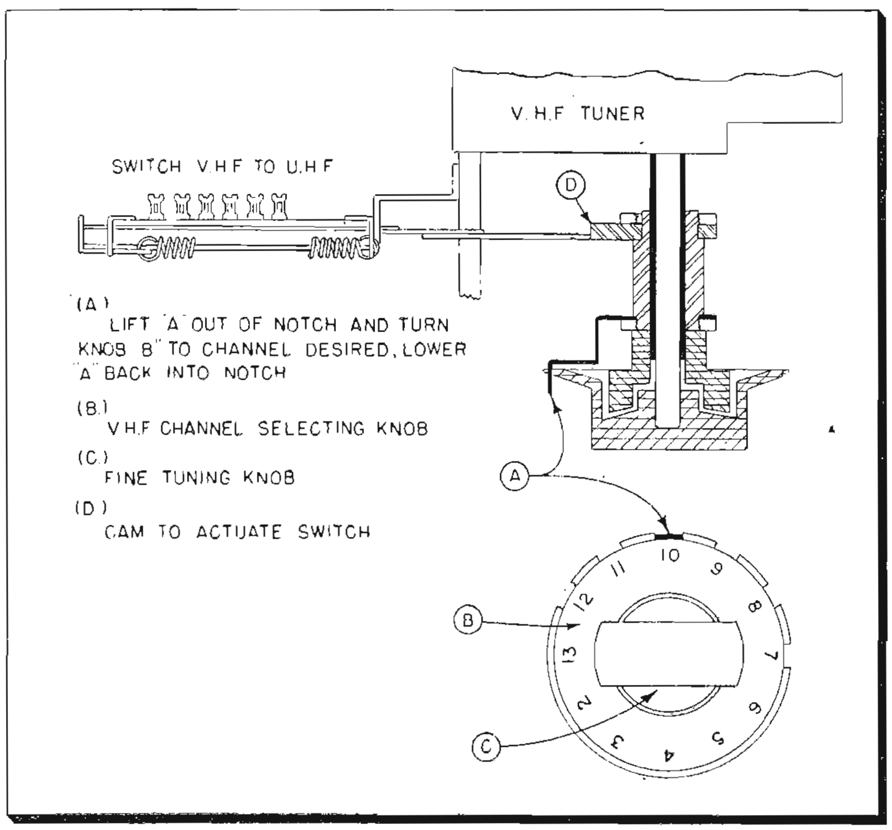


Fig. 2: Mechanical method allows easy selection of conversion channel



TV Receiver Design

chassis permits early production of all-channel units. changeover on easily selected conversion channel

The second basic decision in the engineering of a VHF-UHF receiver concerns the selection of the intermediate frequency to which the first superheterodyne will function. The choice of either a high or low i-f has certain advantages and disadvantages. In the process described, we have carefully considered this problem, while simultaneously considering methods to overcome the undesirable points with the least amount of effort and cost. An i-f of 195 MC was selected, and the analysis and treatment are as follows:

Due to the absence of a practical UHF r-f amplifier tube from which satisfactory power gain could be obtained, the next object, from an engineering standpoint, is to transfer the maximum amount of energy from the antenna to the mixer circuit, or, stated in another manner, the UHF tuning device should present the lowest insertion loss for adequate bandwidth. With proper matching of antenna and mixer, the dissipation loss and mismatch loss can be reduced to a minimum by the use of a single-circuit tuner. A single-circuit tuner has an additional advantage, in that the tracking of the r-f circuits with the oscillator circuits presents no problem in the alignment and production of UHF tuners, and the mistracking loss factor can be neglected.

Sufficient Selectivity

For a UHF receiver, one resonant circuit provides sufficient selectivity at the fundamental frequency, but in order to reject images and undesirable responses it is necessary that the image frequency be separated from the fundamental as much as possible, in order that the off-band responses be reduced to a minimum. Providing the "Q" of a single resonant circuit is adequate, one can obtain the comparable off-band response for a single resonant circuit with an i-f frequency of 195 MC, as can be obtained with two resonant circuits using an i-f of 40 MC.

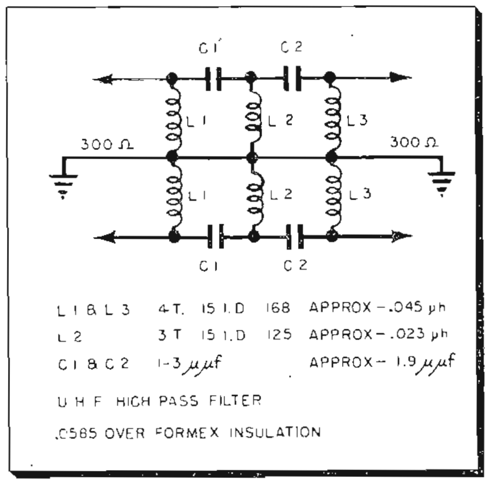
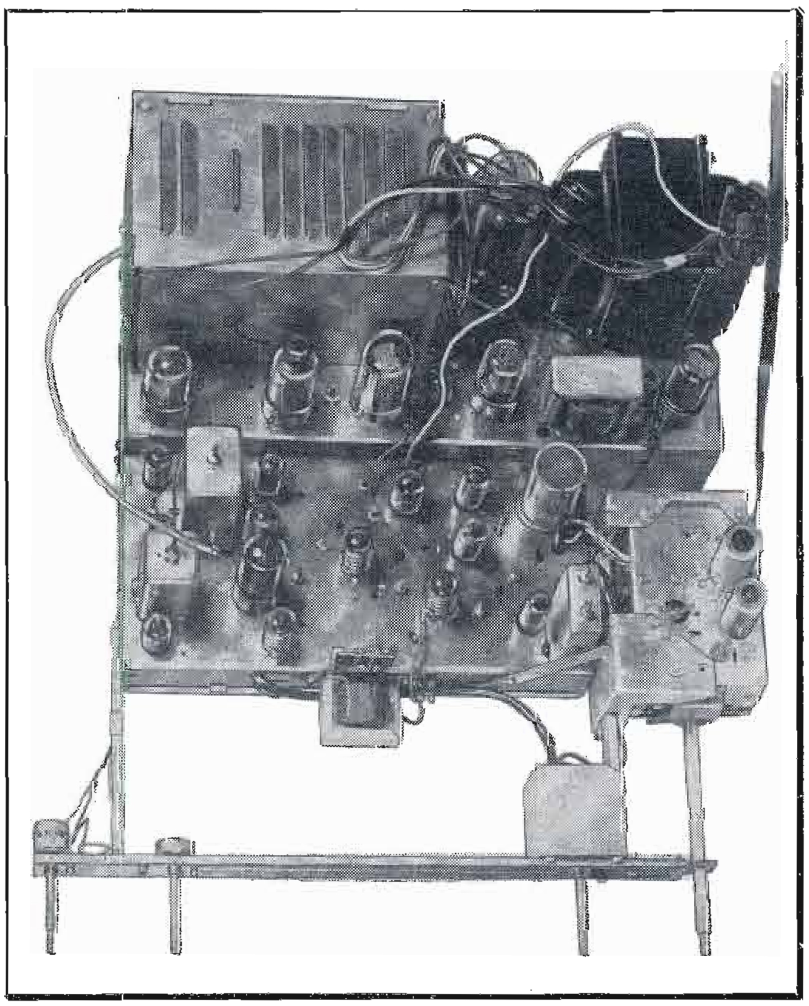


Fig. 4: Circuit of high-pass filter

In order that the spurious responses be kept at a minimum, it is necessary that the local oscillator function at its fundamental frequency. The higher the i-f becomes, the lower the fundamental frequency of the oscillator, and therefore greater frequency stability is secured.

Oscillator drift should not exceed 500 KC in a well designed oscillator circuit. The overall stability of the oscillator is of great advantage in maintaining the proper oscillator injection voltage, which in turn provides constant gain across the UHF spectrum. The oscillator injection voltage is probably one of the most important design points to be considered in a UHF tuner, inasmuch as it is difficult to obtain uniformity

(Continued on page 146)



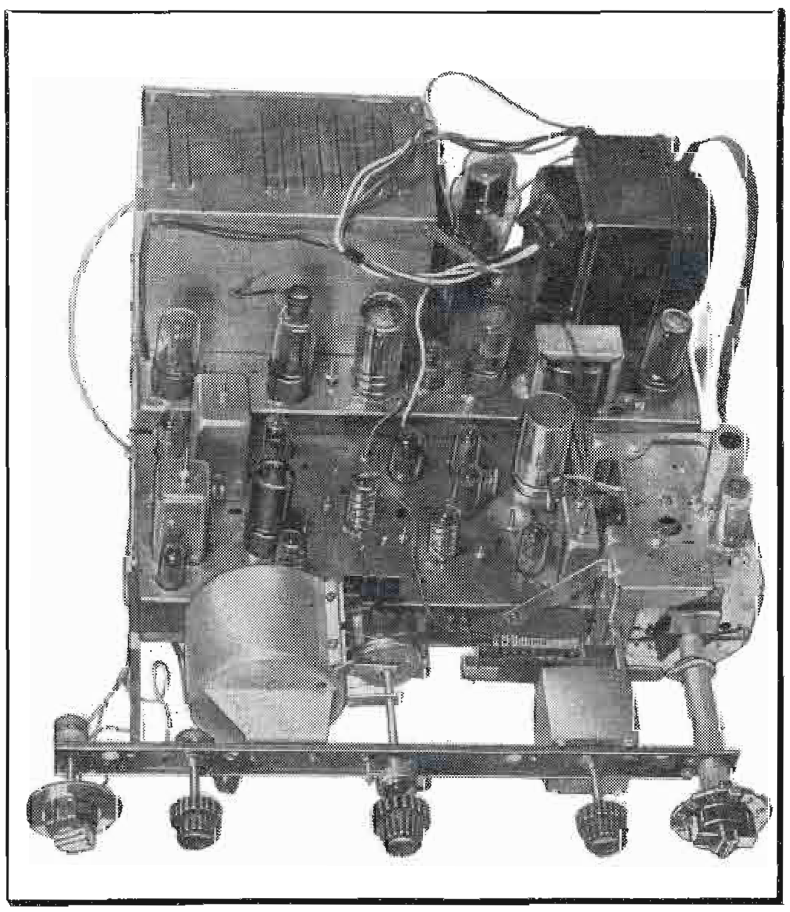


Fig. 5: (l) Typical VHF chassis to which UHF is to be added
Fig. 6: (r) UHF-VHF TV chassis shows added tuning devices

Electronic Failure Prediction

Inclusion of simple measuring circuits in main equipment reduces down time by indicating impending failures

By JAMES H. MUNCY,
National Bureau of Standards, Washington 25, D. C.

THE design engineer is faced with ever increasing equipment complexity to meet advanced functions as dictated by the customer or the competition. Dependability may be enhanced by two possible design approaches. When space, weight and function permit, down time may be kept negligible by rapid localization of failures, and inclusion of features for speedy repair. An attended shipborne or ground radar lends itself to inclusion of these features.

When the electronic equipment has to perform important functions virtually unattended, the anticipation or prediction of failures becomes highly desirable. By prediction is meant the measurement of the condition of a single equipment in such a fashion that incipient failures are detected. Prediction in this sense differs greatly from the life predictions used for large populations of either humans or vacuum tubes.

The fundamental question must first be answered as to whether the failures that occur are predictable on an individual case basis. Do tubes and components fail gradually, or so rapidly as to be termed catastrophic? Purely mechanical shorts or open welds are catastrophic, while cathode give-out and gassiness are gradual. Assuredly, in the immediate past, about 75% of tube failures have been catastrophic. With the considerable effort being expended on improved mechanical construction of tubes, components and assemblies, the parts will stay in place long enough to wear out.

Marginal checking as included in the Whirlwind computer, is the first large effort in this direction. The circuits employed are specialized for digital computers, and these are not easily adaptable to the main body of electronic circuits.

The characteristics of a failure prediction technique may be enumerated:

First: Add no components to decrease reliability

Second: Add little complexity and negligible weight

Third: Semi-automatic in operation

Fourth: An attachable test set is indicated for aircraft applications.

In order that any such technique be acceptable, an investigation of its worth must be made. This article describes the NBS research program sponsored by the Office of Naval Research, with the cooperation of BuAer. As a vehicle, a high performance radio receiver was chosen which is of recent design, yet incorporates lessons gleaned from wartime and postwar experience with very similar sets. It is relatively free of design weaknesses, and its compactness emphasizes the need for keeping additional circuitry to a minimum. A communications set was selected to give the results wide applicability, even though linear circuits are more difficult to predict than pulse circuits.

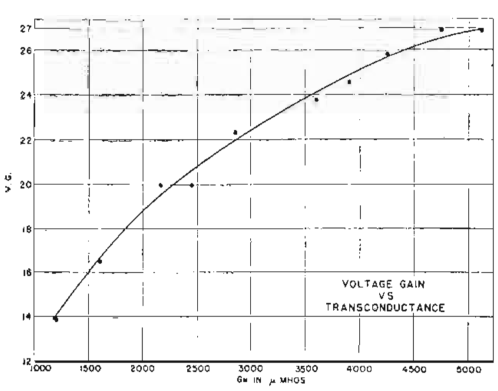


Fig. 2: Voltage gain of i-f tube of Fig. 1 acting as audio amplifier shows agreement with tube's transconductance characteristic

Fig. 1: Condition of tube in receiver i-f stage is checked by introducing signal in grid return

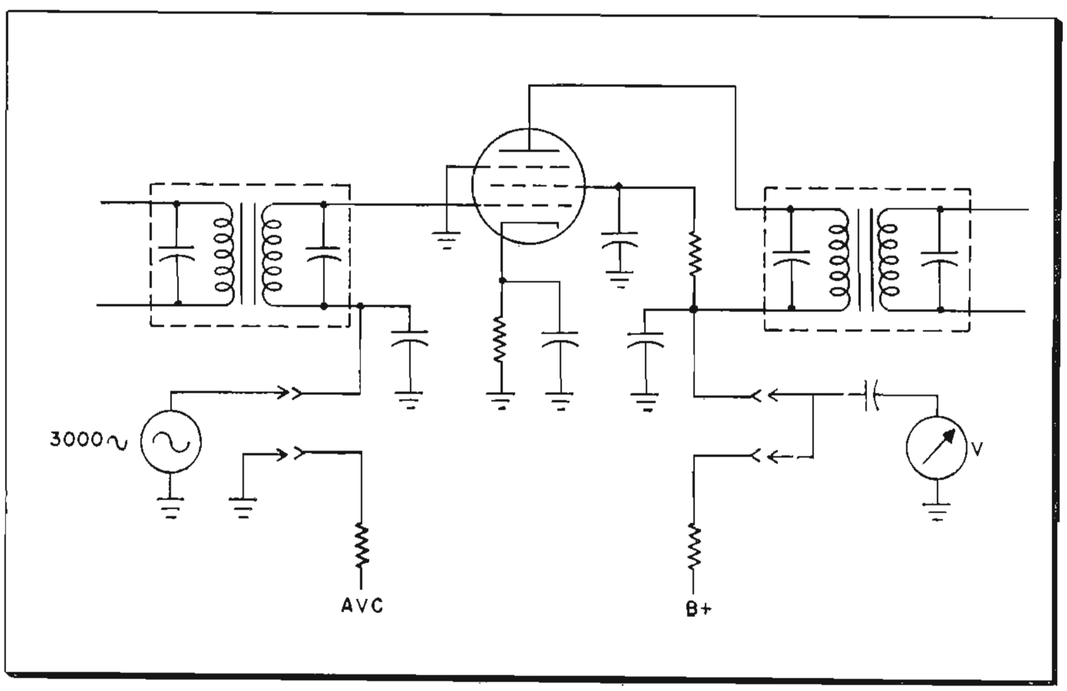
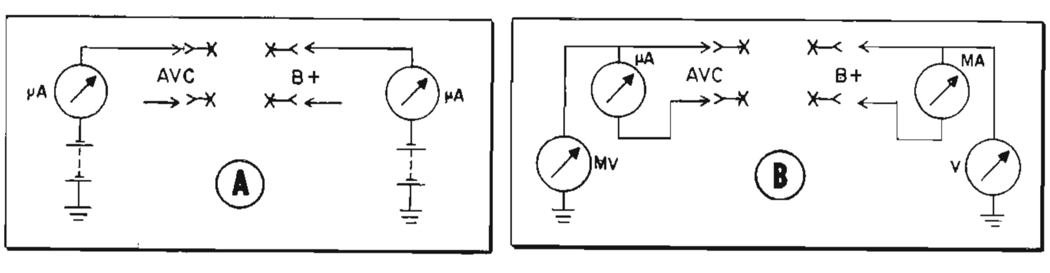


Fig. 3: Test inserts for circuit of Fig. 1: (a) leakage measurement and (b) gassy tube detection



Detecting Deterioration

In a complex device such as this receiver, it is impossible to detect deteriorations within single stages from an overall performance measurement. Since the action of successive stages is multiplicative, the tolerances of overall measurement will mask an incipient failure, making it necessary to establish the condition of stages individually.

Determination of tube condition has been based primarily upon

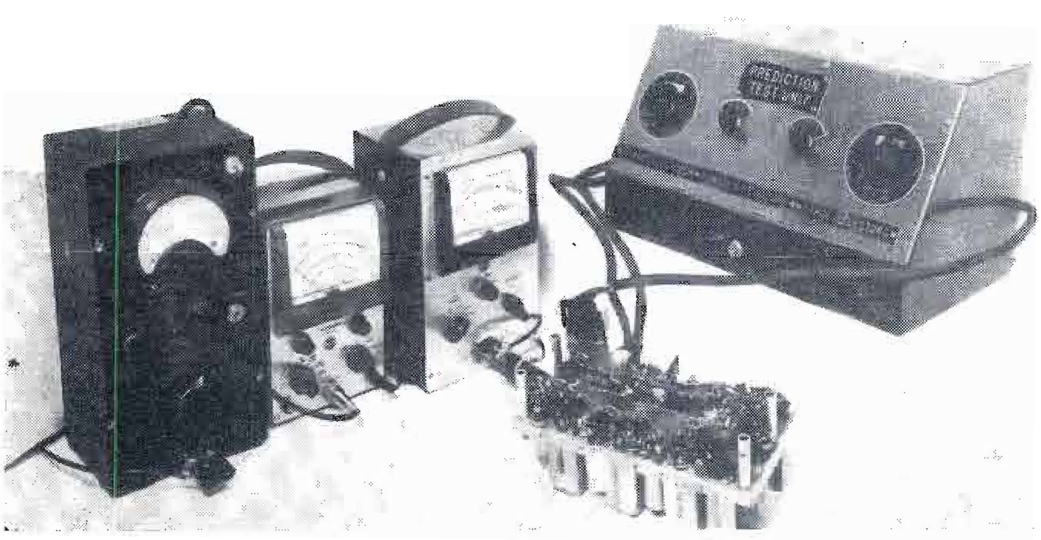


Fig. 6: Interconnection between receiver, laboratory switching unit and standard meters

checking the transconductance without removal of the tube, and without compromising the primary function of the stage. Specifically, let us consider a typical i-f stage. See Fig. 1. The stage will operate normally with shorting bars bridging the circuit breaks in the plate and grid returns. To attach directly test leads to grids and plates for injection at design frequency is impossible because of the high impedance level. With the plate decoupling resistor as a load, the tube may be used as an audio-frequency voltage amplifier. The test signal is introduced in the grid return. The plate and grid decoupling capacitors have high impedance at the test frequency. The test leads may then be of any required length, with simple connectors and switches to measure many stages rapidly. Fig. 2 shows the agreement between voltage gain and transconductance for one such stage.

Fig. 3a shows the test circuits which may be inserted in the avc and B+ circuit breaks of Fig. 1 to measure capacitor wiring and tube leakages, with heater and plate power removed. Grid current is of great importance in detection of gassy tubes, and may be detected with the circuit-break inserts of Fig. 3b. Also, the grid and plate voltages and plate current may be measured.

For a practical field use, by measurement is meant a limit type of measurement that can be performed electronically at a high rate. Also the switching is of such nature as to be readily accomplished by stepping type switches. Other types of circuits are more amenable to probing at other points, or by an entirely different performance measuring technique.

Fig. 4 shows the underside of one of the receivers chosen as a test vehicle before the addition of failure prediction circuits. Fig. 5 shows the added complexity. The bulky test connectors were ones readily at hand. Fig. 6 shows the interconnection between one receiver, a laboratory switching unit and standard meters.

Accelerating Failures

Six receivers have had prediction circuits incorporated and are being operated for an extended time under temperature cycling conditions to accelerate failures. No shock or vibration is used because only catastrophic failures result from these. Fig. 7 shows the interior of the chamber. Hot and cold air are alternately circulated over the receivers so that the components cycle between 10° and 120° C, with a 15-minute total period. Electrical strain is introduced by operating with the plate voltage about 15% above normal. Transients are simulated by cyclicly operating the plates at 50% above normal for one second.

Prediction checks are made periodically. Deteriorating components are not replaced, but are left in service to determine the time margin before complete failure.

Only partial results are now available. Failures of tubes from transconductance decrease and gassiness have been predicted. The advance warning is several tens of hours. Interelectrode leakages have been detected, but none have yet caused failure. Only two tube failures have occurred which were catastrophic: one exhaust tip broken in handling, and one heater burn out. Certainly, it is possible to predict cathode give-out, gassiness, and interelectrode high resistance shorts. For capacitors, it is necessary to await further data. We have proved that unpredictable failures can be caused by operating at two or three times the manufacturer's voltage ratings for very short periods. But under good design practice, the rate of deterioration of capacitors has not yet been determined.

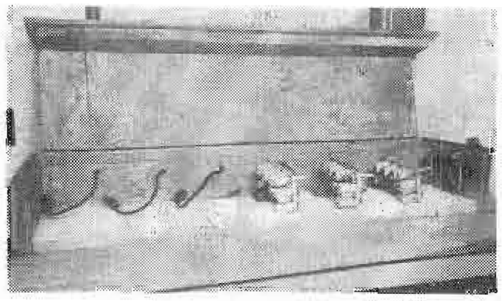
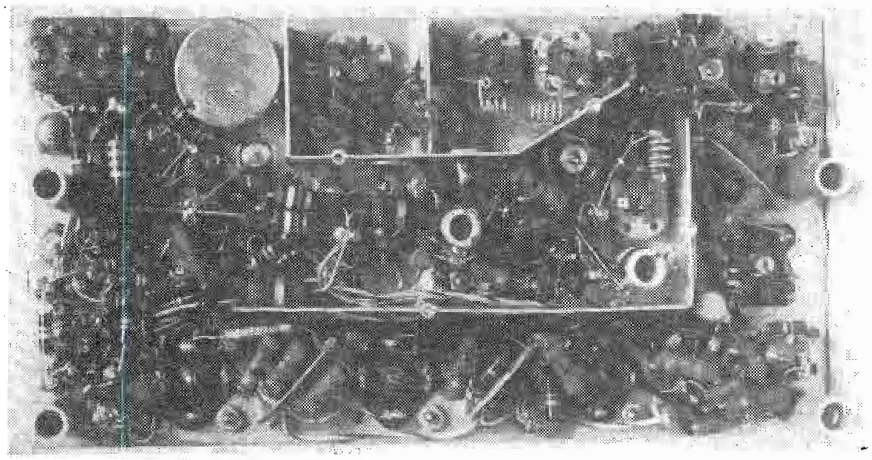


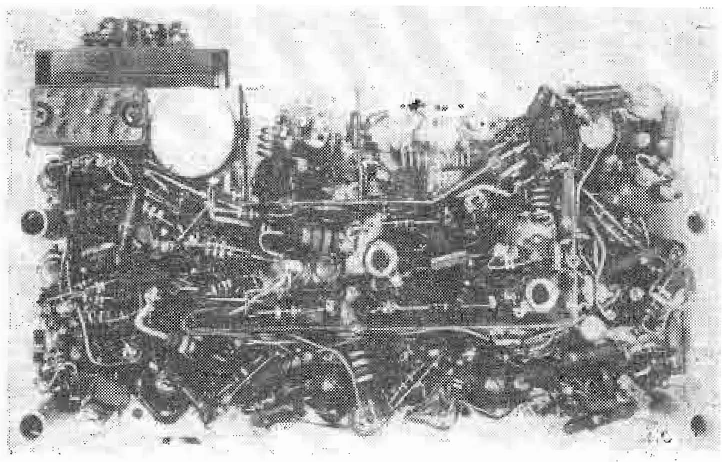
Fig. 7: Temperature cycling chamber

In conclusion, the design engineer *can* do something for reliability besides sitting and waiting for ideal components. If miraculous performance is required, design is the means for detecting fatigue, but above all, do not add a single unreliable circuit.

This paper was first presented at the Symposium on Progress in Quality Electronic Components held in Washington, D. C., May 1952.

Fig. 4: (l) Receiver underside before addition of failure prediction circuits. Fig. 5: (r) Prediction circuits add to bulk and complexity

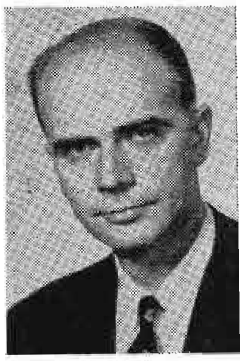




Standardization of

Rigid Coaxial Transmission Lines

Definitive article describes factors guiding formulation of new RTMA standard for 50-ohm lines. Similar military specs now in preparation



*By J. J. DRVOSTEP**
Sperry Gyroscope Co.
Great Neck, N.Y.

*& A. W. LEBERT***
Bell Telephone Labs.
Murray Hill, N.J.

THERE has been a long standing need for the standardization of rigid coaxial transmission lines. During World War II, the Armed Services assigned Army-Navy Type designations to several combinations of commercial tube sizes in order to facilitate the development and production of military equipment requiring coaxial lines. However, tolerances and performance requirements were not established because of the lack of engineering information. At the present time, construction of a large number of television transmitting stations has been authorized by the FCC, and the need for coaxial lines in military equipment has increased, because of the accelerated defense program. To meet this need, the Radio-Television Manufacturers Association has developed and is issuing standard TR-134 for 50 ohm coaxial lines as shown in Table I. Furthermore, the Armed Services are now preparing a military procurement specification based on this standard.

* Chairman, RTMA Subcommittee TR9.11 on Transmission Lines.
**Chairman, RTMA Subcommittee TR9.11.2 on Air Dielectric Coaxial Transmission Lines.

Prior Standardization Efforts

During World War II, the RMA Committee on H-F Line Connectors adopted a characteristic impedance of 50 ± 5 ohms for microwave use. In 1949, partial standardization was effected by RMA when standard TR-103-A, for FM Broadcast Transmitter Transmission Lines (88 to 108 MC/sec.) and standard TR-104-A, for Television Broadcast Transmission Lines (44 to 216 MC/c.) were both published. Unfortunately, however, these standards were based on a characteristic impedance of 51.5 ohms, the lines were severely restricted in frequency range, and the connecting devices were not standardized.

While standards TR-103-A and TR-104-A were in process, another RMA Subcommittee (TR9.11) was developing a standard for coaxial lines primarily intended for the "microwave" region, (1000 MC/c. and higher) and based on a nominal characteristic impedance of 50.0 ohms. Following the consolidation

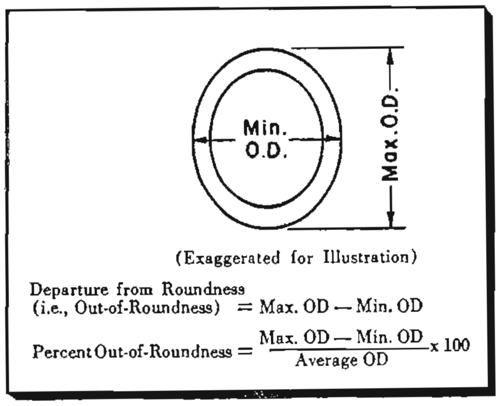


Fig. 1: Determination of coax out-of-roundness

TABLE I—Dimensions, Tolerances, Iterative Impedance and Cutoff Frequencies for Rigid Air Dielectric Coaxial Transmission Lines

	OUTER CONDUCTOR				INNER CONDUCTOR					
Line Size	A Dia.	B Dia.	Wall Thickness Nominal	Maximum Deviation From Average	C Dia.	D Dia.	Wall Thickness Nominal	Maximum Deviation From Average	Iterative Impedance (ohms) Nominal	Max. Min.
6-1/8	6.125 ±.008	5.981 ±.008	0.072	.012	2.600 ±.004	2.520 ±.004	0.040	.0075	50	50.15 49.82
3-1/8	3.125 ±.005	3.027 ±.005	0.049	.0075	1.315 ±.003	1.231 ±.003	0.042	.005	50	50.26 49.73
1-5/8	1.625 ±.003	1.527 ±.003	0.049	.005	0.664 ±.0025	0.588 ±.0025	0.038	.005	50	50.31 49.64
7/8	0.875 ±.0025	0.785 ±.0025	0.045	.005	0.431 ±.002	0.291 ±.002	0.025	.003	50	50.57 49.48
3/8	0.375 ±.002	0.285 ±.002	0.045	.0045	0.125 ±.002	----	Rod	----	50	50.83 48.07

TE_{11} MODE CUTOFF FREQUENCY (Kmc./sec.)

Line Size	Air Line	Undercut Teflon	Overcut Teflon	Undercut Polystyrene	Overcut Polystyrene
6-1/8	0.895	0.686	0.472	0.640	0.390
3-1/8	1.768	1.355	0.932	1.264	0.770
1-5/8	3.505	2.686	1.847	2.506	1.526
7/8	6.818	5.223	3.593	4.873	2.968
3/8	18.800	14.387	9.895	13.422	8.175

Dimensions in inches — 50 ohms
Values of relative dielectric constant used in tables—Teflon, 2.11; Polystyrene, 2.544

of coaxial line activities in the RTMA, it was necessary to obtain the cooperation of the FM, TV and microwave interests and attempt to develop a common standard suitable for all frequencies and services.

50 Ohm Standard Development

At the beginning of World War II, the Army-Navy RF Cable Coordinating Committee went on record to standardize 50 ohms as the nominal characteristic impedance for all future coaxial cable and fitting developments. The 50 ohm solid dielectric cables which were designed following this decision used copalene as the dielectric. Coincident with the introduction of polyethylene as a replacement for copalene, large quantities of cable were required for immediate delivery. Instead of re-designing the cables for the new dielectric, the inner and outer conductors were kept at the same size, and as a result 51.5 ohm cables were born.

In August 1945, the FM and Television manufacturers were advised

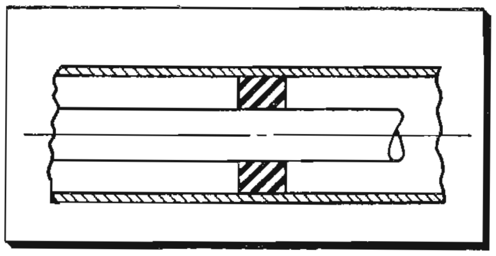


Fig. 2: Coax with uncompensated bead support

by the Chairman of the ANRFCCC that post-war procurement would probably not justify a change in cable design and tooling so as to attain 50 ohms. This opinion served as a basis for the formulation of the early drafts of standards TR-103-A and TR-104-A and the retention of 51.5 ohms as the cable impedance. During 1946, the ANRFCCC surveyed the electronics industry, and found the majority in favor of 50 ohms. Therefore, the committee reiterated its earlier stand that all future coaxial cable and connector developments should be based upon an impedance of 50 ± 2 ohms, and that all existing standard cables should be re-designed on the nominal 50

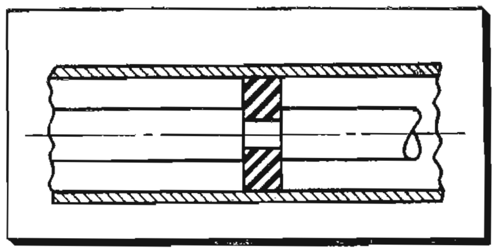


Fig. 3: Coax line with undercut bead support

ohm basis as the opportunity presented itself.

In 1949, the RTMA reorganized its committee structure so that one subcommittee would be responsible for all transmission line standardization. After very careful consideration of the impedance value, RTMA Subcommittee TR9.11.2 resolved that the nominal characteristic impedance value of 50.0 ohms be the preferred impedance for all future air dielectric coaxial lines standardized by the RTMA, except where engineering reasons justify another value or where commercial practice employs another impedance value. It was further pointed out that the adop-

(*Continued on page* 136)

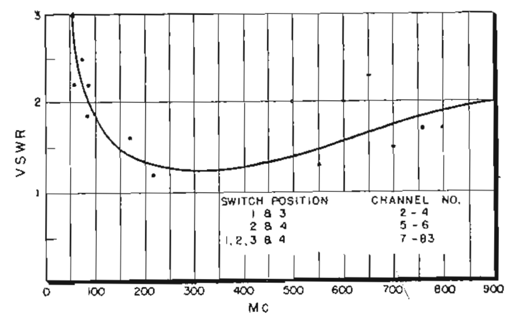
UHF-VHF Cabinet Antenna

PHILCO Corp. has developed a simply constructed, yet highly effective, UHF-VHF cabinet antenna to replace the "Aspen" antenna, which was built into TV receivers of earlier design. The new unit has only slightly less gain than its predecessor, but it features very broad bandwidth, low VSWR, and lobe rotation for directivity to eliminate end effects, particularly at UHF.

As shown in Fig. 1, the system comprises a coil shunted across the transmission line, a shaft to control a four-position switch, and four aluminum foil sheets. These are mounted in the receiver cabinet as indicated in Fig. 2.

The four aluminum elements are combined in various ways to rotate the lobes as shown in Fig. 3. For channels 2 to 4, the following elements (see Fig. 1) are combined on either side of the transmission line by the four-position switch: Position #1—1-2 and 3-4; or Position #3—1-4 and 2-3. This provides 90° of lobe rotation. Similarly, for channels 5 and 6, Position #2 connects elements 2 and 4 across the line; Position #4 connects 1 and 3.

Because an inductance, and not a capacitance, is shunted across the line to tune antenna reactance, channels 7 to 83 can employ all four switch positions to rotate the lobes 135°. Note that channels 2-4 and 5-6 can use only two positions each for



Fgi. 4: VSWR characteristic over UHF-VHF band

a rotation of 90°.

Fig. 4 shows the excellent measured VSWR characteristics over the entire UHF-VHF band. The VSWR is under 3 throughout, and less than 2 for most of the TV spectrum.

Fig. 1: Antenna arrangement comprises a coil, selector switch, and four aluminum foil sheets

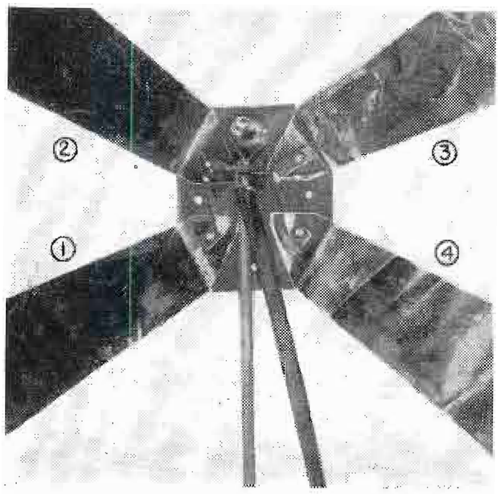


Fig. 2: Antenna mounting includes shaft and knob for operating lobe-change selector switch

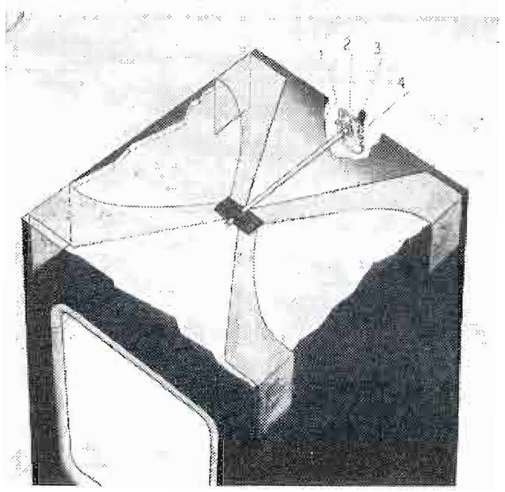
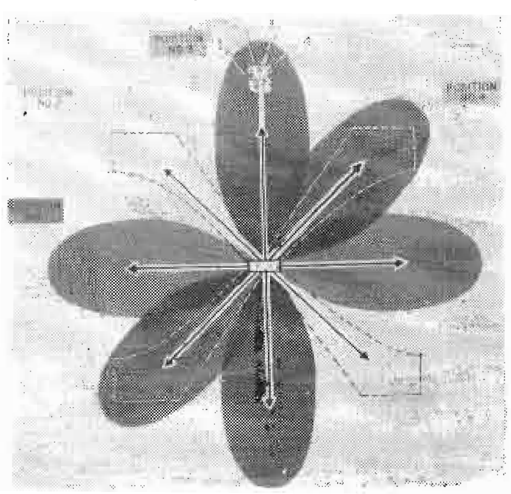


Fig. 3: Four-position switch connects aluminum sheets in four ways to rotate lobes up to 135°



UHF Oscillator Design Notes

Practical engineering approach makes maximum use of available tubes and components. Improved circuit techniques guide selection of dynamic load line

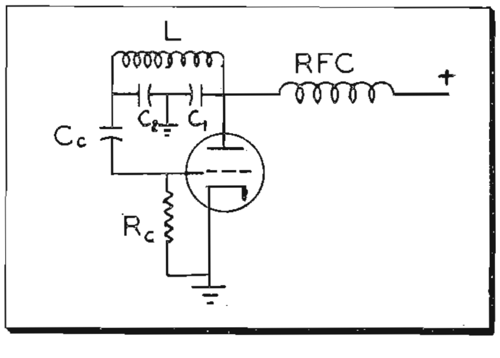


Fig. 1: Basic UHF oscillator arrangement

By KEATS A. PULLEN
Ordnance Dept.
Ballistic Research Labs.
Aberdeen Proving Grounds, Md.

THE design of oscillators for application in UHF television is one requiring a thorough understanding of circuit techniques. This article reviews the design techniques and interactions as they affect overall UHF oscillator design.

The examination of an oscillator of any type shows the need for fulfilling three basic conditions. The first condition is an effective overall loop amplification of at least unity in the steady state condition. The second condition is the provision of a suitable frequency selective network. The third is feedback in proper phase to permit oscillation. The amplification in TV oscillators is generally provided by a specially designed triode electron tube. The frequency selector and phase control circuit is provided by either an inductance-capacitance, or lumped constant circuit; or a tuned line, or distributed constant circuit.

The oscillator circuitry must be tailored to function with available tubes and other available components. Since the characteristics of the tube are the characteristics over which the designer has the least control, the entire procedure is one of making best use of the available tube characteristics.

Several significant effects which must be given consideration at UHF TV frequencies are (a) tube interelectrode capacitance, (b) tube lead inductance, (c) tube inductance-capacitance loading, and (d) tube transit-time grid loading.

The tube interelectrode capacitance interferes with high frequency oscillators in two ways. The first of these ways is reactance loading. The inherent reactance of the grid-to-plate capacitance of 5 μμf is approximately 67 ohms at 500 MC.

The second way in which the tube interelectrode capacitance affects UHF oscillator operation is the variation of interelectrode capacitance as a function of the tube electrode temperatures, electrode voltages, and the effective overall tube amplification.

The tube internal lead inductance introduces difficulty primarily because the tube itself can react only to voltage differences at the electrodes themselves. There may be be from 1 to 6 cm of lead wire between the solder point on the tube socket and the internal connection at the tube electrode. If one assumed 0.01 μh lead inductance per centimeter of iwre, a lead 1cm long would have 30 ohms reactance. As a double L-section filter, the combination has as low as 60 ohms surge impedence.

The lead inductance of the tube causes difficulty by inserting an impedance between a tube electrode being grounded and the circuit ground point. The lead impedance can insert degeneration in a cathode lead. Or it can permit radio frequency leakage past a tube element, possibly causing spurious oscillation.

In addition to the grounding problems resulting from lead inductance, the L-section filters can reduce by transformer action the voltage developed across the feedback network to a point which may make oscillation difficult or impossible. As long as the inductive reactance of the leads is small compared to the tube internal capacitive reactance, the tube capacitance may be lumped with the main tuning capacitance. Otherwise, it may not be.

Inductance Circuit

Where stability conditions permit at UHF, no external shunt capacitance other than the tuning coil distributed capacitance is used. The tube leads are part of the inductance circuit. The position of the tube in the socket then will alter the circuit frequency. Tuning may be by use of either a tuning slug or a series variable capacitor.

The most commonly used circuit arrangement for use in UHF oscillator circuits is shown in Fig. 1. If the tuned impedance of L—C_1C_2 is taken as R_T, then the voltage gain returned

Fig. 2: Conductance type characteristic curves

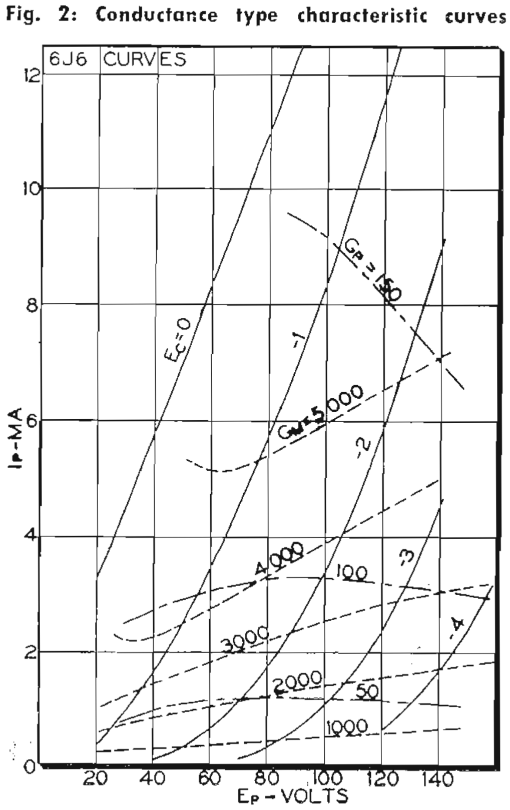
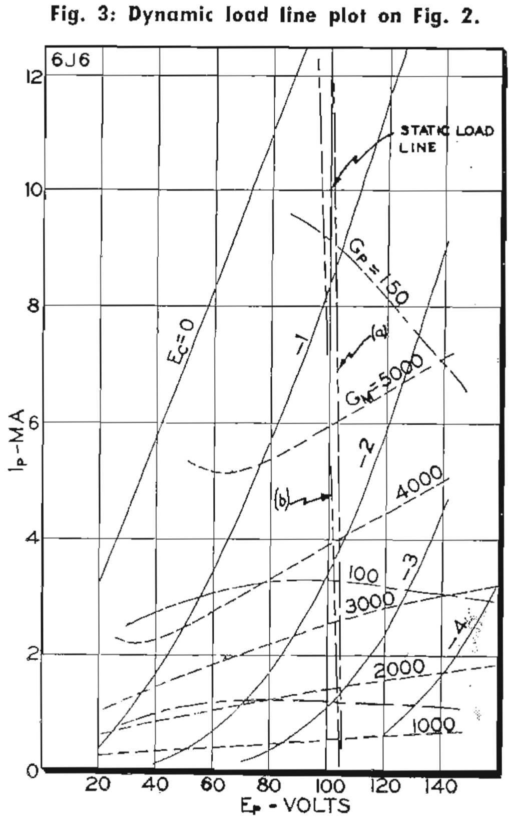


Fig. 3: Dynamic load line plot on Fig. 2.



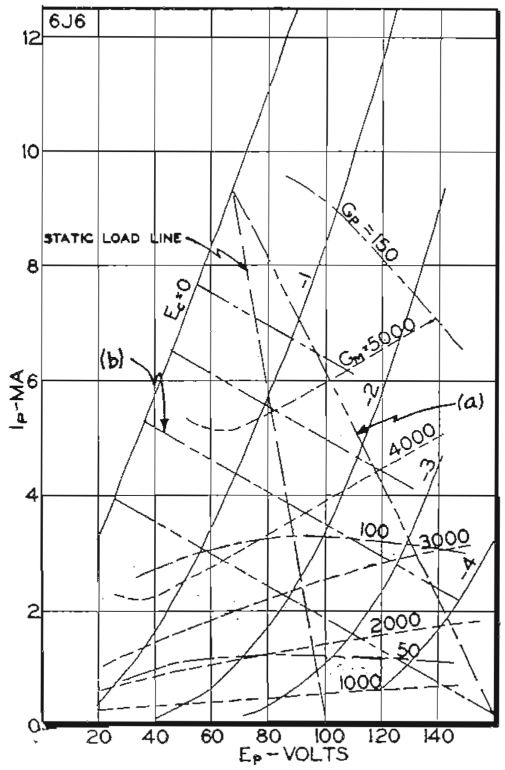


Fig. 4: Range of voltage swing, plate circuit

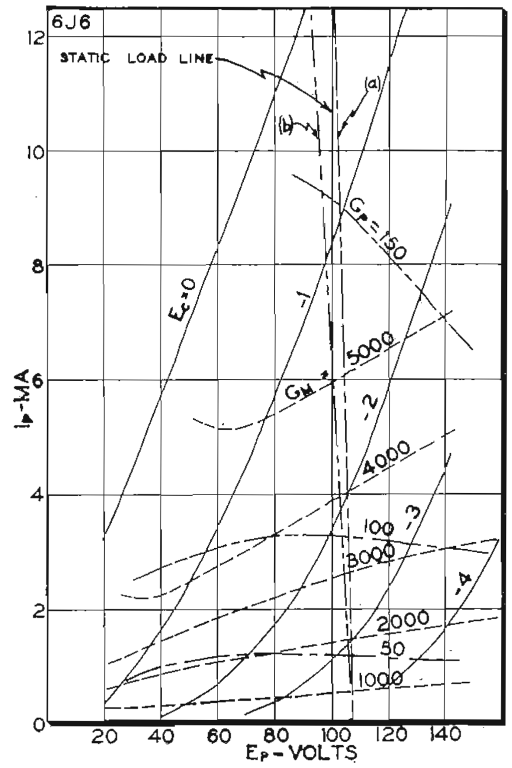


Fig. 5: Design curves follow plot of Fig. 3

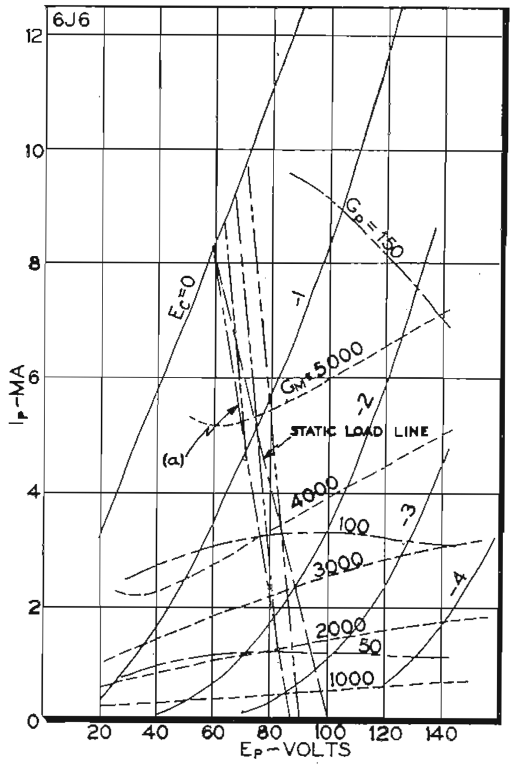


Fig. 6: Load line characteristic for 6J6 tube

to the grid will be approximately (grid and plate loading neglected)

$$VA = +g_m R_T [C_1/(C_1 + C_2)] \quad (1)$$

The minimum value of C_1 includes C_{pk} plus part of C_{gp}. Similarly, C_2 includes C_{gk} and part of C_{gp}.

Since the tube is the only nonlinear element in the oscillator, its action produces the cycle limit required for a stable oscillation. The cause of the limit is the combination of grid rectification biasing the control grid toward reduced transconductance, with the attendant reduced average transconductance.

Coil & Capacitor Q

The value of unloaded R_T over the frequency range desired for the oscillator requires knowledge of both coil and capacitor Q and the effective reactance level at the internal tube elements. First the reactance level at the external coil-capacitor combination may be determined. The calculation of the reactance can be based either on the coil inductance or the total capacitance including that added by the tube. The equation is

$$X = 2\pi fL = 1/(2\pi fC_T) \quad (2)$$

From this value of X, the value of unloaded R_T is

$$R_T = XQ \quad (3)$$

Since, at very high frequencies, the value of X_C for the tube itself may be quite low, from 50 ohms to possibly 500, if the external loading capacitance is to be used to swamp the tube capacitance, the coil and capacitor Q's must be as high as possible. This requirement on maximum possible Q is a very important consideration in design of UHF oscillators.

The amplification of the tube as an amplifier depends both on the tube G_m and the portion of the tuned circuit impedance which is effectively the plate load impedance. This plate load impedance has the unloaded value

$$R_L = R_T [C_2/(C_1 + C_2)] \quad (4)$$

The correction for circuit loading is considered shortly.

A set of conductance-type characteristic curves[1] (Fig. 2) may be used with this value of load impedance, R_L, to find the operating characteristics under conditions of negligible loading. The procedure is as follows. The first step is to draw the static load line for the oscillator. The plate circuit operation of the tube is approximately symmetrical about this line. As the circuit is turned on, the tube characteristic curve rises toward the typical contours. As the contour representing the transconductance required for oscillation is crossed in the tube warm-up or the application of voltage, oscillation begins. The amplitude rises until the phasor amplification VA at operating frequency is unity. A series of dynamic load lines of slope R_L may be plotted on curves in Fig. 2. The lines are spaced at convenient intervals from the zero bias line down to a point where the zero bias transconductance is about equal to the average value required in practical operation (Fig. 3). The proper area for the actual required dynamic load line is just above this last line.

Static Load Line

The range of voltage swing in the plate circuit is such that the static load line is almost exactly the mid point of the swing. The peak positive plate voltage is an equal distan along the load line to the right of the static line as the zero bias line is to the left. A contour can be plotted through the peak positive points (contour *a*). The plate voltage swings between the zero bias contour and contour (*a*) along one of the members of the dynamic load line family (Fig. 4.).

Now the data required to select the actual dynamic load line are available. The required load line is approximately that one which intersects the mean bias contour at the transconductance required for unity phasor gain.

(*Continued on page 142*)

CUES for BROADCASTERS

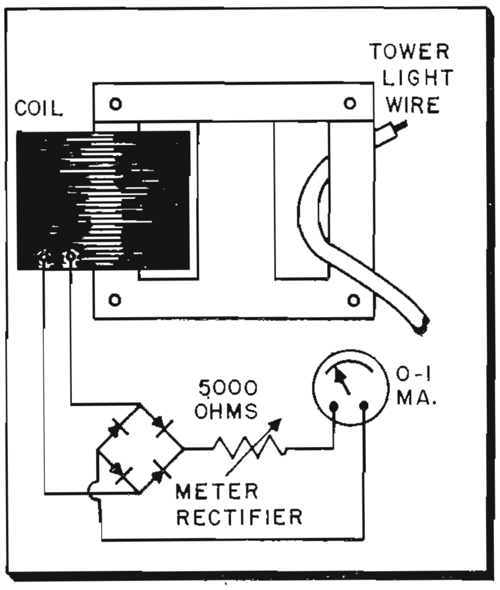
Practical ways of improving station operation and efficiency

Remote Tower Light Burnout Indicator

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

THIS simple remote indicator to detect burned out tower bulbs, or a defective flasher unit, does not require cutting the tower light wires and does not introduce any appreciable voltage drop in the tower light wiring. The indicating meter can be installed anywhere convenient to the transmitter operator.

An ordinary receiver type replacement filter choke is used. The "I" laminations are removed and the coil is slipped off the center leg of the "E" laminations and replaced on one of the end legs. By passing one of the tower light wires through the remaining opening in the core, and replacing the "I" laminations, an ac



Current transformer tower light indicator made from filter choke coil and ac meter

voltage will be inducted into the choke coil. A 0-1 ma meter and a copper oxide meter rectifier connected across the coil will give an indication of the current drawn by the tower lights.

For tower lighting using a two wire circuit, the core may be placed around either the neutral or the hot wire. The jumping meter needle will indicate flasher operation. The meter dial may be calibrated in amperes or number of tower lights burning. For tower lighting using a three wire system, the core should be placed around the neutral wire. It should be noted that in this position, the meter will read higher with the flashing beacon *off*.

If necessary, the sensitivity may be increased by looping the tower light wire through the core window twice. The variable resistance is used to set the meter to the predetermined calibration marks.

$$$ 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.

Simple Remote Switch for Presto Recorder

WILLIAM E. DAVIS, Engineer WDSA, Dyersburg, Tenn.

RACK mounted Presto recorders may be remotely controlled for playing tapes without turning the amplifiers off. A small SPST switch mounted in the control room in series with the ac going to the motors starts and stops the tapes. It is suggested that this switch be in series with line No. 11 on the power supply receptacle (J 101). This will permit tapes to be cued, and then turned on and off remotely. It is also suggested that another SPST switch be installed at the recorder in parallel with the remote switch to short circuit the remote switch, and thus permit the recorder to operate as usual for local control.

Microphone Identification

ROBERT M. CROTINGER, WHIO-TV, Dayton, Ohio

ON the WHIO-TV mobile unit we use a number of microphones in different locations and combinations. We have found it convenient to keep a roll of ordinary white adhesive tape with the equipment, and place a strip of it over each gain pot. The location, use, or some distinguishing name can then be written on the tape in pencil, thus identifying each microphone positively. This eliminates the necessity of trying to remember where each mike is.

Extending Life of Drive Belts

NATHAN LEVY, Recording Supervisor, WNYE, New York, N. Y.

SEVERAL of the professional tape recorders now on the market make use of a notched rubber drive belt to assure synchronous operation of the tape driving capstan. After a while these belts stretch and wear, and produce a high acoustic noise level. When adjustment of the belt alignment and/or tension fails to remedy the situation, the belt is usually replaced. However, most of these belts can have their useful life extended at least 50% by the following treatment. (1) brush the dust carefully off the belt; (2) lightly rub a piece of paraffin over the teeth of the belt.

In most cases the belt runs more quietly after this treatment than it did when it was new. It is not recommended that this procedure be followed with new belts because of the questionable effect of petroleum products on natural rubber.

Low-Cost Vertical Transcription Head

JAMES METZGER, Chief Engineer, *Keynote Recording Co., 116 Ridge Avenue, Dayton, Ohio*

MANY broadcast stations are faced with the need for an inexpensive transcription pickup to play vertical library records. It is economical to use a modified General Electric Variable Reluctance cartridge. To play vertical records it is only necessary to reverse the interior connections to one of the pickup coils. To do this the cartridge cover is removed, the leads to one of the coils are unsoldered, and reversed. The standard 2.5 mil. needle may be used. If it is desired to use the same cartridge for both lateral and vertical transcriptions, the coil leads may be brought out of the cartridge and connected to a DPDT toggle switch, as shown. At Keynote we use a "triple-play" dual-needle cartridge; thus only one tone arm is needed to play both microgroove and standard records, either lateral or vertical. Be certain that the preamplifier used has plenty of reserve gain, as the vertical connection results in lower output than the lateral.

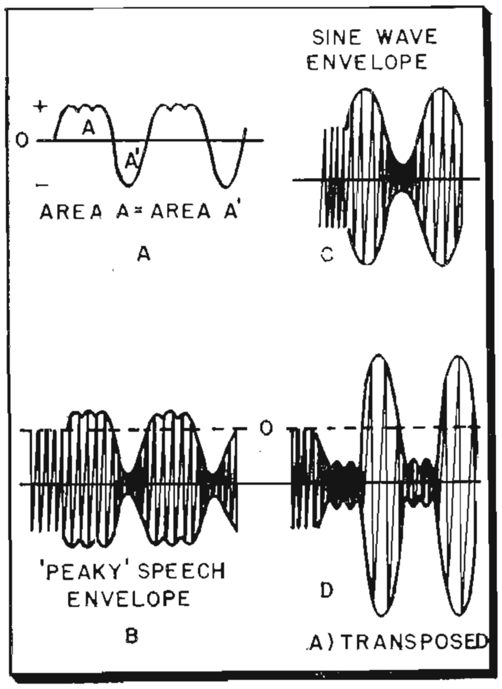
A More Efficient Modulation Envelope

DAVID O. WORTMAN, Chief Engineer, KVON, Napa, Calif.

IN the small radio station an additional 3 to 6 db audio peak power is usually welcome. The circuit is simple but produces results well worth the time to install. Parts required are a DPDT switch and some wire.

Referring to A in the drawing, a sample of "peaky" speech wave will be seen. Note also that the line designated as "O" is not equidistant from the positive and negative peaks.

The position of this line is determined by the amount of power in each half cycle of the wave and lies at a point where the positive half cycle's area equals the negative half cycle's area. If this wave is used to modulate a carrier, the result will be as shown in B. 100% modulation will occur in a negative direction without the departure in a positive direction being over, say, 50-60%. This results in a lower peak power than is actually *possible* and desirable. If speech is alternated with music on the carrier the difference in power levels can be easily noted, since a wave train made up of music (i.e. tones) contains positive and negative departures which are equidistant from "O" and when 85% modulation occurs in a negative direction a like amount occurs during the next half cycle (positive). See C in the drawing. If the polarity of the audio wave of A were to be reversed and used to modulate the carrier, the result would be as shown in D. A double pole-double throw switch is inserted in the line from the console to the limiter or transmitter. Depending upon the way the switch is thrown line transposition will occur and also a change in phase of 180° of the audio. As mentioned previously, no change in level of modulation is possible when the switch is reversed if music is being played.



Modulation envelope waveforms

The action of the switch may be checked with the station modulation monitor. Most of the present modulation monitors have a switch whereby the positive or negative audio peaks may be read. With this switch thrown to the "positive" reading position and while feeding speech alternate the position of the "phase-reversal" switch. In one position or the other an increase in overall modulation should be noticed. This procedure should be repeated for each person who uses that particular microphone. In some cases it will be found that the greatest percentage of modulation with certain voices will be obtained with the switch in the opposite direction. *This is entirely dependent upon the characteristics of the voice involved.*

In the case of bi-directional microphones the phase of the audio wave train may be reversed by using the other side of the mike, but since this can not be done with some of the present day dynamic types addition of the switch is the only practical solution. Insofar as women's voices are concerned, not much difference in overall modulation is usually noticeable, since their voices do not contain peaky characteristics.

To check the theory behind this article without first installing the phase-reversal switch set the modulation monitor peak indicator switch first to the positive position then to the negative position and apply speech to the input noting the difference in indicated modulation level. Remember that the meter on the modulation monitor reads the positive and negative peaks of the *audio*, not the positive and negative *carrier peaks*.

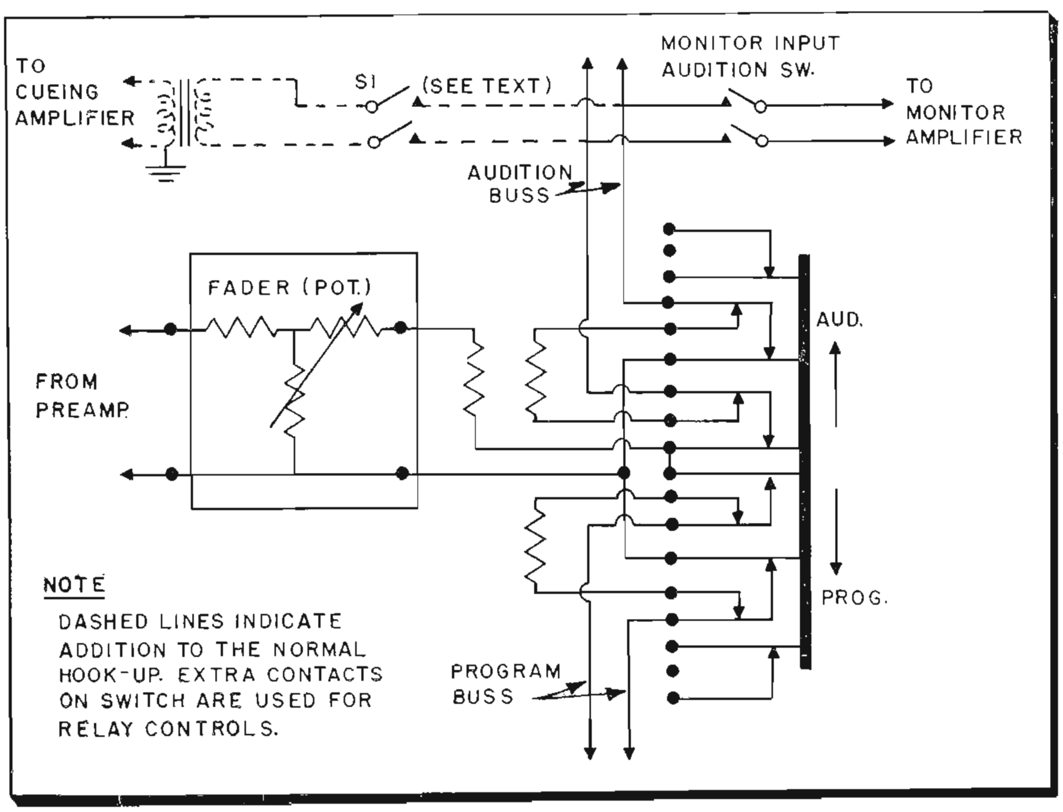
Cueing on Collins Console

JOHN L. KLUNGLE, WHTC, Holland, Mich.

IN most stations, some provision is made for cueing. In the Collins console, this is accomplished by special switches which connect the output of the turntable preamps, directly into the monitor amplifier. But this removes program from the monitor which is a bad feature, because occasionally while cueing, the record will end, putting the "swish-swish" on the air, unbeknown to the operator.

In the Collins console (and several other makes) for every microphone, turntable, etc., there is a "program-audition" switch, connected to the output of the preamps through faders. Program takes its normal course through the program switch to the program amplifier. The audition goes through the audition switch, to the audition buss, from there to the audition monitor switch which feeds audition to the monitor amplifier. We bridged the audition buss (through a switch) with the 500 ohm winding of a high quality transformer. The high impedance secondary of the transformer is fed into our Magnecord amplifier. To cue records, the console "program-

Modified Collins Console permits cueing to and from many audio sources. Text discusses many methods of taking maximum advantage of the various combinations provided



(Continued on page 122)

Planar Triode Frequency Multiplier

Having particular applications in laboratory measurement equipment, type 5768 offers convenient means for frequency multiplication in 150-3000 MC range. Advantages include: double-ended construction; small, reliable, and stable associated circuitry

By H. R. HOLLOWAY, O. SAALBORN & H. B. BRISKIN
Sylvania Electric Products Corp., Physics Laboratory, Bayside, L.I., New York

THE increasing importance of the UHF and VHF spectra to the solution of communication problems has increased the attendant need for accurate, stable and dependable equipments. More and more frequently, it is necessary to have available low-power, crystal-controlled signals in the frequency range from 250 MC to 3000 MC. A few applications for such signals are as local oscillators of fixed tuned receivers, signal generators for measurement work, and in secondary frequency standards.

The frequency region up to about 250 MC is easily attainable with frequency multipliers using standard receiving-type tubes like the 6AH6 or the 12AT7, in lumped constant circuits. These tubes, and others perform well up to 900 MC as oscillators, but not as amplifiers or as frequency multipliers. Heretofore, the 250 MC to 3000 MC region has been the "awkward range" to reach unless the design engineer employed greatly derated higher power tubes of conventional construction, lighthouse tubes, or klystrons. The planar triode type of tube, with its high g_m, low interelectrode capacities, convenient double-ended construction, and low power drain, fills the gap in the array of available tubes for this frequency range.

This paper describes three similar multipliers and multiplier-amplifier combinations which operate in the frequency range from 160 to 2880 MC. When operating as a frequency tripler driving a doubler, an output greater than 75 mw can be attained; when these multipliers are followed by an amplifier, the output power can be raised to a minimum of 150 mw.

Power Requirements

A dimensional sketch of the Sylvania Type 5768 disc-seal planar triode[1] is shown in Fig. 1, and the electrical characteristics are summarized in Table 1. The grid flange permits excellent shielding between the input and the output circuits, and the cathode and plate rods make for very low lead inductances and inter-electrode capacitances. In a grounded-grid, concentric line circuit, the double-ended 5768 operated stably as an amplifier or frequency multiplier at frequencies as high as 3000 MC. The power requirements of the tube are low, the heater consuming 2.52 watts, while the maximum plate input power is 2.0 watts.

The multiplier unit to be described here is a good example of the capabilities of the tube when operated other than as an amplifier, and consists of a frequency tripler and a double in cascade. Driving power of 100 mw as the input frequency of 480 MC produces an output of 80 mw at 2880 MC. This is sufficient power for most laboratory measurement work, and ample power to provide excellent isolation from a detector if used as a local oscillator. In the configuration used here, it should be noted that the tube cannot be used as a straight narrow band, high Q amplifier at 3000 MC because of its slightly excessive cathode lead length, but 3000 MC is within the passband when the tube is operated as a broadband amplifier.

TABLE I

DIRECT INTERELECTRODE CAPACITIES (COLD, AVERAGE)

Grid-cathode	1.35 μμf
Grid-plate	1.00 μμf
Plate-cathode	0.01 μμf

OPERATING CHARACTERISTICS

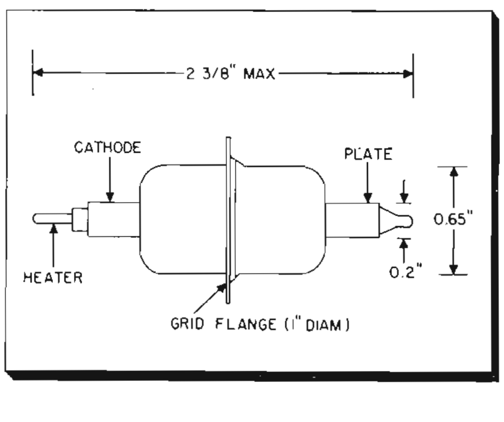
Heater Voltage* (nominal)	6.3	v.
Heater Current	0.4	amp
Plate Voltage	250	v. dc
Cathode Bias Resistor	220	ohms
Plate Current	8	ma
Transconductance	6750	μmho
Amplification Factor	100	

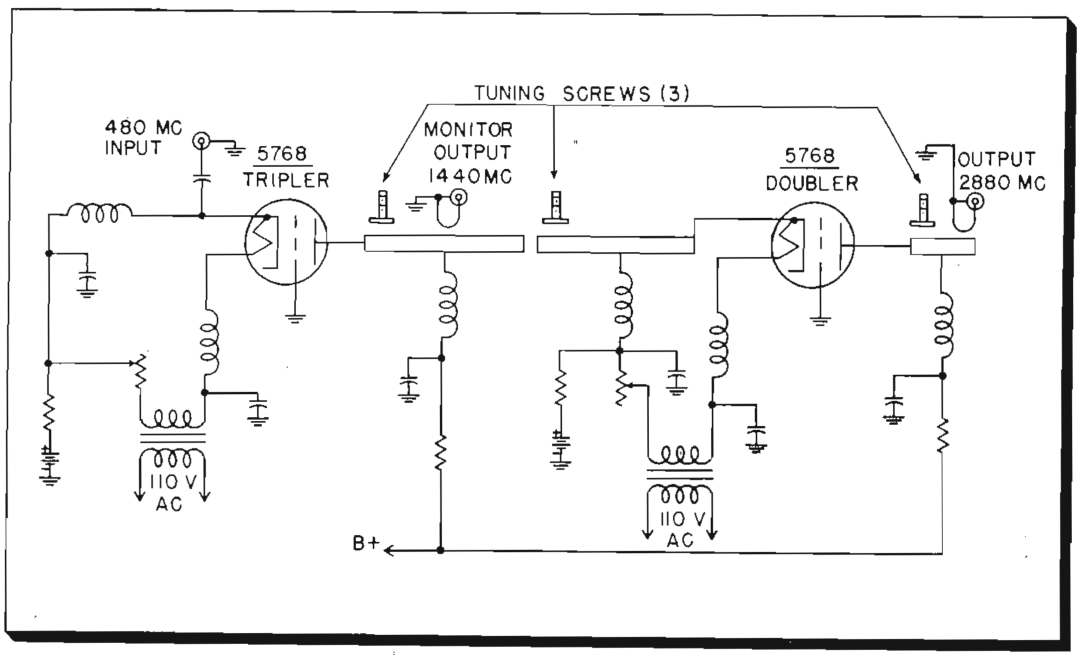
* Heater voltages should be set to give 0.4 amp heater current.

The calculated input impedance of the 5768 at 480 MC is approximately $120\underline{/-75^\circ}$ ohms. Accordingly, the cathode input can be fed directly from a coaxial cable through a blocking capacitor with the tolerable loss

Fig. 1: (Below) Outline sketch and characteristics of type 5768 planar triode

Fig. 2: (Right) Schematic of 5768 planar triode "times-six" frequency multiplier





for UHF

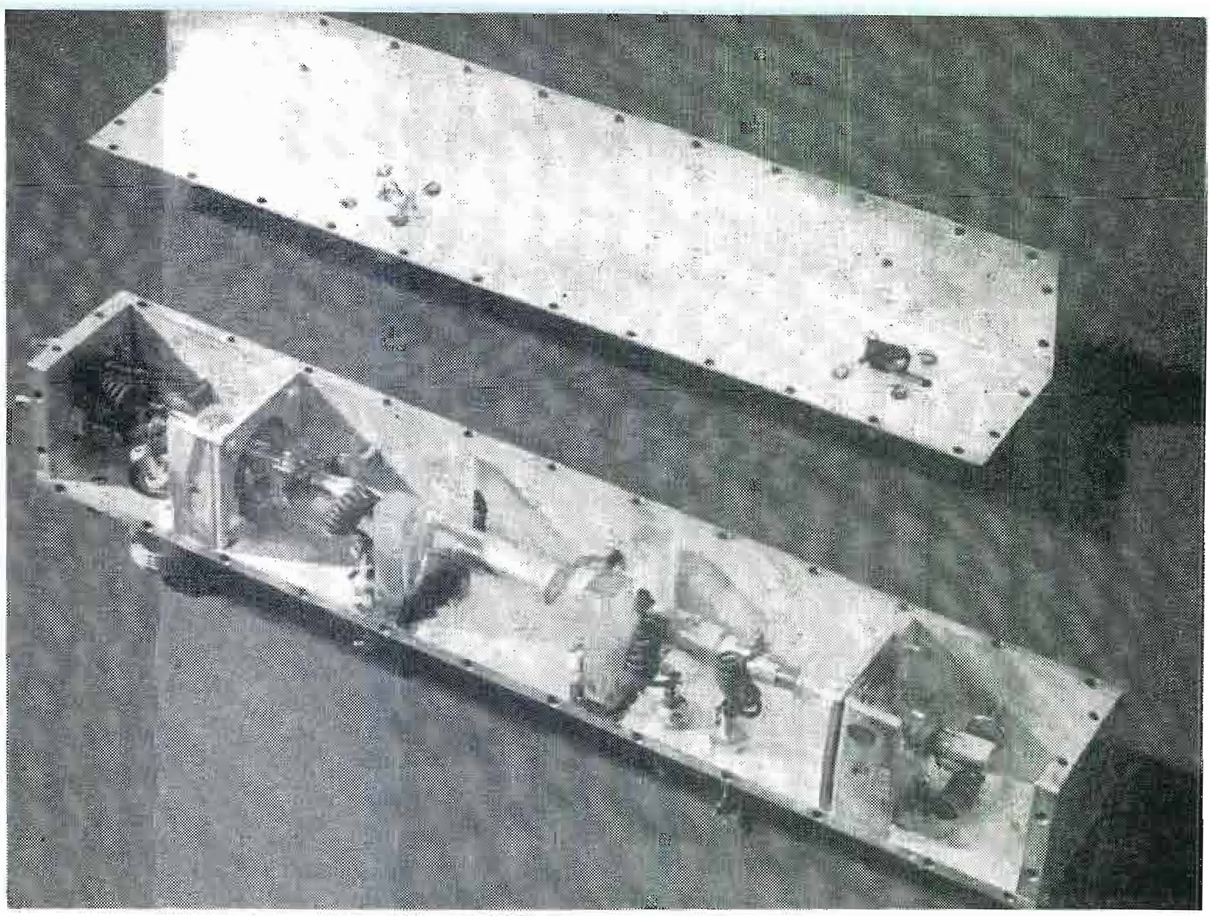


Fig. 3: Photo showing construction of the "times-six" unit

of about 10%, and with a considerable saving in space and parts that would be necessary if the input were tuned. Actually, a small variable shunt capacitor in the form of a screw and washer is available at the input cavity to help compensate for this mismatch.

The schematic of the "six-times" unit is shown in Fig. 2, and photographs of the unit as constructed are shown in Fig. 3. The plate circuit of the "times-three" multiplier is an open half-wavelength concentric line tuned to 1440 MC, which is coupled to a similar open half-wavelength line serving as the tuned cathode input of the "times-two" multiplier stage. The plate circuit of this second multiplier is also an open half-wavelength concentric line which is tuned to the output frequency of 2880 MC. Output power is extracted by means of a 6x9 mm loop positioned as close as possible above the quarter-wave point of the output line. Power connections to the input and output portions of each are necessarily made at the low impedance quarter wavelengths points on (or through) the lines. The heater operates at the same potential as the cathode, thereby requiring separate heater-supply transformers for the two stages.

Coupling Multipliers

The open half-wavelength line was chosen for use in this unit because of the relative ease in coupling the two multipliers. Use of shorted quarter-wavelengths lines for the 1440 MC section would decrease the overall size of the unit by 30% or more; but this would require loop coupling between the plate of the first multiplier and the following cathode. If considerations of size are of prime importance, it would be profitable to employ the shorted lines even at the expense of added effort in determining the optimum coupling loop configuration.

To approach the highest practical Q of the lines, a ratio of outer conductor radius to inner conductor radius of approximately 3.6 is used, resulting in a line impedance of approximately 77 ohms. The cavity outer conductor is made of silver-plated L-shaped brass stock with inside dimension of $1\frac{1}{8}$ in. on each of the four sides. The grid ring or disc of the 5768 is 1 inch in diameter, so that ample clearance for it is available without crimping. The inner conductor is silver plated $\frac{3}{8}$ inch O. D. brass rod, with short spring finger contacts of smaller tubing to slip over the cathode and plate rods.

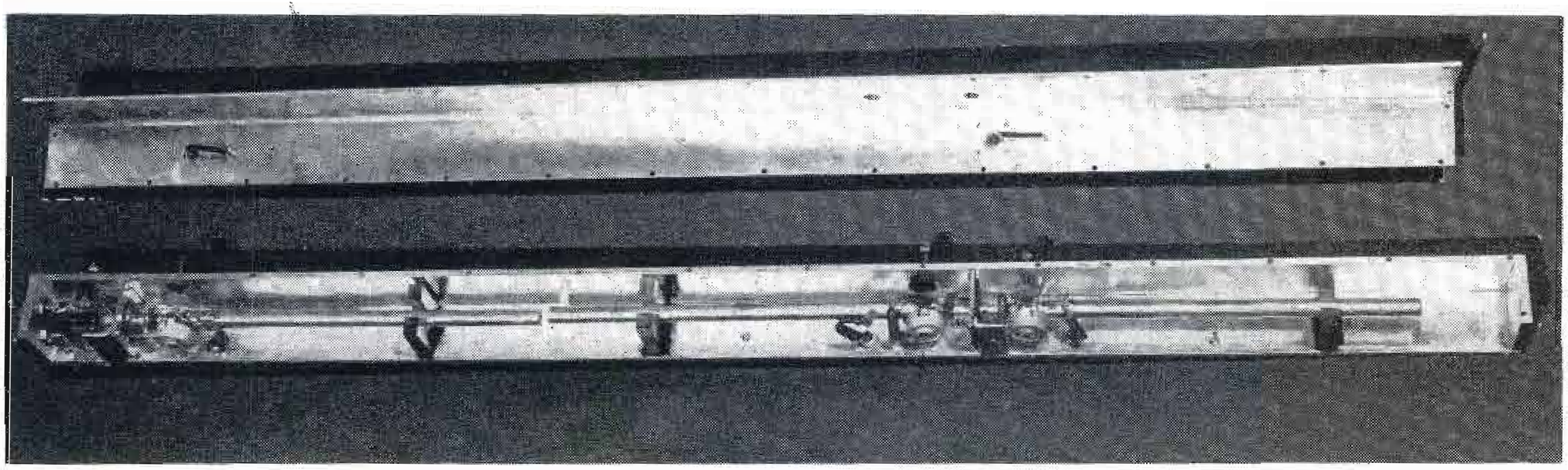
Because of the close spacing of the

(*Continued on page* 153)

TABLE II

	X3 Multiplier	X2 Multiplier	Total (where applicable)
Input Frequency	480 mc	1440 mc	
Output Frequency	1440 mc	2880 mc	
Heater Voltage	5.8 v. ac	5.8 v. ac	5.8 v. ac
Heater Current	0.4 amp	0.4 amp	0.8 amp
Total Heater Power	2.32 watts	2.32 watts	4.64 watts
Plate Voltage	150 v. dc	150 v. dc	150 v. dc
Plate Current	10 ma	10 ma	20 ma
Plate Input Power	1.5 watts	1.5 watts	3.0 watts
Cathode Battery Bias	+10.5 v.	+1.5 v.	
Input Driving Power	100 mw	20 mw	
Output Power	20 mw	80 mw	

Fig. 4: Construction of the "times-three" unit and amplifier



The Microwave Interferometer

Highly accurate K-band instrument employs Doppler radar technique to provide continuous record for ballistic measurements

By H. C. HANKS, Jr.
Glenn L. Martin Co.
Baltimore 3, Md.

THE microwave interferometer developed by The Glenn L. Martin Co. for the Ballistics Research Lab., Aberdeen Proving Ground, U. S. Army Ordnance Corps., measures the time-displacement of the projectile within a gun barrel. This highly accurate instrument provides, for the first time, a successful continuous record for small bore measurements.

In approaching the development problem, it was recognized that conditions of the projectile's travel within the gun barrel change once it is outside of the barrel. Hence, the time-displacement of the projectile needed to be measured by methods different from those employed in the past. The projectile is surrounded by an impervious medium, the gun barrel—the only unobstructed view being from the gun's muzzle. Previously, probes had been inserted into the barrel, but this method has several disadvantages, some of which are enumerated below:

(1) Use of a small number of probes makes it possible to determine only the average velocity of the projectile over large increments of displacement.

(2) The values of peak accelerations or velocities cannot be determined, nor can their locations be determined with accuracy by use of widely spaced probes.

(3) An infinite number of probes would have to be used to afford a continuous record, thus involving an enormous quantity of time-measuring equipment.

(4) The probe method does not necessarily discriminate between the shock wave and the projectile.

An excellent continuous record, on the other hand, may be obtained through application of a CW-Doppler radar technique. Precision measurements by this method require a very short r-f wavelength. An additional advantage of the high frequency derives from the fact that it permits the measurement of time-displacements within small bores. It was decided, therefore, to use a frequency in the K-band, of approximately 24,000 MC which provides a wavelength of 1.25 cm. This frequency makes it possible to measure time-displacements in bores as small as 0.3 in.

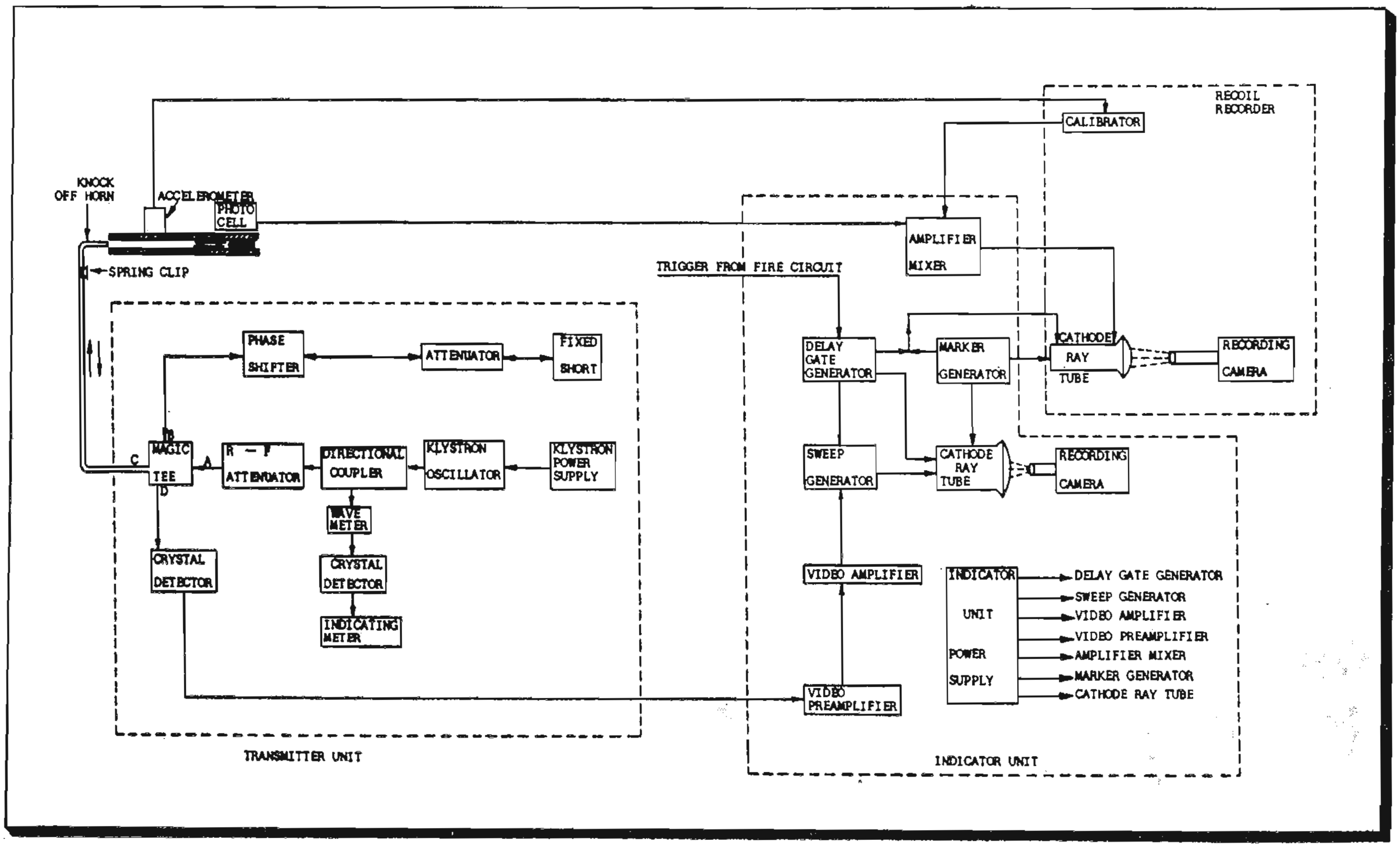
Time-Displacement

Measurement of the time-displacement of the projectile within and with respect to the gun barrel is accomplished in two steps: (1) That of the projectile with respect to ground, and (2) that of the gun barrel with respect to ground. These two measurements are made simultaneously, and when the records are read, the results are combined to give the projectile velocity with respect to the barrel.

A master block diagram of the system employed in the microwave interferometer is shown in Fig. 1.

A K-band klystron is used to gen-

Fig. 1: Master block diagram of system employed in microwave interferometer. R-F energy generated by K-band klystron is divided by magic tee



erate the r-f energy, the frequency being determined by the frequency meter. The r-f energy is divided into two parts by the magic tee. One part is directed to a fixed short, while the other is directed to the projectile, or moving short, via the gun barrel. As the projectile moves, the r-f energy reflected by it to the magic tee will vary only in phase, assuming the attenuation change to be negligible. The waveform appearing at the crystal detector is the resultant of a rotating and a fixed vector of equal amplitude. The output of the crystal detector is therefore a sine wave, whose frequency is a function of the projectile's velocity. See Fig. 2. The maxima of the sine wave occur for a projectile movement of one-half the r-f wavelength in the barrel.

It is desirable that the ac output of the crystal detector be zero for the initial position of the projectile. To obtain this, the two reflected waves must be equal in amplitude and 180° out of phase. The condition is effected by means of a phase shifter and an attenuator in the r-f arm which is terminated by the fixed short. Adjustment of these two components establishes the initial output. Since the video output is quite low, it must be amplified by a video amplifier. The video signal is displayed on a spiral trace in the indicator unit.

Spiral Trace

The amplified video signal is used to modulate the spiral trace. The distance between maxima of the sine wave represents a projectile travel of one-half the r-f wavelength in the barrel. It should be remembered that the wavelength in the barrel is a function of the bore, and is not the same as the wavelength in free space. The time required by the projectile in moving the known distance between maximum and maximum must be known in order to determine the velocity of the projectile. Consequently, timing marks are generated and used to blank the trace every 10 μsec. The velocity of the projectile with respect to the ground can be determined from this record.

To obtain the actual velocity of the projectile with respect to the barrel, a correction must be made to account for the recoil velocity of the gun. The recoil recorder furnishes this information. In operation, an accelerometer is mounted on the barrel. As the gun recoils, it generates a voltage which is a function of the barrel's acceleration. The voltage is amplified and used to deflect the sweep of a Du Mont Type 304-H Cathode-ray Oscillograph. Since this oscillograph sweeps several times during the recoil, a TV type scan is produced. To determine recoil velocity, the acceleration per unit time must be known, which calls for timing marks, generated in the indicator unit, to blank the trace every 20 μsec. Since accelerometers are not normally calibrated at the expected recoil accelerations, calibration points representing displacement are introduced on the record.

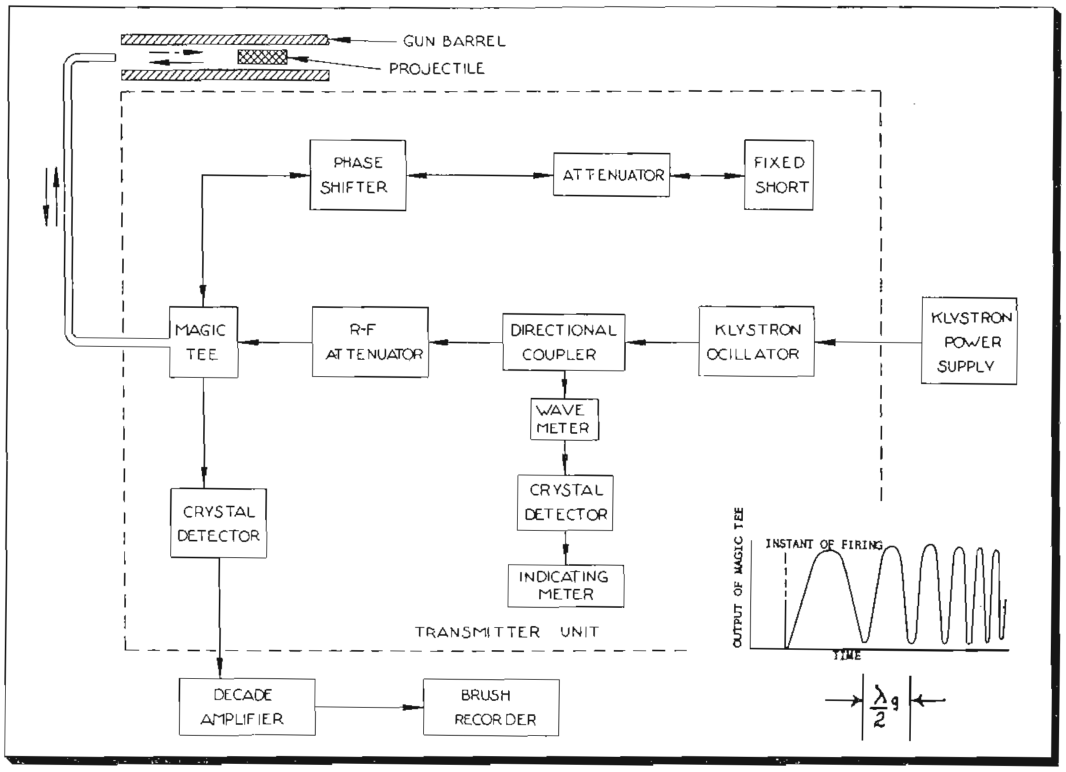


Fig. 2: Laboratory r-f setup and magic tee output waveform

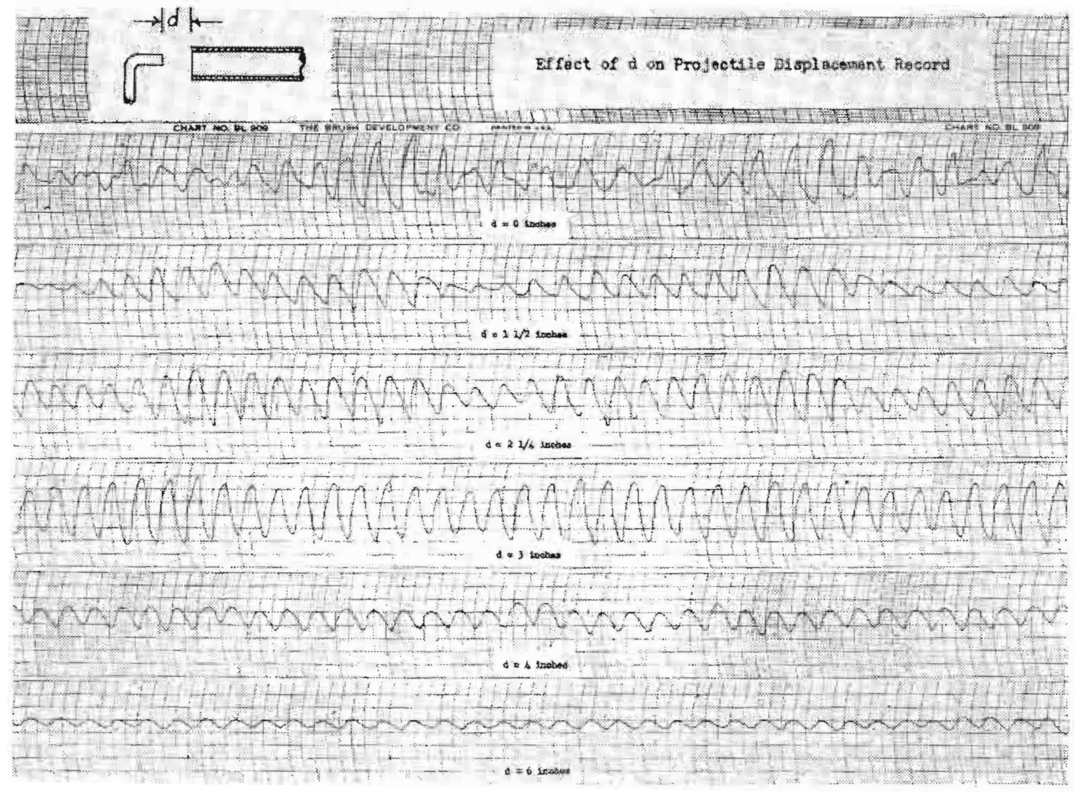


Fig. 3: Test projectile displacement for 40-mm bore, various guide positions

Numerous methods of coupling the r-f energy to the gun barrel were evaluated by experimentation during the development of this equipment. The r-f link can be considered in three parts: (1) transmitter unit, (2) coupling unit, and (3) gun barrel. The transmitter unit consists of the klystron, directional coupler, components for determining the frequency, attenuator pad, magic tee, phase shifter, variable attenuator, fixed short, detector and output waveguide. These units are all of conventional design.

To obtain reflections from the projectile, it was necessary to couple the r-f energy from the output waveguide to the gun barrel. The waveguide will support only the TE_{10} mode; however, due to the size of the bore, the gun barrel is capable of supporting additional modes. These extraneous modes can be excited in the gun barrel, due to the shape of the wave front when it

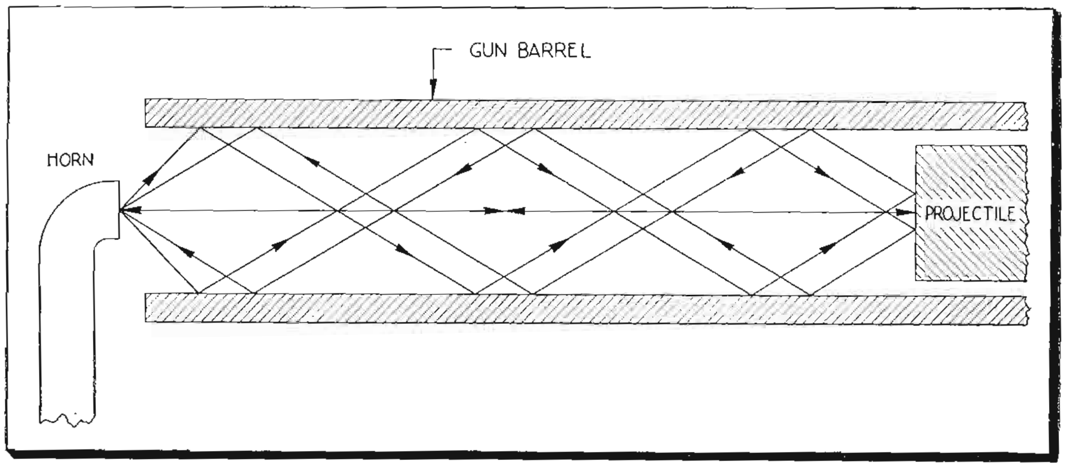


Fig. 4: Multiple path transmission of r-f within barrel of the test gun

reaches the muzzle. This shape can be changed by varying the distance between the muzzle and the waveguide. The gun barrel acts as a waveguide. The effect of the attenuation of the steel on the phase velocity is small; consequently, its effect was neglected in all our calculations.

Laboratory measurements were made with the equipment connected as shown in Fig. 2. During the development of the interferometer, unusable records were obtained on the Brush recorder. The cause was attributed either to modes or to multiple path transmission within the gun barrel. Consequently, calculations were made to ascertain which modes a ⅝-in. bore and a 40-mm bore would be capable of supporting, if excited at a frequency of 24.0 KMC.

Propagation Condition

For propagation of the electromagnetic wave, the following condition must exist: $\lambda_c > \lambda_o$, where λ_c is the cutoff wavelength and λ_o is the free space wavelength. λ_c is a function of the mode and is given by $\lambda_c = 2\pi a / \chi_{m,n}$ and $\lambda_c = 2\pi a / \chi'_{m,n}$ for the E and H modes—where "a" is the radius of the bore and $\chi_{m,n}$ and $\chi'_{m,n}$ are the roots, respectively, of the Bessel functions $J_m(X) = 0$ and $J'_m(X)' = 0$. from $\lambda_c > \lambda_o$ it can be seen that $2\pi a/\chi'_{m,n}$ and $2\pi a/\chi_{m,n} > \lambda_o$ hence $\chi_{m,n}$ and $\chi'_{m,n} > \lambda_o$. The value of $2\pi a/\lambda_o$ was calculated. The tables of Bessel's functions give the values of $\chi_{m,n}$ and $\chi'_{m,n}$. Supportable modes occur whenever the values of $\chi_{m,n}$ and $\chi'_{m,n}$ are less than $2\pi a/\lambda_o$.

Table I shows the various modes which can be supported in both ⅝-in. and 40-mm bores. It shows that the larger the bore, the greater the number of modes it is capable of supporting. Due to the difference in phase velocities for the various modes, the interference pattern obtained is a function of the excited modes. It is unlikely that many of these modes are actually excited; however, the data would not be usable, if more than one mode were excited in the gun barrel, and the coupling method can be considered satisfactory only if one mode is excited.

Conical Horn on Muzzle

To avoid interfering with the trajectory, it is desirable to keep all the interferometer components out of the projectile path. To achieve this, a tilted, conical horn was secured to the muzzle. A transmitting horn was attached to the transmitter unit and its propagation was directed in line with that of the off-axis muzzle horn. This method of coupling resulted in the excitation of more than one mode in the gun barrel. A possible additional difficulty might have been the misdirected propagation due to the change in position of the gun barrel during recoil.

If the extraneous modes could be suppressed, it would be possible to utilize the off-axis feed horn on the muzzle. Adequate mode suppression did not appear feasible, hence the method of r-f coupling was changed.

The next method utilized a reflector, placed at 45° with respect to the gun-barrel axis, to permit an offset of the transmitting horn from the line of fire. The reflector was placed at various distances from the gun barrel. In view of the attenuation of r-f energy over the length of the transmission path and of the low power of the klystron, a high-gain transmitting antenna was used. Two difficulties became apparent with this system, namely: (1) the signal-to-noise ratio was approximately 1:1, and (2) the alignment difficulties were of such magnitude as to render it impractical for field application.

The next method undertaken for coupling energy into the gun barrel comprised application of the energy directly into the muzzle by means of an open-ended waveguide. The effect of the positioning of the waveguide with respect to the muzzle of the gun was determined by recording the projectile displacement pattern obtained for various positions of the waveguide on a Brush recorder as shown in Fig. 3. The set-up was similar to that shown in Fig. 2. This established the distance from the open-ended waveguide to the muzzle that would be required to prevent the excitation of undesired modes.

TABLE 1
Modes Supportable in 5/8-in. Bore and 40-mm Bore

5/8-in. Bore		40-mm Bore	
E_{mn} or TM_{mn}	H_{mn} or TE_{mn}	E_{mn} or TM_{mn}	H_{mn} or TE_{mn}
01	01	01	01
11	11	11	11
	21	21	21
		31	31
		41	41
		51	51
		61	61
		02	71
		12	02
		22	12
		32	32
		03	42
			13
			23

Measurements were made on both

(Continued on page 102)

Fig. 5: Projectile displacement record #1

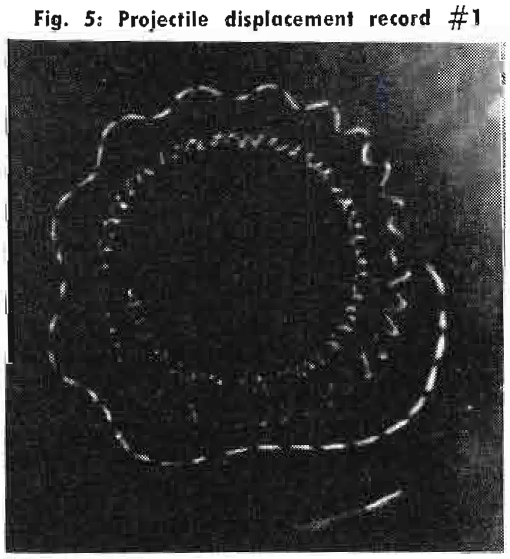
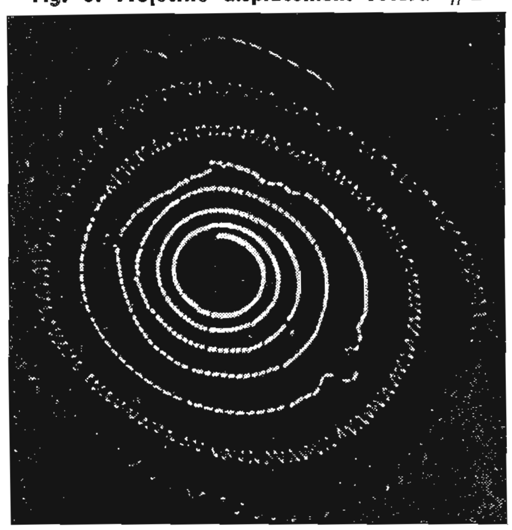


Fig. 6: Projectile displacement record #2

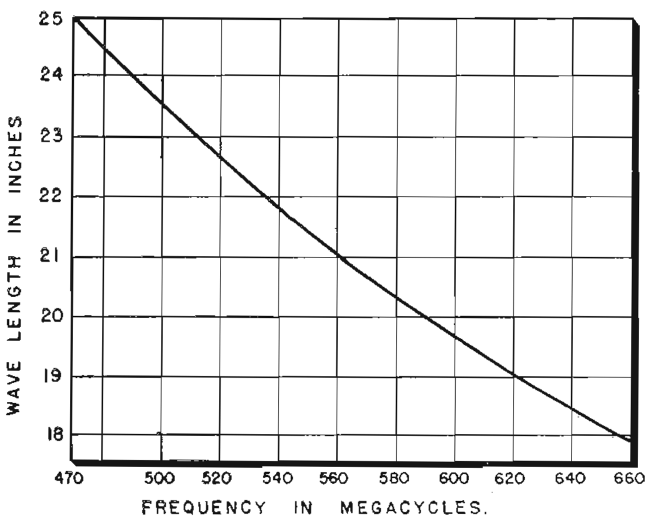


Page from an Engineer's Notebook

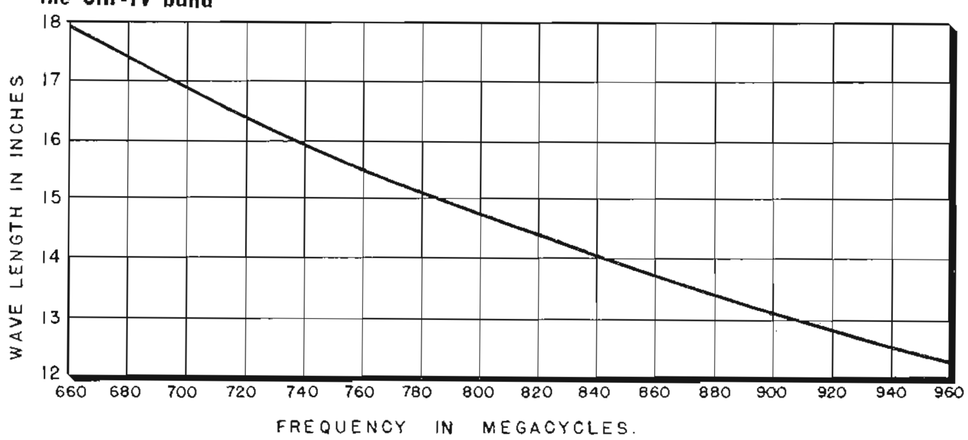
No. 18 — UHF-TV Frequencies & Wavelengths

Compiled by J. M. De Bell Jr., W. Budd and M. Casey, Allen B. DuMont Labs. Inc., Clifton, N. J.

Channel Number	Visual Frequency Carrier	Aural Frequency Carrier	Wavelength Centimeters	Wavelength Inches
14	471.25		63.660	25.063
		475.75	63.058	24.826
15	477.25		62.860	24.748
		481.75	62.273	24.517
16	483.25		62.079	24.441
		487.75	61.506	24.215
17	489.25		61.318	24.141
		493.75	60.759	23.921
18	495.25		60.575	23.848
			60.030	23.634
19	501.25		59.850	23.563
		505.75	59.318	23.354
20	507.25		59.142	23.284
		511.75	58.622	23.080
21	513.25		58.451	23.012
		517.75	57.943	22.812
22	519.25		57.778	22.747
		523.75	57.279	22.551
23	525.25		57.116	22.487
		529.75	56.630	22.295
24	531.25		56.471	22.233
		535.75	55.996	22.046
25	537.25		55.840	21.984
		541.75	55.376	21.802
26	543.25		55.223	21.741
		547.75	54.770	21.563
27	549.25		54.620	21.504
		553.75	54.176	21.329
28	555.25		54.030	21.272
		559.75	53.595	21.100
29	561.25		53.452	21.044
		565.75	53.027	20.877
30	567.25		52.887	20.822
		571.75	52.470	20.657
31	573.25		52.333	20.604
		577.75	51.926	20.443
32	579.25		51.791	20.390
		583.75	51.392	20.233
33	585.25		51.260	20.181
		589.75	50.869	20.027
34	591.25		50.740	19.976
		595.75	50.357	19.826
35	597.25		50.230	19.776
		601.75	49.855	19.628
36	603.25		49.731	19.579
		607.75	49.362	19.434
37	609.25		49.241	19.386
		613.75	48.880	19.244
38	615.25		48.761	19.197
		619.75	48.407	19.058
39	621.25		48.290	19.012
		625.75	47.942	18.875
40	627.25		47.828	18.830
		631.75	47.487	18.696
41	633.25		47.375	18.652
		637.75	47.040	18.520
42	639.25		46.930	18.476
		643.75	46.602	18.347
	640		46.875	18.455
43	645.25		46.494	18.305
		649.75	46.172	18.178
44	651.25		46.065	18.136
		655.75	45.749	18.011
45	657.25		45.645	17.970
		661.75	45.334	17.848
46	633.25		45.232	17.808
		667.75	44.927	17.688
47	669.25		44.826	17.648
		673.75	44.527	17.530
48	675.25		44.428	17.491
		679.75	44.134	17.376
49	681.25		44.037	17.337
		685.75	43.748	17.224
50	687.25		43.652	17.186
		691.75	43.368	17.074
51	693.25		43.274	17.037
		697.75	42.995	16.927
52	699.25		42.903	16.891
		703.75	42.629	16.783
53	705.25		42.538	16.747
		709.75	42.268	16.641
54	711.25		42.179	16.606
		715.75	41.914	16.502
55	717.25		41.826	16.468
		721.75	41.566	16.365
56	723.25		41.479	16.330
		727.75	41.223	16.230
57	729.25		41.138	16.196
		733.75	40.886	16.097
58	735.25		40.802	16.064
		739.75	40.554	15.966
59	741.25		40.472	15.934
		745.75	40.228	15.838
60	747.25		40.147	15.806
		751.75	39.907	15.711
61	753.25		39.827	15.680
		757.75	39.591	15.587
62	759.25		39.513	15.556
		763.75	39.280	15.465
63	765.25		39.203	15.434
		769.75	38.974	15.344
64	771.25		38.898	15.314
		775.75	38.672	15.225
65	777.25		38.598	15.196
		781.75	38.375	15.108
66	783.25		38.302	15.080
		787.75	38.083	14.993
67	789.25		38.011	14.965
		793.75	37.779	14.874
68	795.25		37.724	14.852
		799.75	37.512	14.769
69	801.25		37.441	14.741
		805.75	37.232	14.658
70	807.25		37.163	14.631
		811.75	36.957	14.550
71	813.25		36.889	14.523
		817.75	36.686	14.443
72	819.25		36.619	14.417
		823.75	36.419	14.338
73	825.25		36.353	14.312
		829.75	36.155	14.234
74	831.25		36.090	14.209
		835.75	35.896	14.132
75	837.25		35.832	14.107
		841.75	35.640	14.031
76	843.25		35.577	14.007
		847.75	35.388	13.932
77	849.25		35.325	13.907
		853.75	35.139	13.834
78	855.25		35.077	13.810
		859.75	34.894	13.738
79	861.25		34.833	13.714
		865.75	34.652	13.643
80	867.25		34.592	13.619
		871.75	34.414	13.549
81	873.25		34.354	13.525
		877.75	34.178	13.456
82	879.25		34.120	13.433
		883.75	33.946	13.365
83	885.25		33.889	13.342
		889.75	33.717	13.274
	900		33.333	13.123
	920		32.609	12.838
	940		31.915	12.565
	960		31.250	12.303



Wavelengths vs. frequency for the UHF-TV band



TV Horizontal Deflection Design

A practical system analysis showing how physical design requirements for most efficient output transformers may be achieved

PART TWO OF TWO PARTS

By
JOHN NARRACE
Project Engineer
Wells-Gardner & Co.
2701 North Kildare Ave.
Chicago 39, Ill.

PART One of this article, appearing in the Jan. 1952 issue of TELE-TECH, discusses TV deflection circuit conditions and step-by-step procedure for designing an efficient transformer. Utilizing the same symbols and tables as Part One, Part Two (below) further details the design requirements.

The sum of the ac and dc flux densities should not cause saturation of the core, as brought out in Fig. 4.

Since, for any core a maximum flux density (B_m) is available, effort should be made to utilize as much of it as possible for B_{ac}. A gap is inserted to reduce the polarizing effect of the direct current I_p and large variations in permeability for a given ΔI_p. The gap can become too great and reduce the effective permeability to such an extent as to affect coupling, hence deflection. Expressing it in terms of flux densities, it would require a greater ampere-turn product to develop enough magnetomotive force, creating enough flux to overcome the reluctances of the air gaps and length of magnetic path.

For most horizontal output transformers applications in present circuitry, a gap of 0.008 to 0.010 in. is satisfactory for separate windings (primary and secondary), and 0.004 to 0.006 in. for autotransformers.

Also, for a given gap, the ac flux density should be as large as permissible so the greatest effective voltage appears across the yoke, causing the yoke to increase its ampere-turn product and thereby increase deflection. This shown by the transformer relation,

$E_a = \Delta I_{pri}\, M$, where M = mutual inductance (assumed fairly constant).

If it is necessary to reduce the ac flux density to remain within the B_m requirements or because of the increased nonlinearity of the B and H curve at higher flux densities, an increase of turns will aid in this respect if other compromises such as distributed capacitances and coupling are still met.

It can be stated that in general the incremental permeability of the "C" core is approximately 205, with 80 to 90 ma dc and the $\Delta I_p/\Delta T_{dr}$ that results in the present circuitry when using a total gap of 0.008 to 0.10 in. With a gap of 0.004 to 0.006 in. and 65 to 75 ma dc, μ_{ao} = 452. This is the usual figure used when designing autotransformers.

Winding Considerations

Since a fairly low turns ratio exists between primary and secondary, a wide coil for good coupling is permissible, although C_d will be high, 25 to 40 $\mu\mu f$ being common for widths of 0.750 to 0.0875 in.

The winding pattern and the proper constant to be used with the factor γ is derived from Table II. Then the gear ratio (G_r) can be solved from equations (33) and (34). Equation (33) is applied when turns/crossover is required; hence cam cycle/winding cycle, and (34) vice versa.

$$G_r = \gamma \pm \gamma\,(0.625\delta/b) \quad (33)$$

$$G_r = \gamma \pm (0.625\delta/b) \quad (34)$$

b = size of cam (width of coil)

δ = wire size including insulation

0.625 = a factor derived from consideration of winding angle and distance between adjacent turns (1.25δ).

A minus produces a progressive winding for Eqs. (33) and (34).

The approximate gears can be found on the C & D scales of the slide rule. These values are then calculated by long hand. It pays to do this until a set of gears are found whose ratio equals that arrived at by the gear ratio formula to a three place accuracy. If this is done, the gears arrived at will give a uniform pattern and the coil will have good mechanical rigidity.

Further formulae required for designing various universal windings:

$$\text{Turns per layer} = N/L = b/1.25\delta \quad (35)$$

$$\text{Height of winding} = C = 1.25\delta^2 N\,(0.93)/b \quad (36)$$

N = Number of turns

For flattening due to winding tension, wire and insulation variations, 7% is allowed. With this information, the physical dimensions of the winding are complete and C_d can be calculated with good accuracy, and hence flyback time is thus determined.

Example for a hypothetical case:

$\hat{e}_{1y} = \hat{I}_{yf}\,(\omega L_T\, e^{\pi\cdot/4Q}) = 2000$ v.

and

$$N_{HV} = (N_p + N_s) \quad (37)$$
$$= (600 + 250) = 850 \text{ turns.}$$

N_p and N_s are assumed

δ = #38 HFSN = 0.007 in.

γ = 1 = 2 crossovers/turn

Actual b = 0.192 (Coils sometime "pull in" during winding. This is caused by too many crossovers per turn or too small a friction coefficient of form.)

Using Eq. (36):

$C = (0.00006125 \times 850 \times 0.93)/0.192 = 0.25$ in.

Referring to Fig. 5 and applying Eq. (15)

$C_1 = (8289 \times 4)/(4.45 \times 0.003) = 248.3\ \mu\mu f$

b = 0.192 in.

D = 1.375 in.

ϵ = 4.

δ = 0.007 in.

δ_{bare} = 0.004 in.

S = 0.003 in.

$A = \pi b D = 0.8289$

N = 850

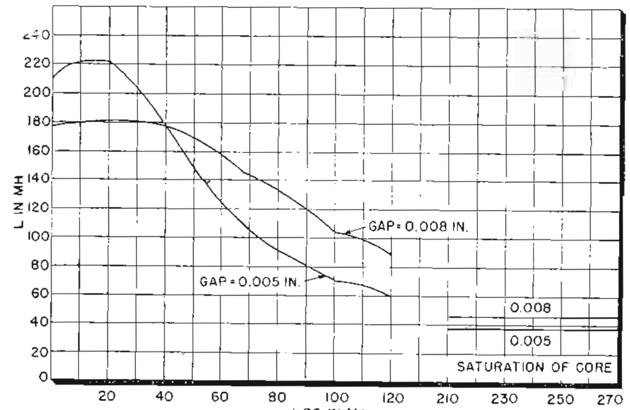
$N/L = (0.192)/(1.25 \times 0.007) = 21.94$

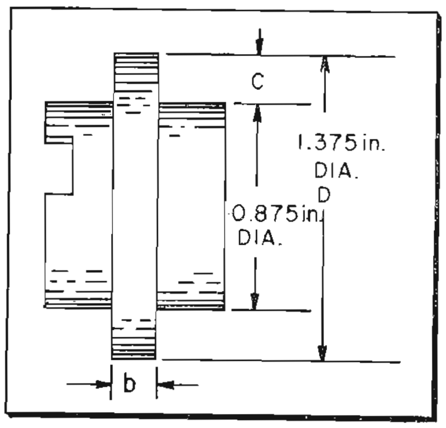
Number of layers = L = 850/21.94 = 38.74

From Eq. (14):

$C_d = C_1/N_1 = 6.4\ \mu\mu f$

Fig. 4: (l) Inductance curves for a coil measured on a 1000-cycle bridge. DC flows through winding consisting of 600 turns of #31 HNN wire, pi width=0.812 in. Fig. 5: (r) Physical dimensions of coil are a basis for computing the distributed capacitance and flyback time





To show the validity of this method, the close correlation of mechanical and electrical results are compared.

Electrical Results:

Inductance @ 1000 CPS = 24.71 mh

Self resonant frequency = 397 KC

$$C_d = 1/\omega^2 L \text{ or } \left[\left(\frac{159.2}{f}\right)^2 / L\right] \quad (38)$$

$\omega = 2\pi f$

f = Frequency in KC

$C_d = 6.4\ \mu\mu f$

The same method is used for the primary and secondary windings. The results are tabulated as follows:

C_d of HV winding = 6.4 $\mu\mu f$

C_d of Pri. winding = 35 $\mu\mu f$

C_d of Sec. winding = 52 $\mu\mu f$

C_d of Yoke winding = 14 $\mu\mu f$

C_{leads} = 10 $\mu\mu f$

$C_{driver\ tube}$ = 6.5 $\mu\mu f$

$C_{rect.\ tube}$ = 1.25 $\mu\mu f$

$C_{damper\ winding}$ = 43 $\mu\mu f$

$C_{damper\ tube}$ = 5 $\mu\mu f$

Reflected C of HV Circuit = $C_d + C_{rect}$ = 255 $\mu\mu f$

Reflected C of pri. circuit = $C_{d\ pri.\ tube} + C_{driver}$ = 239 $\mu\mu f$

Reflected C of damper circuit = $C_d + C_{damper\ tube}$ = 99.36 $\mu\mu f$

Summing up the total capacity across the secondary and yoke circuit:

255 Reflected HV
239 Reflected Primary
100 Reflected damper
24 Yoke leads
52 Secondary
76 Horizontal-to-vertical windings capacity
14 Capacity of winding to core and damper tube lead
760 $\mu\mu f$ = total C_t

$L_t = L_s L_y/(L_s + L_y) = 55.3 \times 13.5/(55.3 + 13.5) = 10.85$ mh

$f = 159{,}230/\sqrt{L_t C_t} = 55$ KC (39)

$T_r = [1/2f] = 9\ \mu$sec (40)

Retrace Time

It is obvious that if the desired retrace time is of too great a period, a further change in winding configuration should be considered. An important fact concerning winding configuration is the amount of visible ringing that can be tolerated. The elimination of these "white bars," that is, where the transformer is responsible, is accomplished by reducing the LC ratio of the individual layers so the energy stored due to the harmonics of the flyback pulse will be small. This can be carried only so far as the voltage between layers is not exceeded.

As a representative example:

If the coil shown in Fig. 5 is narrowed to ⅛-in., a minimum of six "bars" would appear during the first portion of the trace. It can be deduced that a smaller b dimension will give more severe vertical striations.

If the primary-secondary winding is at fault, (this can be ascertained by removal of the tertiary and by supplying the second anode potential from another TV chassis), then an intermeshing of layers with a resultant rearrangement of capacitances in the winding is required.

Table III gives the necessary information to obtain this type of winding pattern using the four most popular wire sizes. This type of winding pattern does not necessarily have to be rigidly adhered to as long as the proper rearrangement of capacitances is accomplished. Another consideration related to retrace time is a reduction of primary-secondary turns ratio, thus reducing reflected C, but requiring greater peak plate current from the driver tube. Also, a reduction of secondary inductance, reducing L_t, results in less efficiency and lower primary inductance, all of which imposes a greater peak plate current requirement on the driver tube.

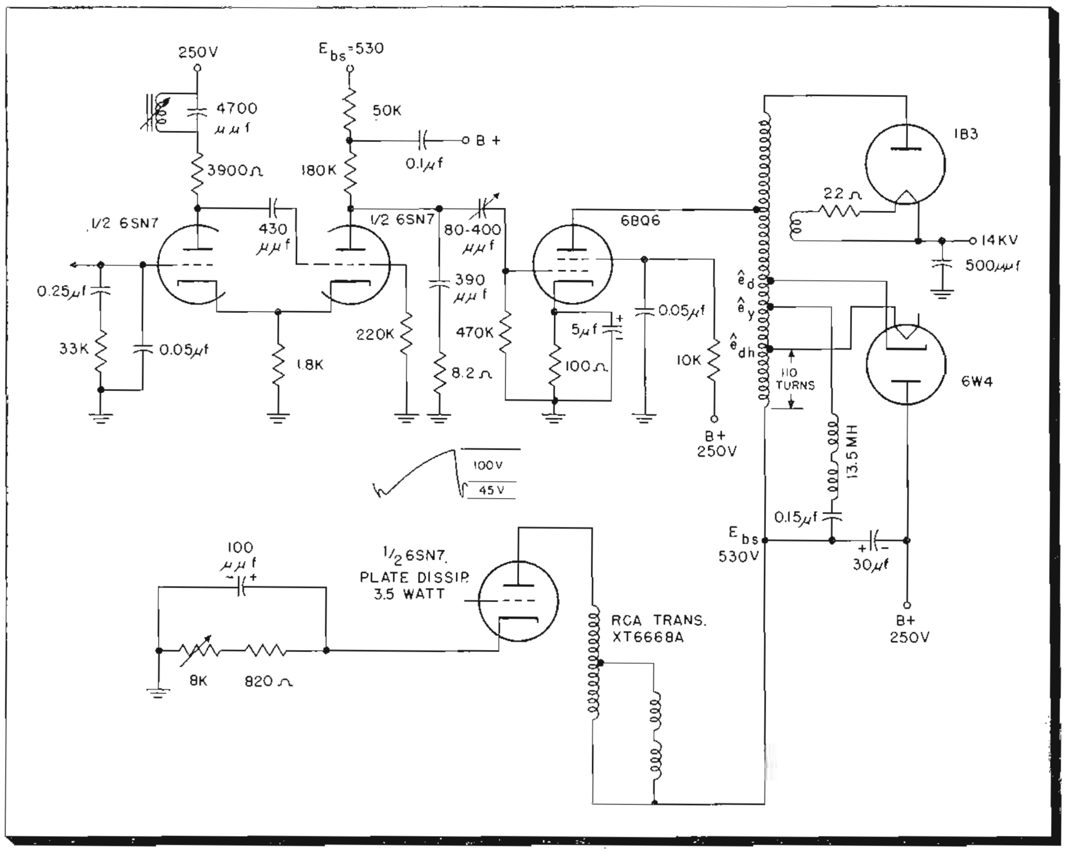


Fig. 6: Circuit used with flyback. Linearity control may be inserted in damper plate circuit

Reducing Yoke Inductance

Reducing yoke inductance again results in increasing peak plate current, although there is some compensation due to the higher efficiency because of the greater L_s/L_y ratio. If the driver tube is operated at too high a peak plate current an obvious increase in plate dissipation will result, and a cramping of the right side of the raster is obtained due to operating below the knee of the plate characteristic curve.

The advantages gained by using the opposite leg of the core as a separate form for the HV winding are:

1. The coil is much smaller physically, thus reducing the distributed capacity for the same amount of turns because a smaller area is divided by the same number of layers.
2. The coil can have greater width, increasing the ease with which it can be wound, hence higher productive output.
3. In production, the tertiaries can be wound and inventoried, and at a later date the primary-secondary coil wound. Also, breakage of leads and mistake in turn count will only affect the individual coils.
4. A larger wire size can be used and fewer feet of wire are required.

Good Regulation

Regulation: Thus far no mention of regulation has been made. A high coefficient of coupling between primary-secondary, and proper tertiary design are the first requisites of good regulation. Good regulation would be considered as 6 to 9% change in second anode voltage with a current variation of 0 to 120 μa. Reducing the secondary inductance will help, but this reduces efficiency. Also, the retrace pulse should be as free as possible from "spikes."

Regulation can be defined as the ratio of loaded to unloaded circuit Q. That is why the regulation gets poorer as the efficiency is increased. Raising the secondary inductance reduces the shunt losses of the transformer (core losses, etc.), thereby increasing unloaded circuit Q. Unloaded circuit Q is the Q that exists when no beam current is being used, that is, when the CRT is in cutoff condition.

Yoke Capacitor: Although an integral

expression could be derived to enable calculation of the series yoke capacitor, it is determined empirically for a given system. A larger capacity resulting in a slower rate of change during the mid-portion of the trace.

Leakage Inductance: If the leakage inductance is too great, the loss of coupling is apparent, but another important factor is the negative plate pulse at the finish of retrace. If this pulse is too great in amplitude, a tendency towards Barkhausen oscillations will occur.

Since the close correlation between transformer and circuit requirements have been established along with the inception of some of the author's original formulae in this article (Eqs. 1, 6, 8, 10, 11, 33, 34, 41) a simplification of the original procedure is possible. That is, determining the energy requirements of the system may be eliminated.

Summary

The following summary will clarify this concept:

1. Yoke requisites
2. Add 10% to required I_{yp-p} to allow for tolerances and sufficient deflection at low line voltage
3. Decide on K and η
4. Determine $\hat{I}_p$
5. Calculate N_p/N_s using the following equation and using highest turns ratio possible to minimize peak plate current ($\hat{I}_p$)

$$\frac{N_p}{N_s} = \frac{\hat{I}_{yf}}{\hat{I}_p} \qquad (41)$$

6. Calculate N_p/N_d using Eq. 11
7. Calculate L_s using Eq. 2
8. Determine N required for L_s using Eq. 29
9. To find N_p, multiply N_s by the ratio of Eq. (41), and establish N_d by dividing N_p by the ratio of Eq. (11).
10. Decide on wire size to be used
11. Distributed capacitance, winding dimensions, etc., are now determined. An autotransformer was constructed from the information given in this article. The following are its electrical and mechanical specifications:

δ = 32HFSN (heavy formvar single nylon)
b = 0.812 drive gear 29, idler 1/1, cam gear 115
N_s = 300, N_d = 470, N_p = 750 (Number of turns indicated are referred to start of winding)
For HV winding:
δ = #40 HFSN (heavy formvar single nylon)
δ = 156 drive gear 59, idler 1/1, cam gear 39
N_{HV} = 1000
Total gap = 0.005 in.
Electrical results:
B+ = 250 v.
HV = 14.5 kv
E_{bs} = 560 v.
E_{scr} = 130 v.
I_{scr} = 0.012 amp
I_k = 0.077 amp
E_k = 7.7 v.
P_d = 7 watts
Linearity = 1.5% (though subject to variations as great as 12% due to different perveances of various damper tubes).
K = 99.8%
Regulation = 7.5% from 0 to 120 v.
Pulse Voltages:
$\hat{e}_p$ = 4600 v.
$\hat{e}_d$ = 3000 v.
$\hat{e}_{ly}$ = 2500 v.
$\hat{e}_{dh}$ = 1500 v.
Turns Ratios:
N_p/N_s = 2.5
N_p/N_d = 1.59

The circuit used with the transformer is given in Fig. 6. This circuit and transformer can be used at 300 v. B+ and supply 16.5 kv anode voltage. If a linearity control is used, it can be inserted in the plate circuit of the damper. See Fig. 7. Consideration must be given to the fact that deflection and high voltage will be adversely affected by the reduced power input due to reduction of the plate voltage (E_{bs}) by the amount of inductive voltage existing across the linearity control (E_{l-in}) Thus, $E'_{bs} = E_{bs} - E_{l-in}$

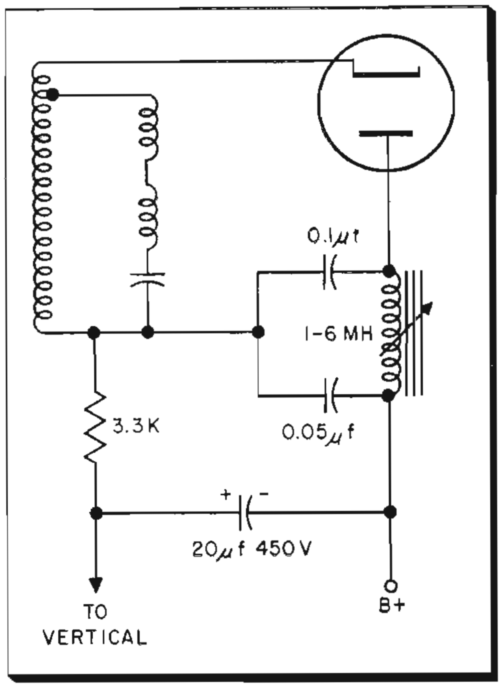


Fig. 7: Circuit employing linearity control

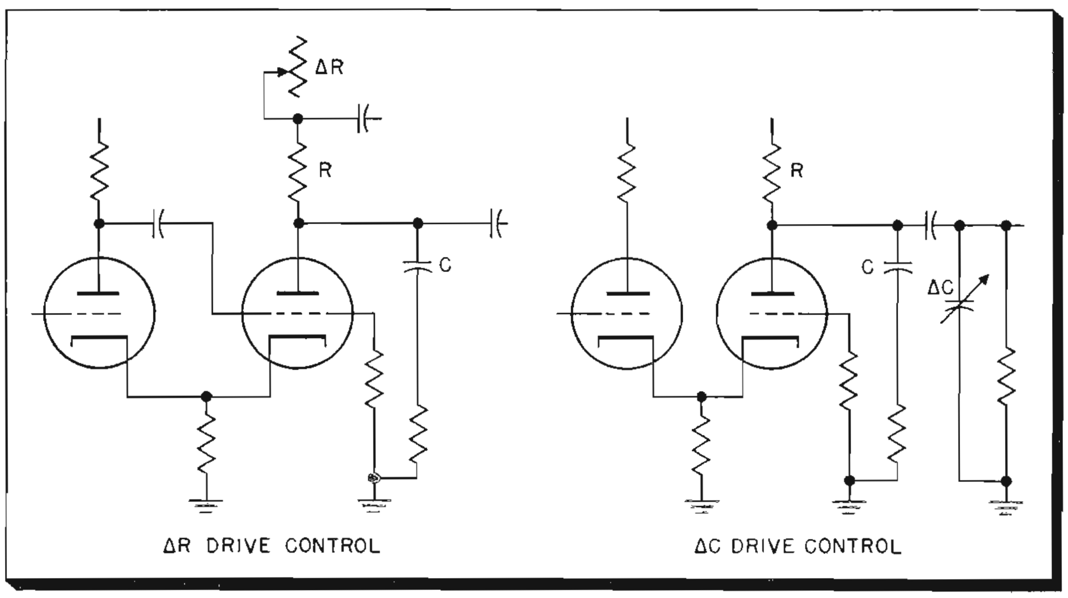
This can be compensated for by increasing screen voltage.

Factors Related to Grid Waveform Requirements: Due to the non-linearity of I_p of the driver tube, there will be a slightly parabolic shape to the plate current waveform when a linear saw-tooth voltage is impressed on the grid. By using inverse functions, the desired linear I_p can be obtained. The time constant RC is varied until maximum deflection is acquired with a minimum amount of cathode current, still maintaining the required linearity.

A time constant from 6.5 to 7.5 is generally used. The time constant is also dependent on R and C used in the cathode of the driver tube. Obviously, if a greater amount of degeneration is used in the driver tube circuit, a longer time constant will be required.

Usually the horizontal oscillator is designed with a given E_p range on the discharge tube, or if a $\triangle C$ is used in the grid of the driver tube, E_p is more or less fixed. With this in mind, it remains for the charging capacitor to vary the RC product. See Fig. 8.

Fig. 8: Variable-resistance and variable-capacitance methods of varying drive voltage



It is the author's opinion that the only sensible drive control is a variable capacitor for the coupling capacitor that connects to the driver tube grid. This allows the oscillator frequency to remain substantially constant while varying the drive.

The size of the peaking resistor is a compromise between the capacity of the charging capacitor, the amount of "drive" available for a given coupling capacitor, and required cutoff to obtain the high voltage desired. An extreme amount of "peaking" will result in slight cramping of the raster at the finish of the trace if other parameters of the circuit have remained substantially the same. Cramping will also be the result of insufficient E_{bs} for a given turns ratio between primary and secondary. This is due to the sacrificing of minimum plate voltage because the expression $E_{lb} = -L_b \Delta I_p / \Delta T_{dr}$ has utilized a major portion of the E_{bs} available.

APPENDIX

Various formulae:

Driver tube conduction period, T_{dr}:

$$T_{dr} = \left[\frac{\hat{I}_{yf}}{\hat{I}_{yf} + \hat{I}_{ys}}\right]$$

Damper tube conduction period, T_d:

$$T_d = \left[\frac{\hat{I}_{ys}}{\hat{I}_{yf} + \hat{I}_{ys}}\right] T_s$$

Since the characteristic impedance is the geometric mean of L_p and L_{op}, then

$$L_{ep}/L_p = 1 - K^2$$

and $K = \sqrt{1 - L_{ep}/L_p}$

The efficiency of a direct drive deflection system using an inductance in series with the yoke can be solved by the following expression.

$$\eta = \left[\frac{1}{\frac{L_{sr} + L_y}{L_y}}\right] \quad \begin{array}{l} L_{sr} = \text{series inductance} \\ L_y = \text{yoke inductance} \end{array}$$

The peak plate current at finish of trace is:

$$\hat{I}_p = .5\, I_{y\ p\text{-}p}$$

If a direct drive system consists of an inductance in shunt with the yoke then Eq. (1) can be applied, letting

$$K = 1$$

$$\eta = \left[\frac{1}{1 + L_y/L_s}\right]$$

The peak current existing at finish of trace:

$$\hat{I}_f = .5\, I_{y\ p\text{-}p}\,(2 - \eta)$$

and:

$$\hat{I}_p = \hat{I}_f$$

If a thermocouple meter is used to measure yoke current,

$$I_{yp\text{-}p} = 1.21\,(2\sqrt{2}) = 3.42\, I_y \text{ rms}$$

To determine the rms voltage of the flyback pulse, the following analysis can be made:

If the pulse is assumed to be a half cosine wave then $a = \hat{e} \cos \omega t$ and from trigonometric identities,

$$\cos^2\theta = 1\text{-}\sin^2\theta = (1 + \cos 2\theta)/2$$

Let $\theta = \omega t$.

Using the basic integral expression,

$$|E| = \hat{e}\sqrt{\frac{1}{2\pi}\int_0^{2\pi} a^2\, d(\omega t)}$$

Then determining the duty cycle of the flyback pulse by letting 63.5 μsec = 360° and 8 μsec = x°

Thus, $x° = (8/63.5)\,360 = 45.36° = \pi/4$

Therefore, applying the previous expression, but using the smaller angle:

$$|E| = \hat{e}\sqrt{\frac{1}{2\pi}\int_0^{\pi/4} \frac{1 + \cos 2\phi}{2}\, d\phi}$$

Integrating and evaluating:

$$|E| = \hat{e}\sqrt{\frac{1}{4\pi}\left[\frac{\pi}{4} + 0.5\right]} = \hat{e}\,(0.32)$$

$$\hat{e}/|E| = 3.13$$

TIMETABLE of NEW TV STATIONS COMING on the AIR

A geographical listing of the 175 new commercial TV stations and 11 noncommercial educational outlets for which "post-Freeze" FCC grants and construction permits had been issued through January 10, 1953. Where possible, estimated date for start of telecasting is shown.

State and City	Call Letters	Channel No.	Date On Air
ALABAMA			
Birmingham	WJLD-TV	48	*
Birmingham	*	42	*
Gadsden	WTVS	21	5/53
Montgomery	WCOV-TV	20	3/53
ARIZONA			
Tucson	KVOA-TV	4	3/53
Tucson	KOPO-TV	13	*
Tucson	KCNA-TV	9	*
ARKANSAS			
Ft. Smith	KFSA-TV	22	*
Little Rock	KRTV	17	3/53
Little Rock	KETV	23	*
CALIFORNIA			
Bakersfield	KAFY-TV	29	4/53
Fresno	KMJ-TV	24	5/53
Los Angeles	KPIK	22	5/53
Los Angeles (NCE)	KUSC-TV	28	*
San Bernardino	KITO-TV	18	10/53
Santa Barbara	KEYT	3	5/53
Stockton	KSTN-TV	36	*
COLORADO			
Colorado Springs	KRDO-TV	13	4/53
Denver	KDEN	26	Spring
Denver	KIRV	20	*
Pueblo	KCSJ-TV	5	3/53
Pueblo	KDZA-TV	3	*
CONNECTICUT			
Bridgeport	WICC-TV	43	1/53
Bridgeport	WSJL	49	2/53
New Britain	WKNB-TV	30	1/53
New London	WNLC-TV	26	7/53
Waterbury	WATR-TV	53	*
FLORIDA			
Ft. Lauderdale	WITV	17	2/53
Ft. Lauderdale	WFTL-TV	23	3/53
Lakeland	WONN-TV	16	*
Pensacola	WPFA	15	6/53
St. Petersburg	WSUN-TV	38	5/53
West Palm Beach	WIRK-TV	21	*
IDAHO			
Boise	KIDO-TV	7	7/53
ILLINOIS			
Belleville	WTVI	54	5/53
Chicago	WHFC-TV	26	*
Danville	WDAN-TV	24	12/53
Decatur	WTVP	17	7/53
Peoria	WEEK-TV	43	3/53
Peoria	WTVH-TV	19	*
Rockford	WTVO	39	3/53
INDIANA			
Lafayette	WFAM-TV	59	5/53
Muncie	WLBC-TV	49	3/53
IOWA			
Sioux City	KWTV	36	*
Sioux City	KVTV	9	4/53
KANSAS			
Hutchinson	*	12	*
Manhattan (NCE)	KSAC-TV	8	*
KENTUCKY			
Ashland	WPTV	59	7/53
Henderson	WSON-TV	50	5/53
Louisville	WKLO-TV	21	*
LOUISIANA			
Baton Rouge	WAFB-TV	28	1/53
Baton Rouge	KHTV	40	*
Lake Charles	KTAG	25	6/53
Monroe	KNOE-TV	8	4/53
Monroe	KFAZ-TV	43	5/53
MAINE			
Bangor	WABI-TV	5	2/53
MARYLAND			
Baltimore	WITH-TV	60	*
Frederick	WFMD-TV	62	*
MASSACHUSETTS			
Fall River	WSEE-TV	46	5/53
New Bedford	WNBH-TV	28	2/53
Springfield-Holyoke	WWLP	61	1/53
Springfield-Holyoke	WHYN-TV	55	3/53
MICHIGAN			
Ann Arbor	WPAG-TV	20	4/53
Battle Creek	WBKZ-TV	64	5/53
Battle Creek	WBCK-TV	58	8/53
East Lansing	WKAR-TV	60	8/53
Flint	WCTV	28	1/53
Flint	WTAC-TV	16	*
Jackson	WBIM-TV	48	*
Kalamazoo	WKMI-TV	36	*
Muskegon	WTVM	35	*
Saginaw	WKNX-TV	57	2/53
MINNESOTA			
Duluth	KFTV	38	2/53
MISSISSIPPI			
Jackson	WJTV	25	1/53
Meridian	WCOC-TV	30	*
MISSOURI			
Festus	*	14	6/53
St. Joseph	KFEQ-TV	2	8/53
Springfield	KTTS-TV	10	5/53
Springfield	*	3	*
NEBRASKA			
Lincoln	KOLN-TV	12	2/53
Lincoln	KFOR-TV	10	5/53
NEW JERSEY			
Asbury Park	WCEE-TV	58	Late '53
Atlantic City	*	52	*
New Brunswick (NCE)	WTLV	19	*
NEW YORK			
Albany (NCE)	WRTV	17	*
Binghamton (NCE)	WQTV	46	*
Buffalo (NCE)	WTVF	23	*
Buffalo	WBUF	17	4/53
Buffalo	*	59	*
Elmira	WTVE	24	4/53
Ithaca (NCE)	*	14	*
Ithaca	WHCU-TV	20	11/53
N. Y. City (NCE)	WGTV	25	*
Poughkeepsie	WEOK-TV	21	12/53
Rochester (NCE)	WROH	21	*
Syracuse (NCE)	WHTV	43	*
Watertown	WWNY-TV	48	*
NEVADA			
Reno	KZTV	8	3/53
NORTH CAROLINA			
Asheville	WISE-TV	62	4/53
Greensboro	WCOG-TV	57	*
Raleigh	WETV	28	4/53
OHIO			
Akron	WAKR-TV	49	Winter
Dayton	WIFE	22	Fall
Lima	WLOK-TV	73	*
Lima	WIMA	35	Summer
Massillon	WMAC-TV	23	3/53
Warren	WHHH	67	*
Youngstown	WUTV	21	7/53
Youngstown	WFMJ-TV	73	1/53
Youngstown	WKBN-TV	27	1/53
Zanesville	WHIZ-TV	50	4/53
OKLAHOMA			
Lawton	KSWO-TV	7	4/53
PENNSYLVANIA			
Altoona	WFBG-TV	10	2/53
Bethlehem	WLEV-TV	51	*
Easton	WEEX-TV	57	Spring
Harrisburg	WHP-TV	55	4/53
Harrisburg	*	71	*
Hazelton	WAZL-TV	63	*
Johnstown	WARD-TV	56	*
New Castle	WKST-TV	45	1/53
Philadelphia	WIP-TV	29	*
Pittsburgh	WENS	16	8/53
Pittsburgh	WTVQ	47	8/53
Pittsburgh	WKJF-TV	53	*
Reading	WHUM-TV	61	1/53
Reading	WEEU-TV	33	7/53
Scranton	WTVU	73	1/53
Scranton	WGBI-TV	22	2/53
Wilkes-Barre	WILK-TV	34	1/53
Williamsport	WRAK-TV	36	*
York	WNOW-TV	49	3/53
SOUTH CAROLINA			
Charleston	WCSC-TV	5	4/53
Columbia	WNOK-TV	67	1/53
Columbia	WCOS-TV	25	Spring
SOUTH DAKOTA			
Sioux Falls	KELO-TV	11	3/53
TENNESSEE			
Chattanooga	WTVT	43	3/53
Chattanooga	WOUC	49	*
TEXAS			
Amarillo	KGNC-TV	4	3/53
Amarillo	KFDA-TV	10	3/53
Austin	KCTV	18	*
Austin	KTVA	24	*
Beaumont	KBMT	31	4/53
El Paso	KEPO-TV	13	4/53
Galveston	KGUL	11	1/53

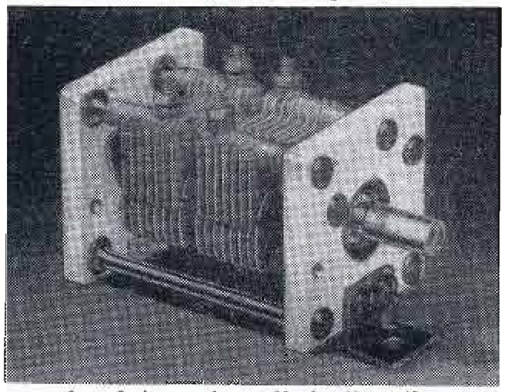
* Information not available at press time.
(NCE) Noncommercial educational station

(*Continued on page* 163)

New Equipment and Components

Variable Capacitor

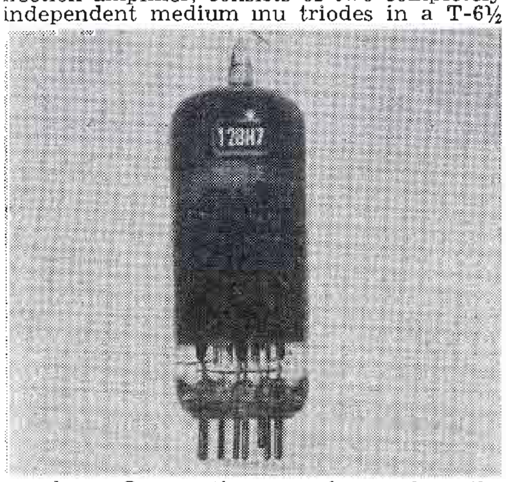
A VHF-UHF variable capacitor (the "VU") will operate in tuned circuits at frequencies from 50 to 500 MC. Two capacitor sections



are placed in series, eliminating the need for contacts to the rotor. The rotor is completely isolated by the use of pyrex glass ball bearings. Consequently, contact and bearing noise is said to be eliminated. The series design is also said to permit a more symmetrical design of the capacitor itself and consequently allows better circuit layout.—**Hammarlund Mfg. Co., Inc., 460 W. 34 St., New York 1, N. Y.**—TELE-TECH

Double Triode

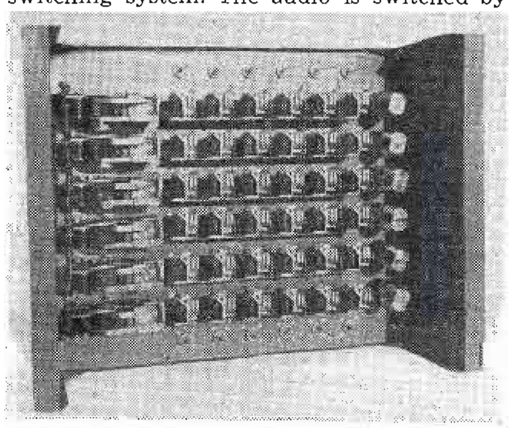
A miniature, high perveance, vertical deflection amplifier, consists of two completely independent medium mu triodes in a T-6½



envelope. One section may be used as the sawtooth generator while the other section serves as the vertical deflection amplifier. Both sections are designed to withstand the high pulse voltages normally encountered in vertical amplifier service. For certain applications where the plate supply voltage must be kept low, parallel connection of the two sections may be used. The heater is designed to operate from either 6.3 or 12.6 volts.—**Radio Tube Div., Sylvania Electric Products Inc., Emporium, Pa.**—TELE-TECH

Video & Audio Monitor Switching Unit

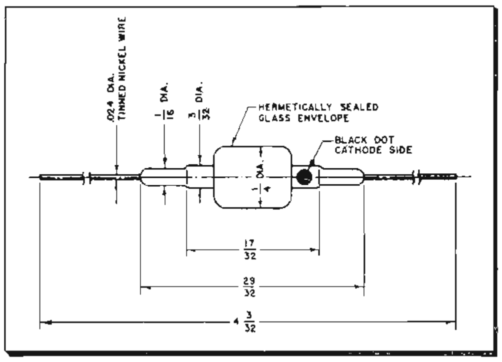
Both video and audio monitor circuits are switched simultaneously in a new monitor switching system. The audio is switched by



two levels of a rotary stepping switch, the third level of which operates the corresponding video relay associated with the audio circuit. Video output of the relay bank is fed to a cathode follower which provides complete isolation of the monitor from the source. Audio switching is across low impedance program monitor busses with bridging monitor inputs. Each of the six monitoring points is provided with a dial assembly mounted in an attractive desk top mounting. Six circuits are available for selection. These may be all "house" circuits or may be split to provide monitoring facilities of "off the air" signals. Each CDMS-1 switching panel has provisions for feeding six stations audio and video wise. The units are so constructed as to be used in multiple if more than six monitoring stations are desired. One bay will accommodate up to five CDMS-1 units and associated relay power supply, thus providing feeds for 30 monitoring stations.—**General Communications, Fort Atkinson, Wis.**—TELE-TECH

Germanium Diodes

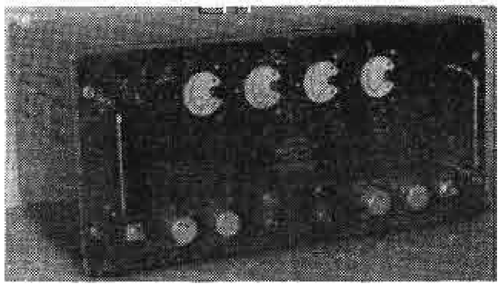
Seven germanium diodes of the hermitically sealed glass variety which are not affected by atmospheric conditions of humid-



ity, altitude and extremely low temperature have been added to the Amperex line. Four are electrically interchangeable with well-known standard types, and the others are new. All are highly resistant to shock and vibration. A number of new diodes, now in development, will follow for which there are presently no interchangeable types on the market.—**Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.**—TELE-TECH

Digital Cycling Counters

Models 654 and 655 digital cycling counters are basic laboratory tools containing counting circuits, gating circuits and an in-

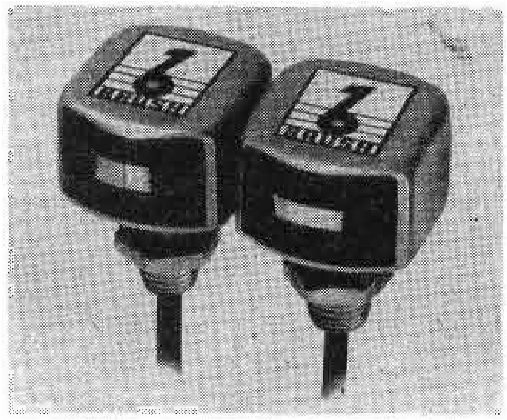


ternal time base. Frequencies, events, or revolutions may be counted over periods of .01, 0.1, or 1.0 sec. Combinations of reading and display time are available so that a virtually constant display of the reading may be obtained with changes taking place as the variable changes. Counting speeds to 100,000 counts per second. Count capacity of the model 654 is 4-digits; on model 655 it is 5-digits. Time base stability of model 654 is ± 1 part in 10,000. The model 654 is specifically designed for routine measurements where greater than 1 part in 10,000 are not required.—**Digital Instrument Co., Inc., P. O. Box 1345, Coral Gables, Fla.**—TELE-TECH

FOR MORE INFORMATION
on New Equipment for Designers and Engineers
See pages 163 and 164

Magnetic Heads

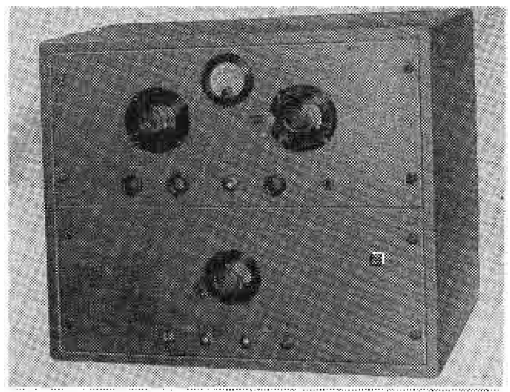
The BK-1090 magnetic head is intended for dual track recording, and is said to provide very high resolution and uniformity.



Outstanding feature of this unit is its low power consumption of less than ½ volt-ampere. The BK-1110 is the erase head companion. These units are cast into a block of specially selected synthetic resin which makes them extremely uniform, moisture-proof, nonmicrophonic, and allows operation throughout a wide temperature range. The low loss core structure is made from thin molybdenum permalloy laminations carefully annealed and cemented together permitting the use of high bias and erase frequencies. They are enclosed in a mu metal shield to provide optimum shielding from extraneous magnetic fields. Shape of the head permits close mounting of adjacent heads and provides correct approach angle of the tape.—**The Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio**—TELE-TECH

Master Oscillator

A series of three high stability master oscillators cover the following ranges: 200-600 KC, 500-1640 KC and 1-16 MC. A stabil-



ity of 5 parts per million is attainable and a resetability of the same order is featured, thus making it unnecessary to reference the frequency against a master standard. Other models are available up to 1,000 MC on special order. Power output of 2 to 5 watts across a 75 ohm load is provided, which permits full excitation of most radio transmitters. The oscillators are mounted on standard width relay rack panels and are supplied with a cabinet for table top mounting. The primary power source is 115 v., 50-60 CPS.—**Wunderlich Radio Co., 2 Fifth Ave., New York 11, N. Y.**—TELE-TECH

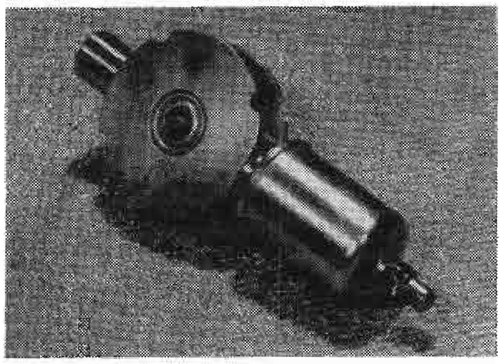
Frequency Standard

Type 2007 Frequency Standard contains a shock mounted miniature high Q tuning fork, a sub miniature double triode tube and all circuitry. Output frequencies available are 400 or 500 cycles with an accuracy of ± 1 part in 50,000 from +15° to +35° C and ± 1 part in 5000 from −65° to +85° C. Sealed in octal base container 1½ in. diameter x 4½ in. high, it weighs less than 10 oz. Power required is 75 to 200 v., dc @ 1 to 5 ma and 6.3 volts @ 300 ma.—**American Time Products, Inc., 580 Fifth Ave., New York 36, N. Y.**—TELE-TECH

for Designers and Manufacturers

Gas Switching Tube

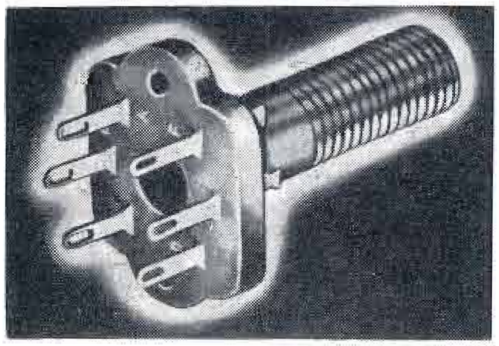
Type GL-1B24-A is an integral-cavity tunable type designed for use in simple duplexers in pulsed microwave circuits



which do not require that the short circuit in the tube have a fixed electrical position. It differs from other tubes of this type in that the tube reservoir is made of steel instead of glass. Use of a steel reservoir is said not only increases the tube's strength, but also decreases the weight appreciably. Weight is only a quarter of a pound. It will operate in the 8490 to 9600 MC band and decouples the receiver from a common transmitting and receiving antenna during a transmission period. It has a recovery time of four µsec at 10 KW peak, three db down and has a leakage power of 30 mw. The transmitter peak power is 100KW—**General Electric Co., Tube Dept., 1 River Road, Schenectady 5, N. Y.**—TELE-TECH

Mica Coil Form

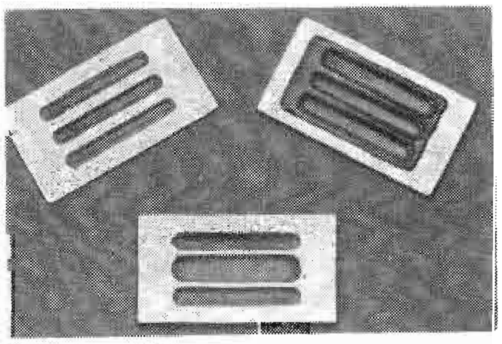
A new coil form is injection-molded of Mycalex 410, glass-bonded mica insulation to provide permanently efficient operation



under temperature conditions too high for Styrene and other plastic materials. The ability of Mycalex 410 to withstand continuous ambient temperatures of over 650°F. is said to solve this problem completely. Use of Mycalex 410 not only results in a precision molded piece produced at moderate cost, but efficiency is high due to the inherent low-loss qualities of this material.—**Mycalex Corp. of America, Clifton Blvd., Clifton, N. J.**—TELE-TECH

Wide Band Microwave Window

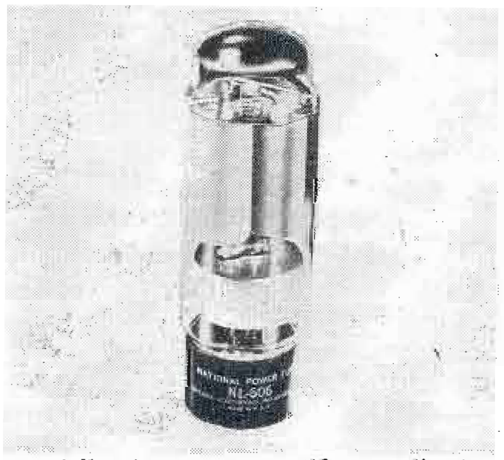
Type P1311 microwave window covers a bandwidth of 40% in the frequency range of 8200 - 12,500 MC at a voltage standing



wave ratio less than 1.25. The voltage standing wave ratio-frequency characteristic behaves like a single resonant circuit with a minimum value of 1.03 in the neighborhood of 9800 MC. The doubly loaded Q of the unit is approximately 0.25. The window blank consists of three parallel slots stamped in a thin blank of kovar 0.600 x 1.100 in. O.D. to which is sealed a rectangular blank of low loss glass. The windows are copper and silver plated and may be soft soldered into a UG-39/U flat flange. It is necessary to mill out the flange to accommodate the window dimension and to break the inside edges of the waveguide at the flange connection to avoid cracking of the glass in the seal. The windows may be used in pressurizing applications and will withstand pressures up to 30 lbs. per sq. in. absolute. —**Microwave Associates Inc. 22 Cummington St., Boston 15, Mass.**—TELE-TECH

Full-Wave Rectifier

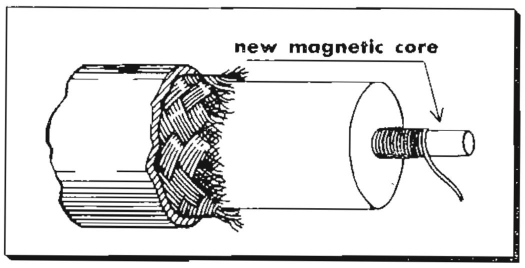
A new high-current full-wave rectifier known as the NL-606, carries 6.4 amps dc, and 25.6 amps peak rating. It was designed



especially for power rectifier applications requiring higher voltages up to 900 v. peak inverse or 250 v. dc. It is gas and mercury filled for quick-starting, long life, and high peak inverse within wide temperature limits. Other ratings are: filament voltage, 2.5 v.; filament current, 17 amps; and peak inverse voltage 900 v.—**National Electronics, Inc., Geneva, Ill.**—TELE-TECH

High-Impedance Delay Cable

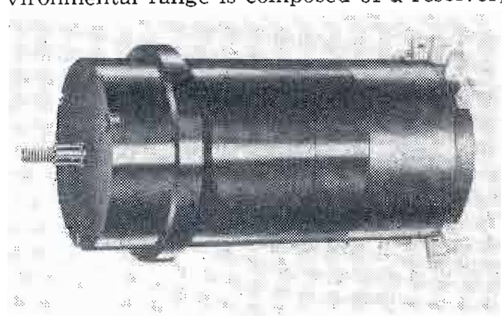
Type HH-1500 delay cable features a flexible, low-loss magnetic core of uniform structure which nearly triples the inductance



of the cable assembly, thereby effectively increasing its characteristic impedance as well as the time delay while substantially maintaining the dimensions and the attenuation characteristic of conventional high-impedance cables, such as RG-65/U. HH-1500 cable may be used to delay signals up to a few microseconds, particularly in pulse generating and oscilloscope circuits, for measuring time intervals in radar and loran systems, and as a transmission line with a high characteristic impedance to match load impedances in the order of 1500 ohm. The delay per foot is 0.073 µsec as compared to 0.042 of the commonly used RG-65/U cable. Therefore, for a given time delay, a saving of about 40% in cable length may be achieved. This in turn means considerably greater signal amplitude and fidelity since the attenuation level (db/ft) of HH-1500 is similar to that of RG-65/U.—**Columbia Technical Corp., 5 E. 57 St., New York 22, N. Y.** —TELE-TECH

Resolver System

An electrical resolver system, capable of operating with accuracy over a wide environmental range is composed of a resolver,

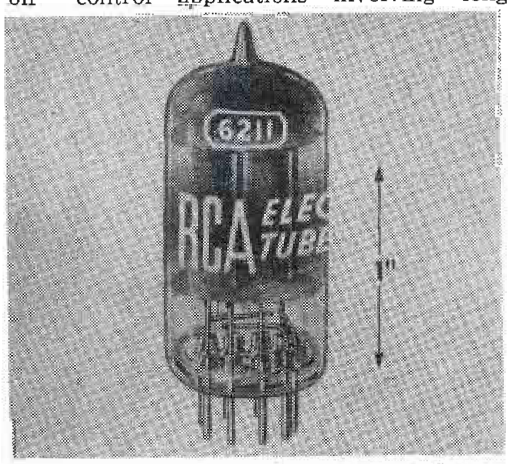


a hi-gain amplifier, and a summing network box. The suitable network box combines its inputs for introduction into the hi-gain amplifier; the amplifier feeds the resolver, either the Basic Resolver or the Vector Solver type; the outputs of the resolver are the desired functions.

Designed originally for the armed services, it operates accurately at temperatures from −60° to +160° F. It is standardized thereby allowing interchangeability without upsetting the system of which it is a part. Flexibility is provided through a choice of network boxes and amplifiers.—**Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.** TELE-TECH

Twin Triode

The 6211 is a medium-mu twin triode of the 9-pin miniature type. Designed for "on-off" control applications involving long



periods of operation under cutoff conditions, the 6211 maintains its emission capabilities and provides good consistency of plate current during its "on" cycles. Balance of cutoff bias between the two units is closely controlled during manufacture. Production controls correlated with typical electronic computer operating conditions, and rigorous tests for shorts and leakage, insure long and dependable performance from the 6211. The 6211 has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a mid-tapped heater to permit operation from either a 6.3 v. or 12.6 v. supply. The heater is made of pure tungsten to give long life under conditions of frequent on-off switching.—**Tube Department, Radio Corp. of America, Harrison, N. J.**—TELE-TECH

Two Band Receiver

Operating in two pertinent fixed frequency ranges (30-50 MC and 152-174 MC) the tunable feature of Monitoradio Model DR200 can be used alternately with the flip of a switch. Under routine operating conditions, it performs as any standard crystal controlled monitor receiver. But when conditions require and monitoring of any other channel or channels is desired, a flip-of-the-switch makes the unit tuneable across the full frequency range. Such flexibility of performance makes the DR-200 ideal for expanding the communications systems of municipal police, civil defense, fire, forestry, state police and pipelines.—**Radio Apparatus Corp., 55 N. New Jersey St., Indianapolis, Ind.**—TELE-TECH

High Impedance VTVM

Two-tube instrument includes stable dc amplifier and series-negative feedback for drift-free operation over eight-hour period

By F. R. BRADLEY* & R. D. McCOY
Reeves Instrument Corp., 215 E. 91 St., New York 28, N.Y.

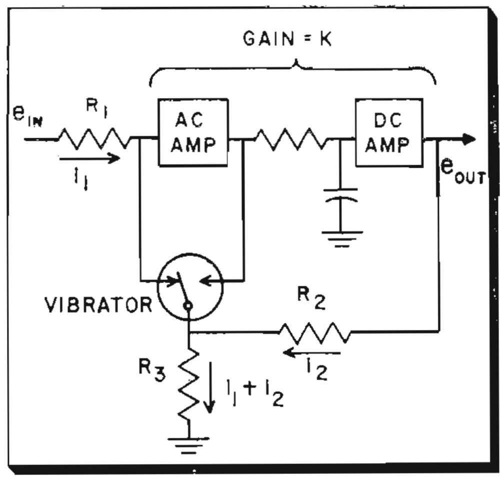


Fig. 1: Block diagram of vacuum tube voltmeter

THE type of circuit to be described utilizes a zero drift dc amplifier in combination with series-negative feedback to provide a high input impedance dc vacuum tube voltmeter circuit having essentially zero drift over an eight-hour period. The circuit given provides a drift free full-scale voltage range of ±0.1 v. dc with complete meter protection.

Fig. 1 shows the circuit in block diagram form. Qualitatively, the input voltage is contact-modulated at a 60-cycle frequency, ac amplified, demodulated by the same contact modulator, filtered, and dc amplified. The phasing is such that e_o is in-phase with e_{in} so that the voltage feedback to the chopper arm, by the voltage divider consisting of R_2 and R_3 is almost equal to the input voltage. The net effect is that of a small potential difference across R_1 (when the junction of R_2 and R_3 is connected to R_1 by the chopper) and correspondingly an increase in input impedance by a substantial factor. The circuit is not so formidable as appears on first glance at the block diagram; the complete circuit utilizes only two tube envelopes and a vibrator.

Impedance Considerations

To develop an expression for input impedance and for voltage transformation ratio observe that, with the vibrator arm closed to the input side, the input to the ac amplifier is $e_{in} - i_1R_1$, while, with the arm in the other position, the input voltage is e_{in}. The result is a square wave of amplitude i_1R_1 at the input grid. Thus the following may be written:

(1) $e_o = i_1R_1K$, where K is the overall amplifier gain.

Also

(2) $e_{in} = i_1R_1 + (i_1 + i_2)R_3$

(3) $e_o = i_2R_2 + (i_1 + i_2)R_3$

From (1) and (2)

$$i_1 = \frac{e_o}{R_1K}$$

$$i_2 = \frac{e_{in} - e_o\left(\frac{R_3}{R_1K} + \frac{1}{K}\right)}{R_3}$$

which may be substituted in (3) to give

$$(4)\ \frac{e_{in}}{e_o} = \frac{R_1R_3K + R_1R_2 + R_1R_3 + R_2R_3}{R_1R_2K + R_1R_3K}$$

also

$$(5)\ \frac{z_{in}}{2} = \frac{e_{in}}{i_1} = \frac{e_{in}}{e_o} \times R_1K = \frac{R_1R_3K + R_1R_2 + R_1R_3 + R_2R_3}{R_2 + R_3}$$

The factor 2 arises because the current i_1 flows only half the time.

Eq. (5) can be simplified somewhat by physical consideration. Resistance R_3 is necessarily quite small (of the order of a few hundred ohms) to provide reasonable efficiency in the demodulation process at the ac amplifier output. It is also desirable that R_2 be much smaller than R_1 (for the case of a current amplifier) so that most of the current flowing in R_3 to produce a potential of $(e_{in} - i_1R_1)$ across it will be supplied from the dc amplifier output. Eq. (5) may thus be simplified with very little error to

$$(6)\ z_{in} = \frac{2(R_1R_3K + R_1R_2)}{R_2}$$

The values used to obtain an input impedance of roughly 16 megohms and a voltage gain of about 450 are as follows:

$R_1 = 500K$ $R_3 = 250$
$R_2 = 10K$ $K = \text{approx. } 500$

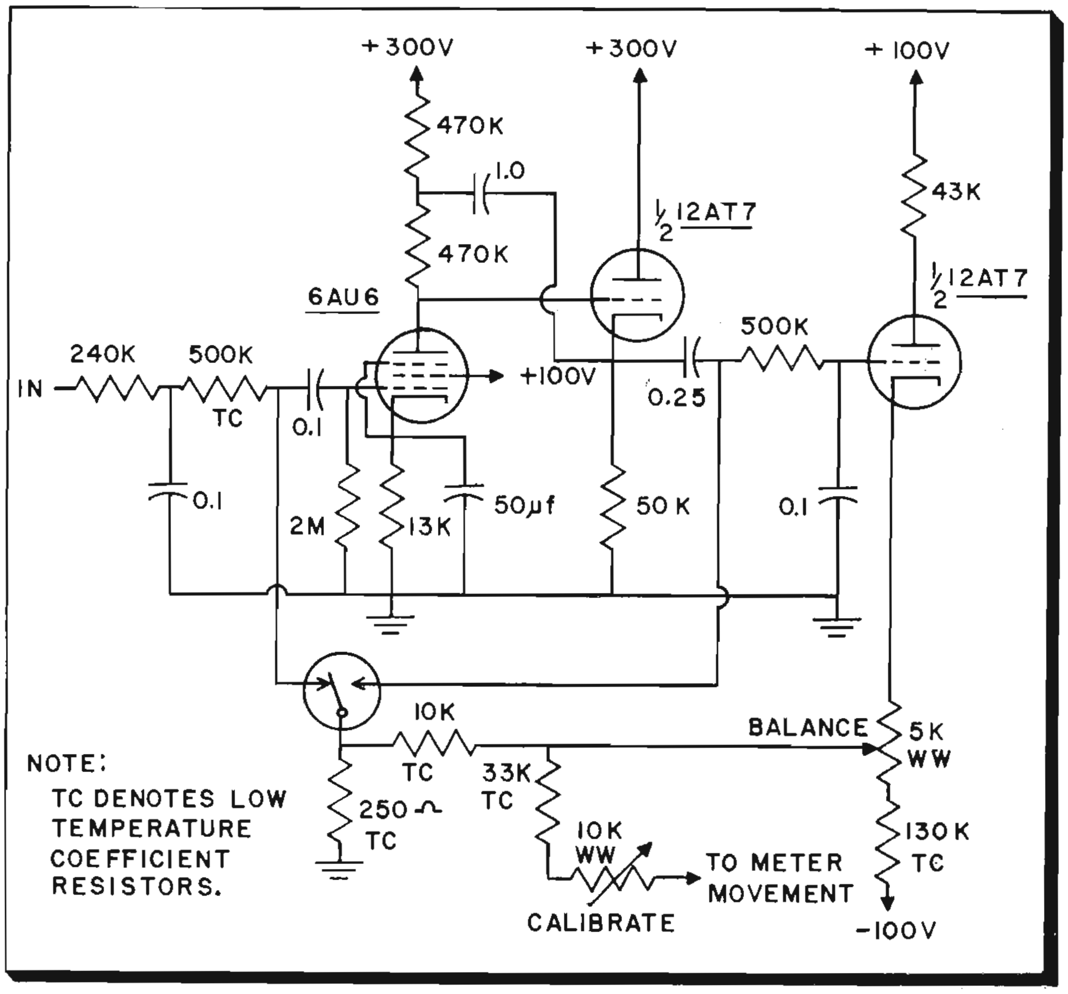
This by no means represents the limit of the circuit. No special effort was made to maximize the impedance, a value of 16 megohms being more than adequate for the purpose.

Circuit Description

The circuit used is shown in Fig. 2. The input resistance consists of a 500 kilohm resistance. In series with the input is an RC filter which reduces the

(*Continued on page* 141)

Fig. 2: VTVM circuit employs 6AU6 ac amplifier and 12AT7 dc amplifier, presents 16-megohm input



*Mr. Bradley is presently with Hillyer Instrument Co., 54 Lafayette St., New York 13, N.Y.

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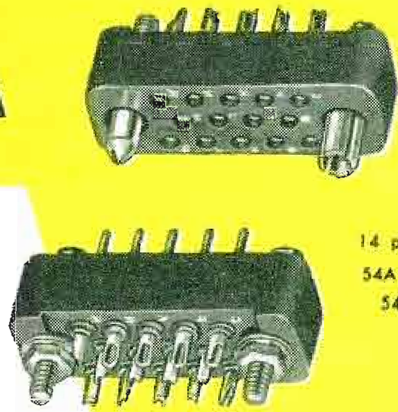

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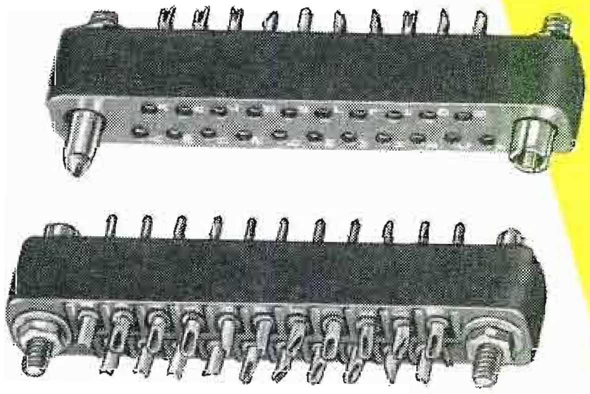

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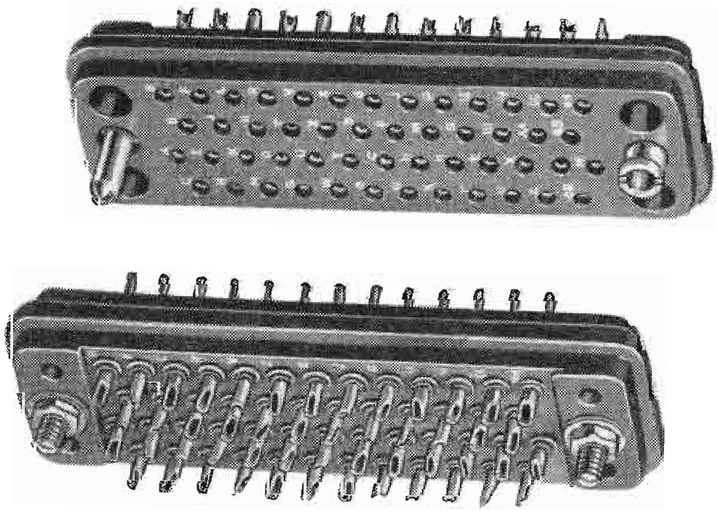

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WASHINGTON
News Letter

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

MORE REALISTIC—Under the administration of President Eisenhower the FCC will be more realistic and far less subject to pressures on its functioning and broad planning to advance the growth of television. While the President at the press deadline of this column had not disclosed whether or not veteran Commissioner Rosel H. Hyde will be designated Chairman, it is regarded as almost a certainty and Commissioner Hyde has already demonstrated his administrative and executive capabilities when he has been Acting Chairman of the Commission on numerous occasions in the past five years. In the case of the controversy over color television, particularly, the FCC will analyze the situation in a down-to-earth manner and instead of more time-wasting and lengthy hearings as in the past will render its decision on the basis of full technical studies of the RCA, CBS and other systems. That approach would serve the interests of the television-using public.

MANY TV PROBLEMS—Besides concentrating on the approvals of the new UHF television stations, the FCC has before it many highly significant policy-making subjects in the television field. The plan of the motion picture industry to establish the television transmission of films and special events to the theatres came before the Commission in a renewal of the lengthy hearings on that problem on Jan. 26. There is also the proposal of community antennas for TV and whether or not such facilities should be under FCC regulation and another issue is the subscription television plans of four or five organizations such as phonevision, telemeter video and subscription-vision. Another troublesome question is the plan of the Belknap Associates to establish their own radio relay system to transmit television programs to community antenna systems in the Midwest and Southwest.

OUTLOOK BRIGHT—Since the electronics-radio "weapons" are so vital to the combat effectiveness of the armed services, the economy program of the administration and Congress is not anticipated to slash deeply into the appropriations required for the production of new electronics-radio-radar "tools" for the Army, Air Force and Navy, particularly the requirements for replacement and modernized apparatus for the military aviation services. The buildup of the Air Force and Navy's aviation strength means a continued huge production of the latest electronic-radio devices, while for the Army Signal Corps and the Navy's fleets and shore establishments there will be necessarily substantial procurement of replacement equipments and components. Since the manufacturing leadership of the industry has predicted a total production of more than $6 billion, both military and civilian, for this year.

OPPOSITION TO THEATRE TV—Most potent opposition to the plan of the motion picture industry to obtain substantial spectrum space for film theatres television is coming from two major groups in the mobile microwave fields. The American Petroleum Institute's Central Committee on Radio Facilities and the National Committee for Utilities Radio have disclosed that they are presenting to the FCC in the theater TV hearings extensive testimony and significant exhibits to substantiate their positions that microwave systems are vital to their operations and are most important to the national mobilization implementation and the nation's economy. With the leading electronic-radio manufacturers such as General Electric, RCA, Philco, Federal Telephone & Radio, Raytheon and Motorola engaging in extensive development and production programs in microwave the views of these major industries—as well as that of the military services—undoubtedly are to receive the most serious consideration by the FCC.

BROADBAND REVIEW—Emphasizing the "compelling" need for further expansion of common carrier mobile radio services, the Bell Telephone Laboratories has asked the FCC to reconsider its decision of July, 1951, which refused the Bell petition for the allocation of 450-470MC to broadband multi-channel radiotelephone systems. The Bell Laboratories cited the imperative needs for expanded public mobile telephone service in the seven largest cities and in the service areas of 22 other large cities. The broadband system will be a coordinated system in which the individual communication channels operate side by side within a continuous band of frequencies, the Bell Laboratories stressed to the FCC. Unlike single channel uncoordinated operation, the Laboratories pointed out, the broadband system will not require additional frequency separation between adjacent channels when the channels are employed in the same area without geographical separations. The FCC was expected to decide that a hearing on the plan would have to be conducted again as it was during the television allocations proceeding.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington, Editor


taged scenes | into a ... fond of paying tribute to his ... (Continued on page ...)
mantic spar- | genius, the funny blond wig which
ng highballs,

RADIO AND TELEVISION

By JOHN CROSBY

Music and Pictures

is attempting with considerable h pictures on television what he well with sound on the radio. After all, is not ot—or shouldn't e show, though ements of both.

g from radio to ced a formidable was essentially a stral show. Voices s don't lend them- graphy very well. couldn't transform an ordinary song- t without ruining f his show which ously built up over dio.

• • •

think, solved the problem very well. work on the Waring show is, in the f the word, art photography. The dif- ween it and the other kind of art pho- simply that the pictures move. But combination of light and shadow, of

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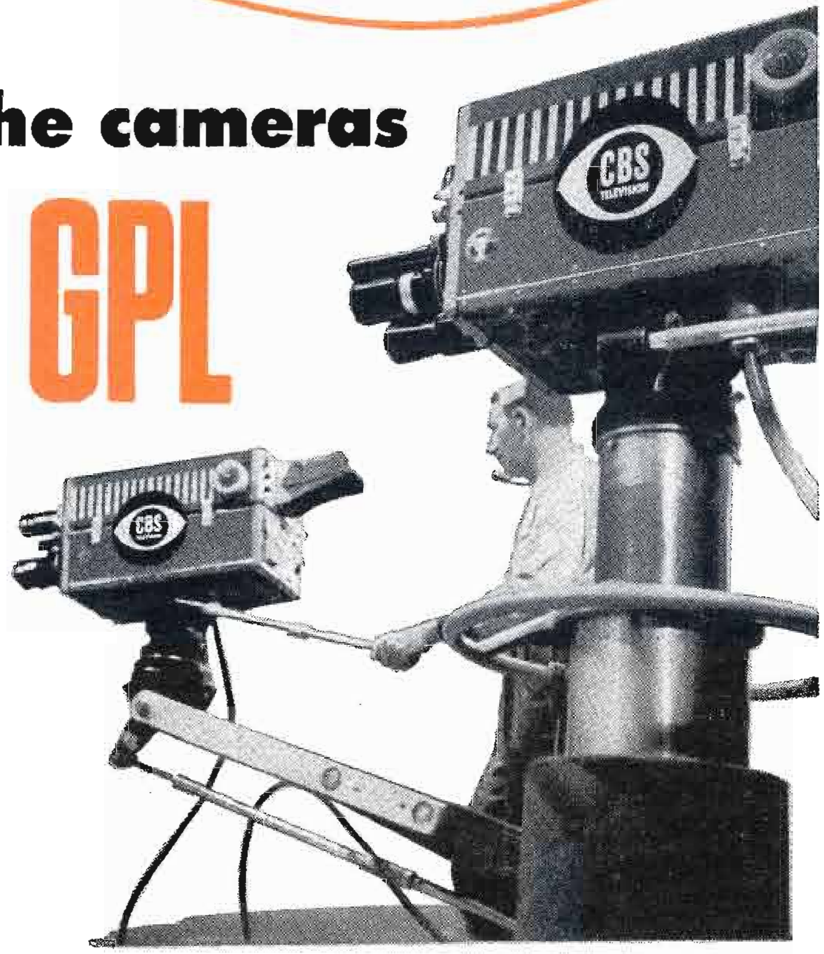
John Crosby

"camera work on the Waring Show is ... art photography"

JOHN CROSBY

and the cameras are GPL



Columnist John Crosby, discussing not electronics but end results on the screen, calls the Waring show on CBS Television "pure television." Such results come from three things: Waring imagination, CBS Television techniques, and GPL camera chains.

> *"The pictures move . . . are a combination of light and shadow, of form and substance that catch and hold the eye."*

A GPL extra in engineering accounts for much of this. Camera and operator may be moving on a boom in a 3-dimensional pattern. Yet the operator has only to concentrate on aim, while the director at the Camera Control Unit adjusts the iris for light and shadow.

> *"The cameras seem to roam at will on that show with a fluidity and grace almost never found in the movies."*

That fluidity is engineered into GPL cameras. Dual focus knobs, push-button lens change with automatic focus adjustment, precision pan and tilt motions – all these enable camera men and directors to capture the full scope of a show. Fantasy or stark realism, sports in sunlight or drama in stage shadows . . . GPL cameras put top quality pictures into the line.

Whatever your type of operation, whether you need one chain or six, investigate these cameras designed for *modern* television. Rugged but lightweight, they are easily interchangeable between studio and field. Circuit design guarantees consistent high quality.

Station owners like their economy; camera crews like their velvet smoothness and operating ease; maintenance men like their long service life.

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

Microwave Interferometer

(*Continued from page* 88)

the ⅝-in. bore and the 40-mm gun. The results indicated that the distance between the muzzle and the waveguide was a function of the bore of the gun, with larger distances required for the larger diameter bore. The effect of a spherical wave front impinging on the muzzle is shown in Fig. 3. The open-ended waveguide is not a point source; hence, a distance of 100λ is not required for a plane wavefront. However, since the waveguide-to-muzzle distance required for single mode excitation was a function of the gun bore, an absolutely plane wavefront was not essential.

One explanation of the discontinuity of the patterns is the existence of spurious modes. Another explanation is a multiple path transmission within the gun barrel. A line drawing representation of the latter is

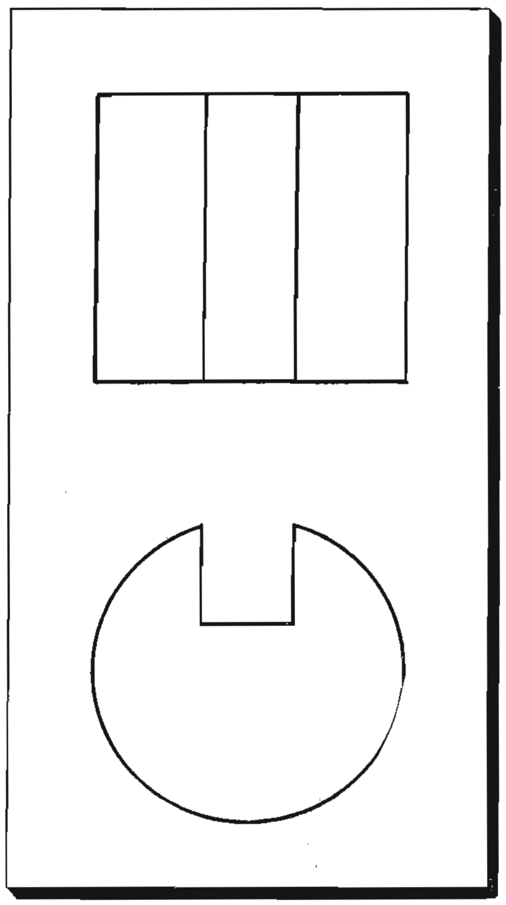
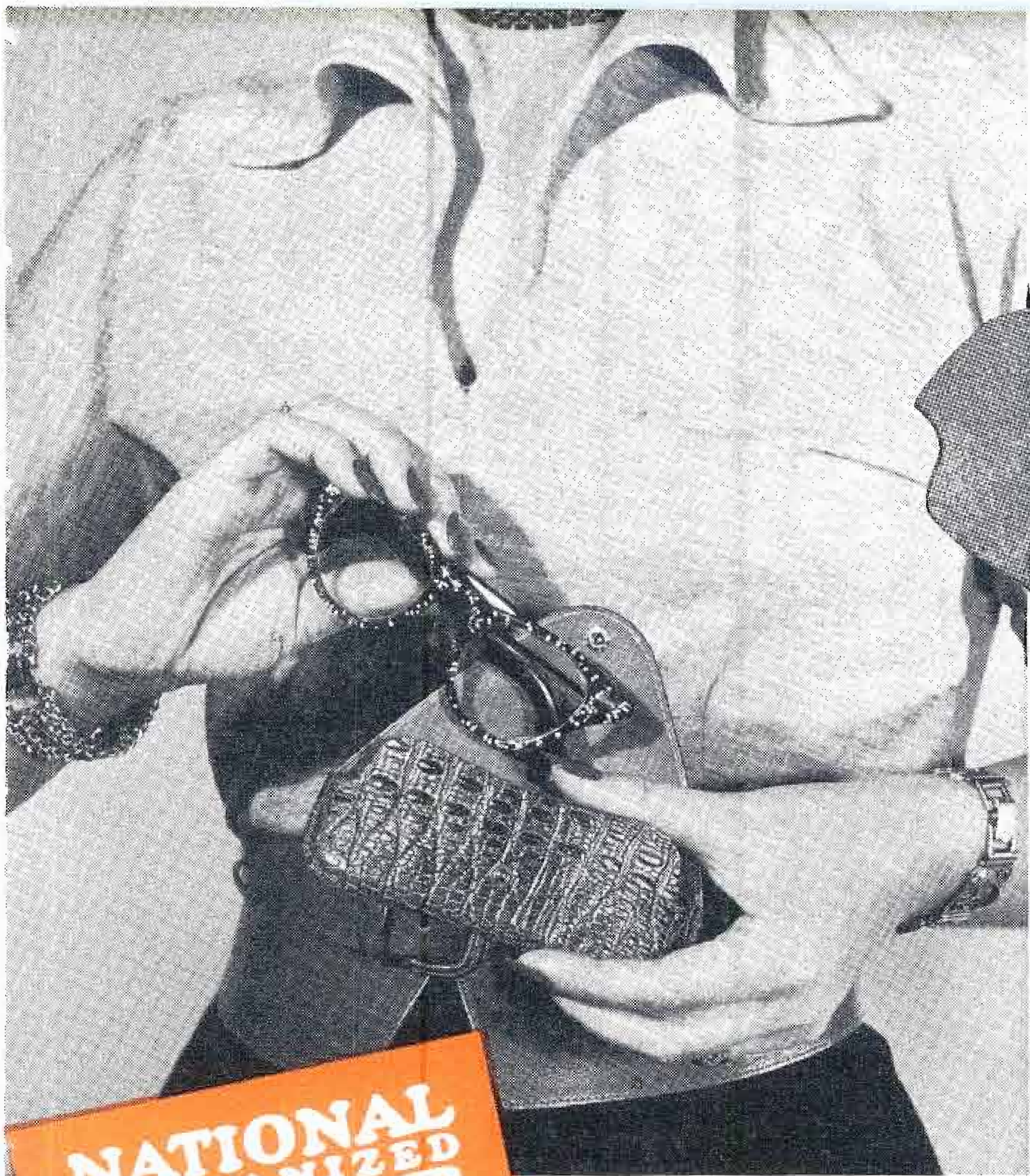


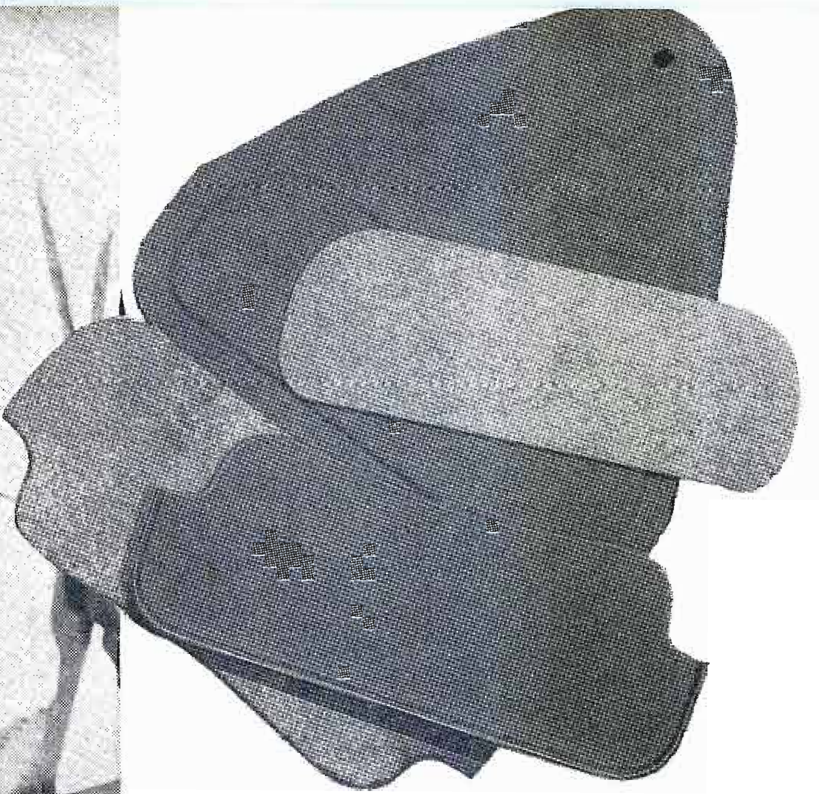
Fig. 7: Cross-section of projectile which is slotted to magnify effect of propellant gas

shown in Fig. 4. If the radiation can be considered as originating from a small source, the wave front is spherical when it reaches the gun barrel. As a result, the transmission down the gun barrel will be along several paths.

When the waves return to the waveguide, the resultant waveform will be the vector sum of the returned energy from the various

(*Continued on page* 104)





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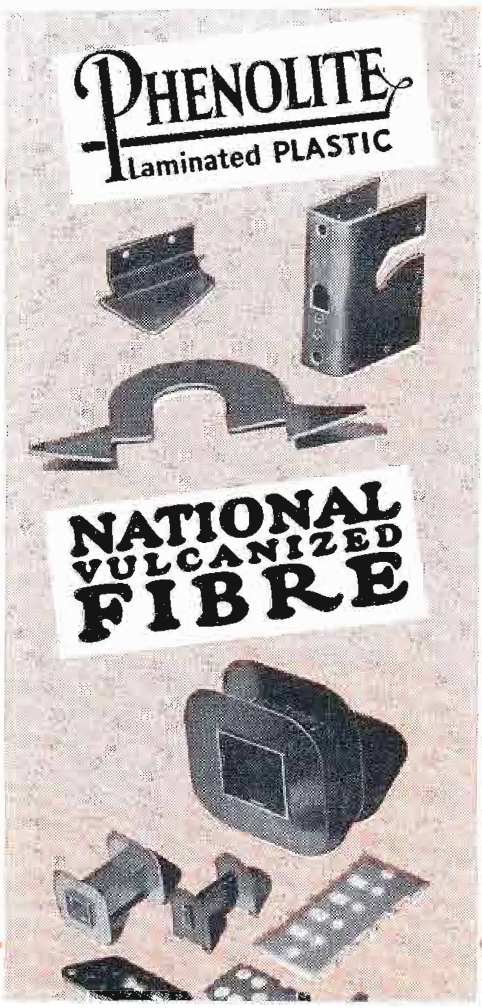

This practical use of National Vulcanized Fibre by American Optical Company in their attractive spectacle cases is typical of the countless contributions National Vulcanized Fibre—*the material of a million uses*—makes to industry and business.

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paths. This vector sum of the r-f energy, when it enters the waveguide, will be a function of the energy received from all the paths of transmission which change as the projectile moves. When this vector sum is combined with the energy returned from the fixed short, the resultant cannot be easily correlated with the projectile position.

Prior to shipment of the microwave interferometer to Aberdeen Proving Ground for tests with an actual gun, the individual units were tested under simulated conditions.

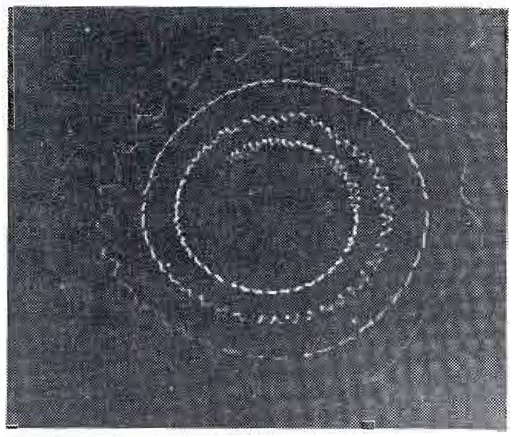


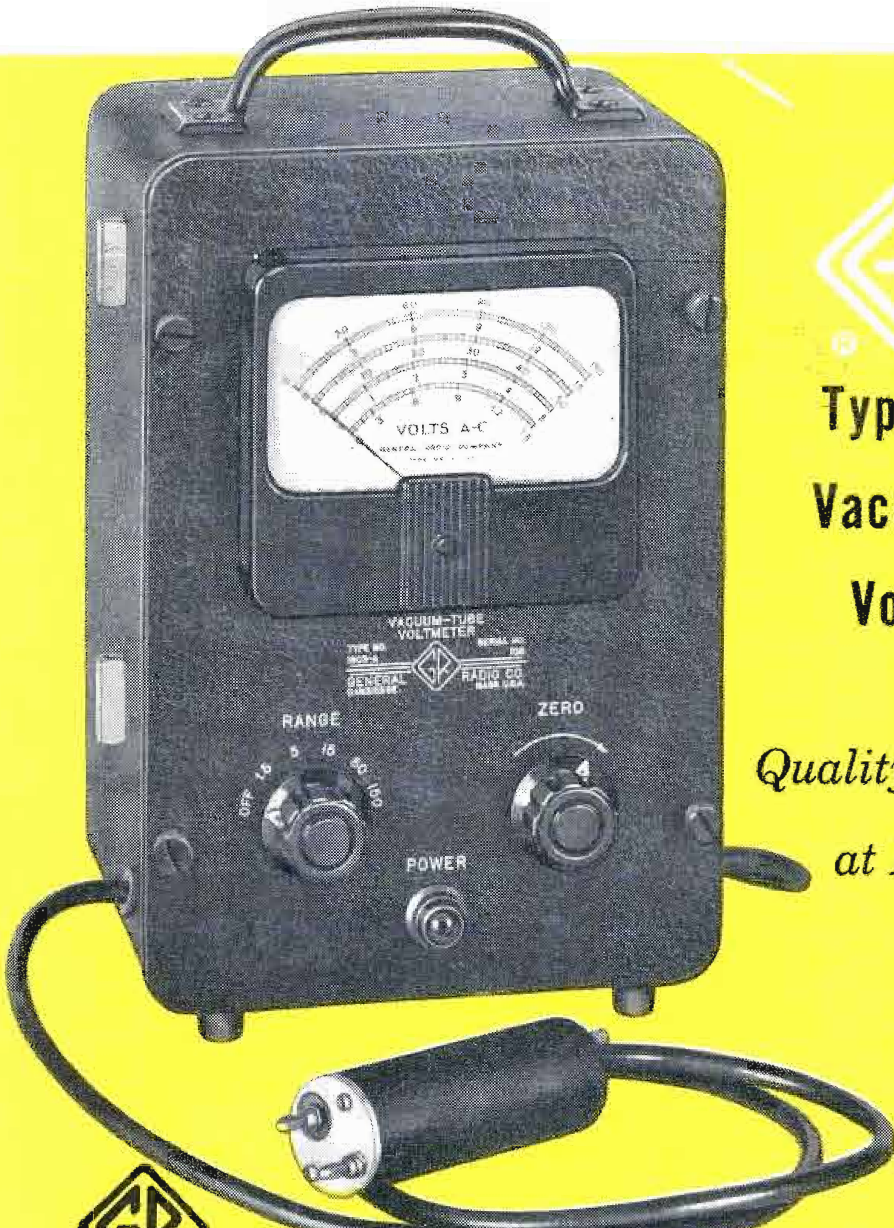
Fig. 8: Slotted projectile displacement record

These tests were divided into three parts: The r-f link, the indicator, and the recoil recorder.

To simulate the conditions in the r-f link during a firing, the motion of the projectile was simulated by having a projectile pulled from the muzzle to the breach of the gun by an electric motor. Flat nose projectiles were made for this purpose of which one type had a r-f choke back of the flat nose and the other did not. From the projectile displacement records obtained, it was determined that the choke used as a definite short was not required. The klystron power supply, transmitter unit, decade amplifier, brush recorder, gun barrel and projectile were connected as shown in Fig. 2. The output of the crystal detector was amplified in the decade amplifier and registered by the Brush recorder. Although the motion of the projectile was reversed and velocity was very low, the r-f conditions present were similar to those attending a normal firing.

Inasmuch as the velocity is determined by the distance moved per unit of time, the distance along the gun barrel corresponding to one wavelength of r-f energy must be established. To determine whether or not the theoretical value of the r-f wavelength in the barrel may be used, each different bore must be calibrated. This can be done by using

(*Continued on page* 106)



Type 1803-A Vacuum-Tube Voltmeter

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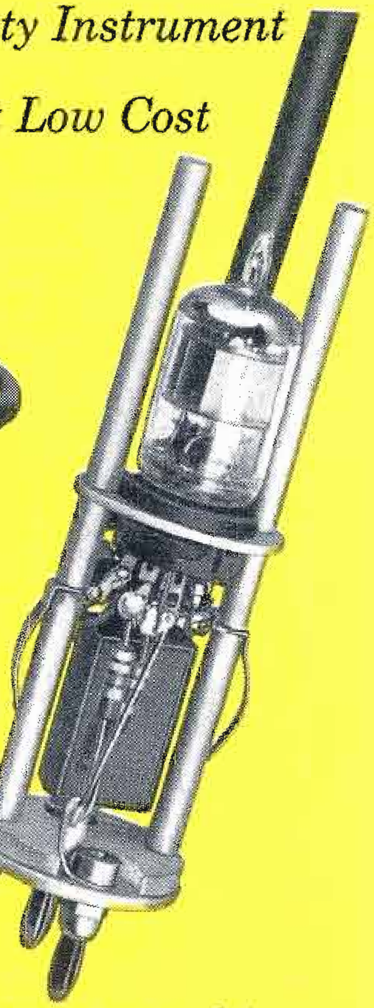
The Type 1803-A Vacuum-Tube Voltmeter fills the need for an easily operated instrument, of adequate range and accuracy, selling at a price within modest laboratory budgets.

This instrument is a standard vacuum-tube voltmeter devoid of frills; it has no d-c or ohm scales, but is a *superior* a-c voltmeter. It will measure voltages between 0.1 and 150 volts to a basic accuracy of 3% and at frequencies up to 100 megacycles. With the accessory Type 1803-P3 Multiplier attached to the probe, the voltmeter range is extended to 1500 volts over a 50 Mc. range.

This voltmeter is small and light in weight, has a completely shielded probe, a single zero adjustment for all five ranges and an internal power supply operating from ordinary 50-60 cycle, a-c lines. For greatest accuracy, there are four meter scales covering the complete 0 to 150 volt range. The cabinet is of welded, heavy gauge aluminum with rubber feet for either vertical or horizontal positioning.



The input voltage is rectified by one section of the twin diode and the d-c passed on to the grid of a triode in one arm of a balanced amplifier circuit. The other, "inactive", diode balances the effects of contact potential of the input diode. The balanced amplifier circuit insures minimum shift in calibration with line voltage changes.

SPECIFICATIONS

Accuracy—*3% of full scale for sinusoidal voltages on all ranges, subject to frequency correction above 50 Mc. (Correction chart supplied)*

Input Impedance—*7.7 megohms in parallel with approximately 10 μμf; the parallel resistance increases at higher frequencies*

Power—*105 to 125 volts or 210 to 250 volts, a-c, 50-60 cycles*

Accessories Supplied—*Type 274-MB Plug, pair of 30-inch test leads, and two alligator clips to facilitate connections*

Dimensions—*(Width) 7¼ x (Height) 11¾ x (Depth) 6⁷⁄₁₆ inches*

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U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes*

a section of a gun barrel and a projectile attached to either a depth gage or to an optical bench. After setting up the transmitter in the normal manner, the output of the detector may be read on a microameter for changes in position of the projectile over a total length of at least 8 cm, in increments no greater than 1 mm.

The results of a typical calibration are plotted as detector output vs. projectile movement. The experimental r-f wavelength in the gun barrel may be determined from this graph. It should be pointed out that the maxima occur every time the projectile moves one-half of the r-f wavelength. The value obtained from the graph is then compared to the theoretical wavelength in the barrel. This may be determined from the equation: $\lambda_b = \lambda_o / \sqrt{1 - (\lambda_o/\lambda_c)^2}$ where λ_o is the free space wavelength. $\lambda_c = 3.41a$ where λ_c is the cutoff wavelength of the gun barrel in which "a" is the radius of the bore.

All units in the above equations must be in the same system of dimensions. The theoretical and experimental wavelengths must be obtained for a minimum of two frequencies, separated by at least 500 MC. If the experimental and the theoretical values do not agree within 0.5%, the experimental value of the wavelength in the gun barrel must be used; hence, the gun barrel must be calibrated for every frequency used.

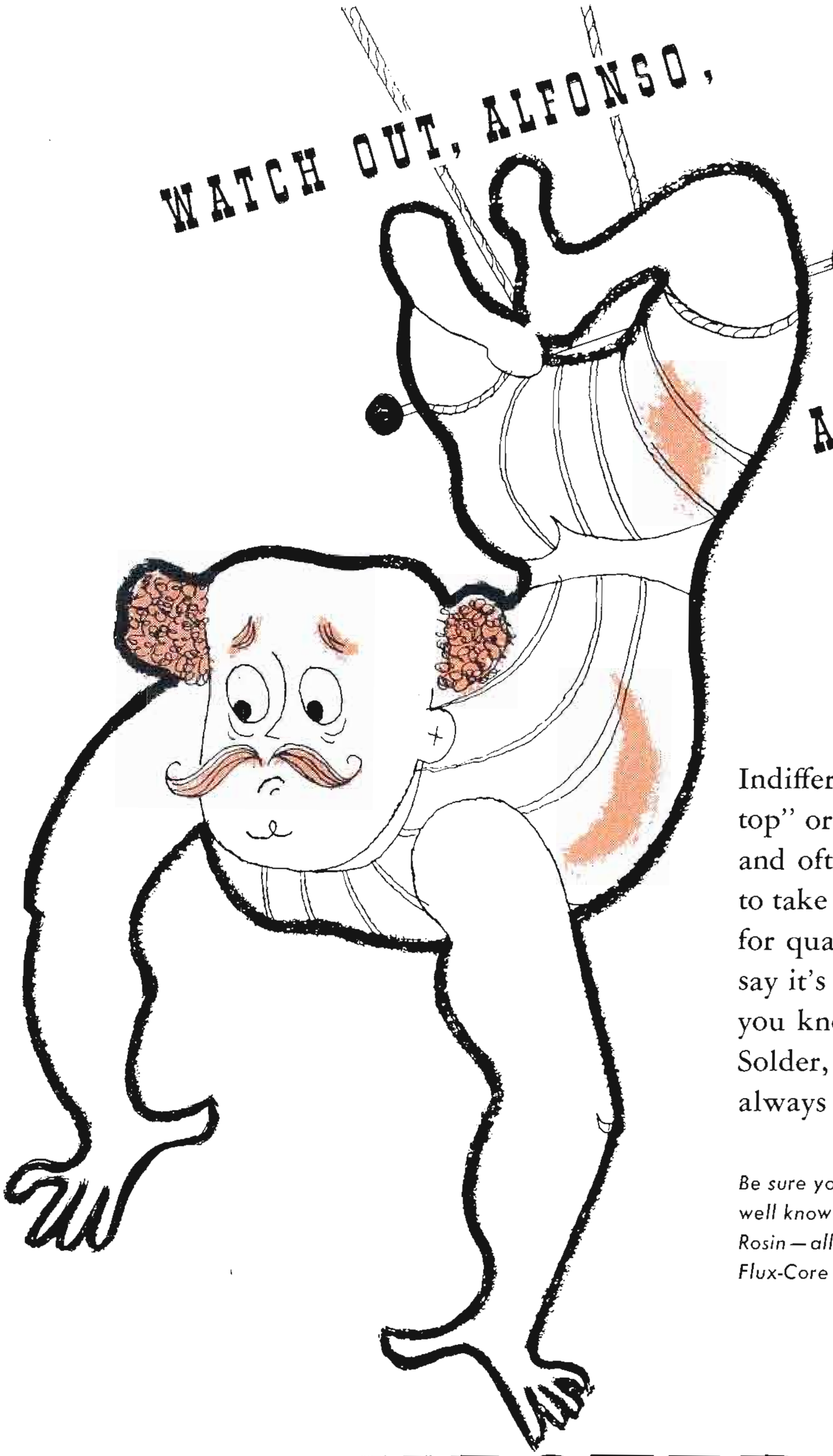
Constant-Frequency Oscillator

In an actual firing, the acceleration of the projectile causes the output of the crystal detector to vary in frequency from 0 to an estimated 500KC in a time interval of approximately 1 millisecond. No attempt was made to build an electronic oscillator which would change its output frequency at that rate. Consequently, a constant-frequency oscillator was used to simulate the output of the crystal detector. A series of frequencies between 500 cycles and 1 MC was employed. The trace on the CRT was photographed for each frequency. These photographs were examined for fidelity with respect to the input signal.

During the initial period of application of the microwave interferometer to an actual gun, engineering consultation by the Martin Co. was furnished to the Aberdeen Proving Ground. Because the r-f horn was destroyed each time, Aberdeen developed a method to manufacture this horn cheaply and quickly. The

(*Continued on page* 108)

WATCH OUT, ALFONSO, ONE TUMBLE'S ALL IT TAKES...



Indifference—whether it's under the "big top" or on the production line—is inexcusable and often fatal. You simply can't afford to take chances with a hard won reputation for quality performance. That's why we say it's a pretty good rule to stick to a solder you know and trust . . . time-proved Kester Solder, constant in solder alloy and always a consistent flux formula.

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method developed consisted of filling a mold in the shape of the r-f horn with Woodsmetal. This form was covered with silver paint and then electroformed to a thickness of 0.015 in. The Woodsmetal was removed by dipping the horn in hot water.

Following installation of the microwave interferometer, records were obtained with a low velocity projectile. During most of the tests special projectiles were used which had a large flat nose. However, when a 0.3-in. bore gun was used, it was found that the projectile wobbled excessively during its passage down the gun barrel. This was eliminated by attaching a small flat aluminum disc to the projectile nose. One of

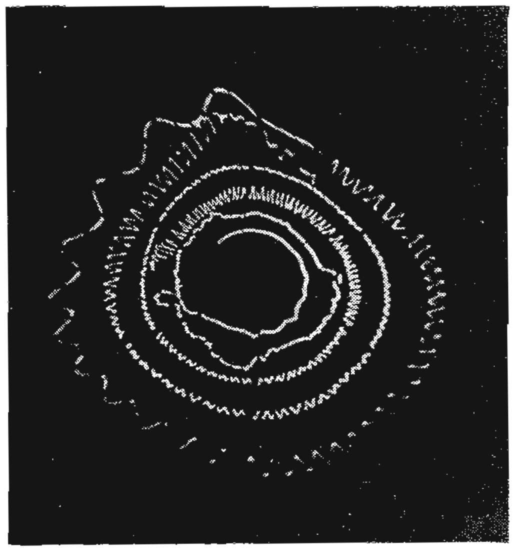


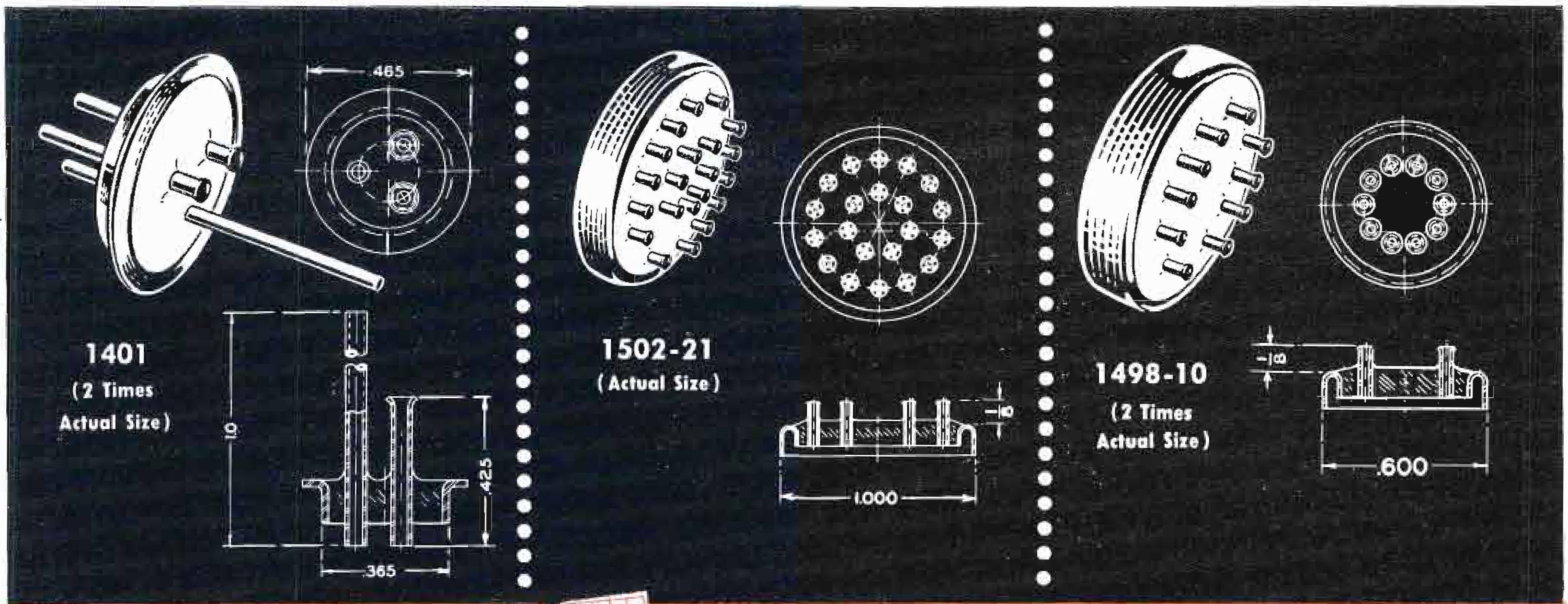
Fig. 9: Record of obturated projectile

the records is shown in Fig. 5. Next, records were obtained with higher velocity projectiles. To clock the start of the projectile's motion, a probe was inserted in the barrel immediately ahead of it. When the projectile touched the probe, a pulse was obtained which started the sweep of the indicator unit.

From Fig. 6 it can be seen that a good record was obtained of the projectile motion from its initial position in the barrel to a random position down the barrel. At this position, enormous attenuation of the signal occurred. The signal temporarily reappeared at projectile positions farther down the barrel. The first step in investigating this phenomenon, was to place a probe on the horn to ascertain the time it took to blow off with respect to the time that elapsed before the signal was lost. It was found that the signal disappeared while the horn was still in position.

Rapid variations in the signal level were attributed to the propellent gases which managed to flow past the non-obturated projectile. To magnify the effect of the propellent gases, a projectile was slotted in the man-

(*Continued on page* 110)



No Matter What Your Needs Are in

Tubular FEED-THROUGH SEALS,

HERMETIC Can Satisfy Them

Specialist engineers and quality production have enabled **HERMETIC** to develop the Tubular Seals shown and many others with these advantages:

- *Labor saving due to elimination of 1 solder joint per terminal*
- *Parts saving because leads can be brought through from equipment to final terminal board connection*
- *Higher current carrying capacity through use of copper leads*
- *Space saving, both inside and outside unit, resulting from minimum lengths of tubing*
- *Available in extra lengths for current carrying and evacuation*
- *Wide variety of sizes, layouts and tubings for every application*

Pictured are typical Tubular Feed-Throughs from 1.00″, 21 tubes (1502-21) to 1/8″ single tube (1470) and other standard and special designs.

- **Write detailing your problem for immediate attention, and ask for your FREE copy of HERMETIC's informative brochure, the most complete presentation ever offered on hermetic seals.**

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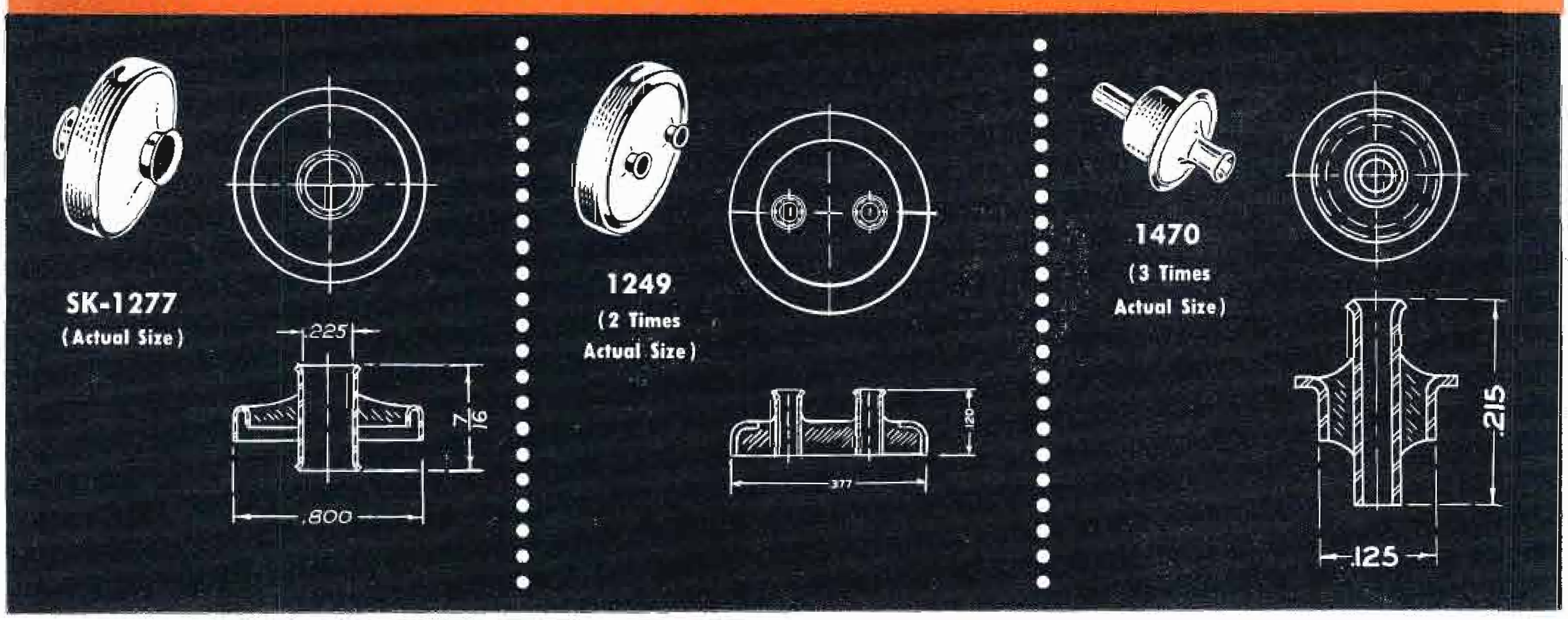
HERMETIC SEAL PRODUCTS CO.
33 South Sixth Street, Newark 7, New Jersey

• FIRST AND FOREMOST IN MINIATURIZATION •



ner shown in Fig. 7. The record (see Fig. 8) for the motion of this projectile showed the signal amplitude varying in a periodic manner. Additional slotted projectiles were then fired and similar records obtained. These indicated that the variation in signal amplitude was due to the ionized propellent gases, which got ahead of the non-obturated projectiles.

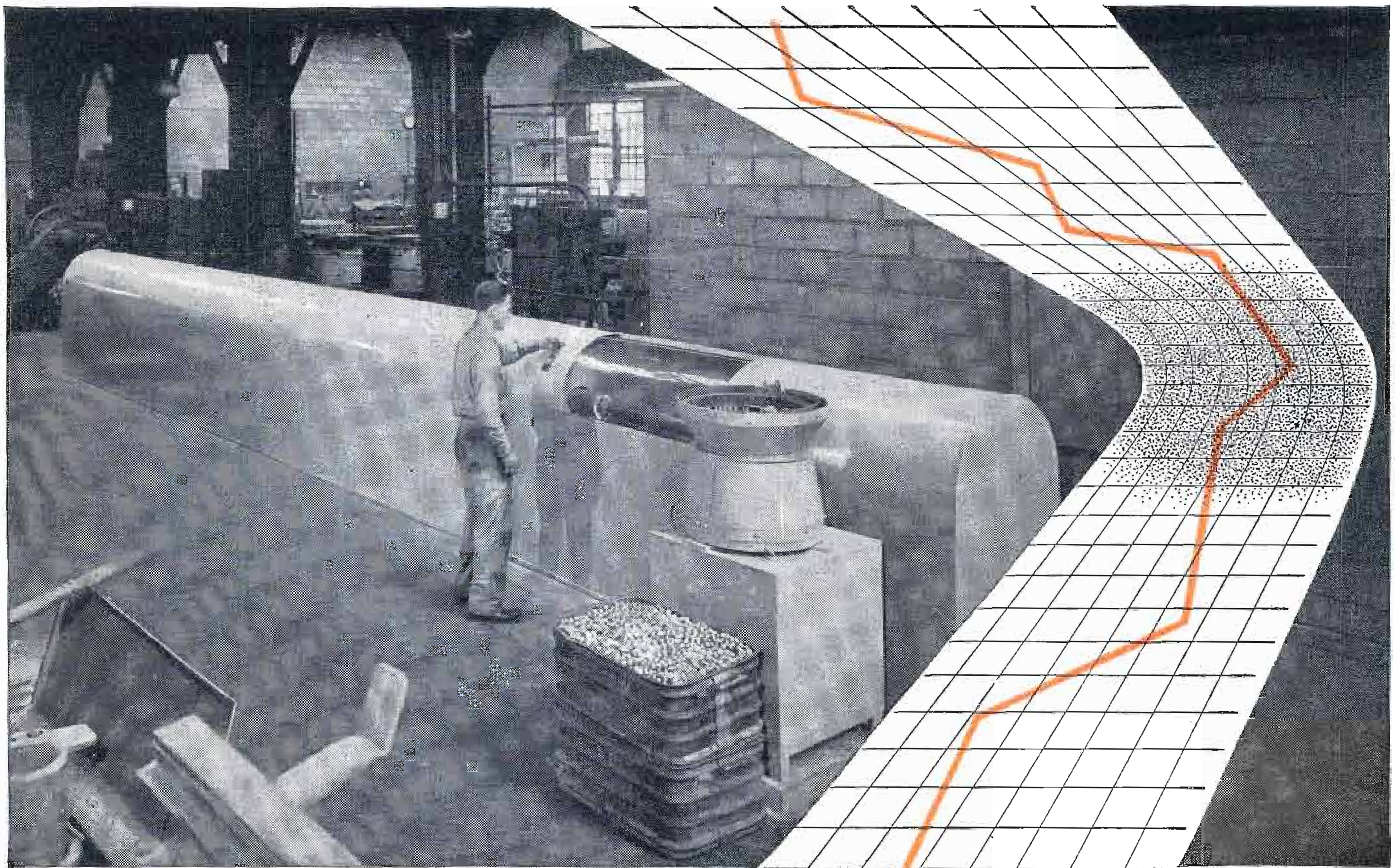
To substantiate this theory, a number of obturated projectiles were fired. The records (see Fig. 9) showed that all of the projective motion occurring while the horn was in normal position could be continuously charted. Supplementary information placed on the record showed that the horn was displaced by the shock wave preceding the projectile, and that the shock wave preceded the projectile by an appreciable distance.

A recapitulation of the field tests has shown that this developmental model has definite limitations. A better method of presentation seems advisable to facilitate reduction of data—which calls for further development work. On the whole, however, Ordnance engineers agree that the project has proved more extensively successful than originally anticipated. These findings, with respect to internal ballistics measurements, promise to have a basic effect upon gun design and future propellants.

Transistors Replace Tubes in Hearing Aids

Using transistors produced by Raytheon Mfg. Co., the Maico Co. has announced the introduction of a new hearing aid which eliminates vacuum tubes and batteries. Three transistors replace the vacuum tubes, and a special miniature battery is used instead of two standard batteries. This initial commercial application confirms TELE-TECH's prediction (Dec. 1952, p. 37) that "first real production along these lines will probably be for hearing aids. According to Maico's president, Leland A. Watson, the firm will be able to manufacture several thousand hearing aids monthly within six months. They will be distributed through the company's 170 outlets in the U.S., and eventually through the firm's 100 foreign outlets. While no definite price has been set as yet, the 2.5-oz. aids are expected to be well above $200. The miniature batteries, good for 75 hours, will cost 25 or 30 cents each.

An earlier application of transistors to hearing aids was demonstrated on Dec. 29, 1952, by Sonotone Corp. The device shown at that time had a transistor added to the power stage, and used standard batteries.



An automatic heat treat machine. Production is about 3 times that possible with manual methods while quality is held within very close limits.

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KEEP COSTS DOWN ... *through automatic production that gives quality control*

Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

Today, Crucible can offer lighter, magnetically stronger Alnico magnets because of these automatic production techniques developed over the sixteen years that we have been producing the Alnico alloys. And behind our familiarity with permanent magnets lies more than 52 years' experience with specialty steelmaking. Let us advise you on your magnet problem.

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52 *years of Fine steelmaking*

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STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Powdered Cores

(*Continued from page* 71)

which is proportional to permeability, magnetizing force, inductance and frequency, the coefficient of proportionality *a* may be called "hysteresis loss coefficient" so that $R_h = \mu\ HLf\ a$, this loss is usually negligible at high frequencies above 200 KC at low H[10]. R_c is the resistance due to the magnetic viscosity of material the loss being called "residual" or "after effect loss" and is proportional to permeability, inductance and frequency, loss resistance coefficient *c* being called "residual so that $R_c = \mu\, L\, f\, c$; the term R_e represents eddy current loss resistance, which varies as square of frequency and may be similarly written as $R_e = \mu L f^2 e$ where *e* is the coefficient depending on particle size, its conductivity, interparticles insulation and packing factor[11].

Residual Loss

Until recently the residual loss was considered linear with frequency. Recent investigations[12] and the work done by the writer, particularly with ferrites and powdered ferrites (IRN-8-9) indicate the presence of a term of the loss of similar nature, but proportional to the cube of frequency. No matter how small loss coefficient is (10^{-16} to 10^{-18} for ferrites and powdered cores) at the extreme end of high frequency spectrum the loss becomes prominent. Similarly we may write $R_g = \mu\, L\, f^3 g$ where g is the coefficient of this loss. We may re-write the expression (4) into:

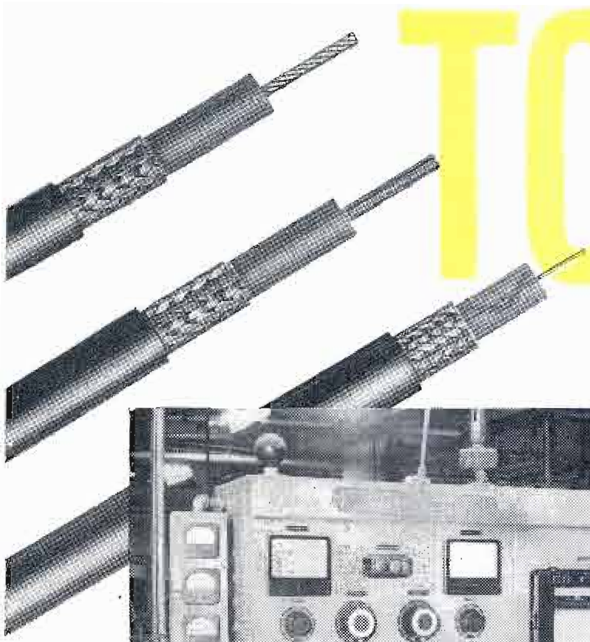
$$R_i = \mu L(aHf + cf + ef^2 + gf^3) \qquad (5)$$

and for high frequencies neglecting R_h and dividing by μLf we get:

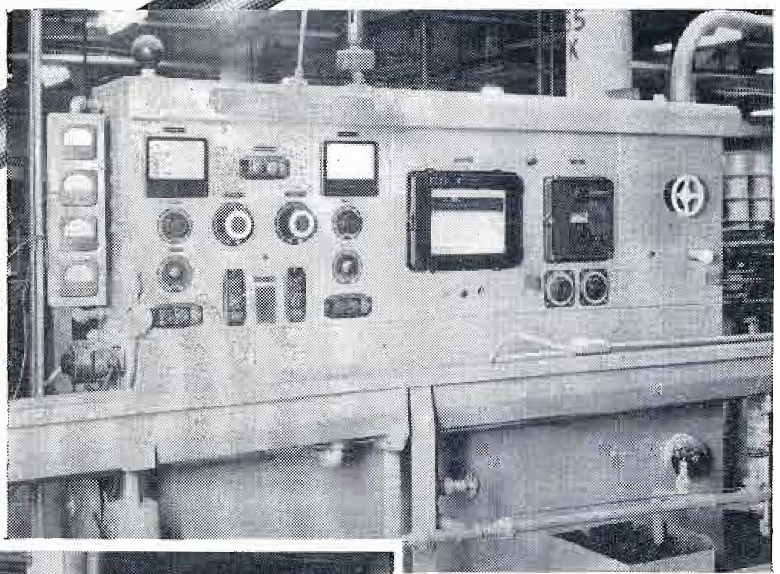
$$R_i/\mu Lf = c + ef + gf^2 \qquad (6)$$

Note that since c, e and ge are constants, at a given frequency $R_i/\mu Lf$ = Const. Bearing in mind that $R_i/Lf = 2\pi Q$ we arrive to μQ = Const. as stated before. It is becoming customary to express loss characteristics in this term $R_i/\mu Lf$ which presents a loss curve when plotted against frequency. Such curve may be graphically analyzed to obtain the values of c, e and g coefficients. Knowing them one can easily calculate the insertion loss resistance of a magnetic material at a desired utilization (μ_{eff}), inductance and frequency. This of course does not take into account the losses of the coil per se, which are considerably augmented by the presence of iron, as the eddy current loss in the copper and dielectric loss (leakance loss) both are increased con-

(*Continued on page* 114)



TOPS in transmission line for HF • VHF • UHF



Federal's "Precision Production" is assured by this electronic panel board which controls diameter and speed of cables during extrusion.

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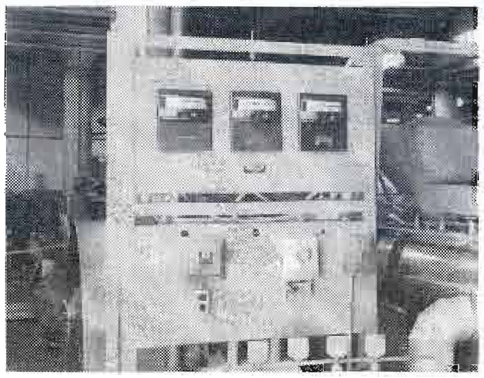

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Why Federal Cables are SUPERIOR

- **CONDUCTORS**—meet highest ASTM standards
- **DIELECTRICS**—of *stabilized* polyethylene
- **BRAIDS**—meet highest ASTM standards
- **JACKETS**—of latest developments in vinyl and polyethylene

Every Federal Cable Fully Tested for:

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- Continuity
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In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

siderably. An approximate formula is given by Welsby[13] and a recent General Aniline Works bulletin[14] gives a graphical presentation of all the losses in a coil with core.

Therefore in measuring loss the use of coils should be avoided as their losses in the presence of iron cannot be ascertained. Coaxial line method has been recently adopted for loss evaluation, which generally requires elaborate precision equipment.

The writer used this method in connection with commercially available h.f. bridge employing closed short coaxial lines fully loaded with

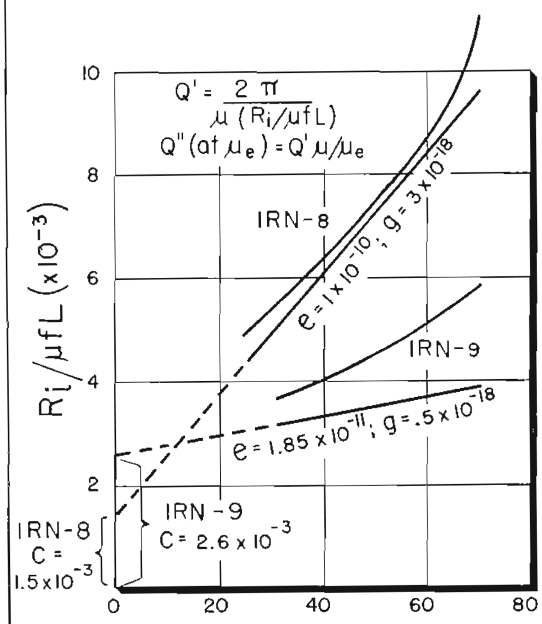

Fig. 4: Iron loss in coaxial line

iron beads. One must be careful to limit the length of a "loaded" line not to exceed in length and in frequency the term $1/40\lambda\mu$ so as to avoid the presence of electrical field which will introduce the error due to dielectric losses. Such measurements and coefficients evaluations are shown on Fig. 3 for core made of carbonyl powder and Fig. 4 for ferrites IRN-8-9. Note the absence of eddy current loss and predominance of residual and g-loss in the ferrites.

Core Stability

This term may include several stability characteristics of the core material. Those which change with time, magnetic shock or temperature. Well designed cores should not have any active chemicals left in their body, which may cause a slow reaction which would change magnetic properties in time. The effect of cure temperature manifests itself by certain changes in magnetic properties which will disappear in a few days, unless accellerating heat treatment is applied for "aging."

Magnetic shock may occasionally

(*Continued on page* 116)

CORES by GENERAL CERAMICS

—high frequency, soft magnetic materials featuring —

- HIGH PERMEABILITY
- LOW LOSS
- HIGH EFFICIENCY
- LIGHT WEIGHT

Ferramic cores effect important savings in the size and weight of coils and transformers at the same time increasing efficiency and overall performance. They eliminate laminations thereby reducing assembly time and cost in many types of components. The advantage of Ferramics are so numerous and outstanding that adoption of this material has been rapid and broad in scope for both the improvement of existing designs as well as the achievement of basically new techniques. Call or write for information on how Ferramics can improve your product.

TABLE OF MAGNETIC PROPERTIES OF FERRAMICS

PROPERTIES	UNIT	A-106	B-90	C-159	D-216	E-212	G-254	H-419	H1-1102	I-141	J-472
Initial Perm. at 1 mc/sec	–	20	95	250	410	750	410	850	550	900	330
*Max. Perm.	–	100	183	1100	1030	1710	3300	4300	3800	3000	750
*Sat. Flux Density	Gauss	1500	1900	4200	3100	3800	3200	3400	2800	2000	2900
*Residual Mag.	Gauss	1000	830	2700	1320	1950	1050	1470	1500	700	1600
*Coercive force	Oersted	5.0	3.0	2.1	1.0	.65	.25	.18	.35	.30	.80
Temp. Coef. of initial perm.	%/°C	.15	.04	.40	.30	.25	1.3	.66	.80	.30	.22
Curie Point	/°C	300	260	330	165	160	160	150	125	70	180
Vol. Resistivity	ohm-cm.	$1x10^7$	$2x10^5$	$2x10^6$	$3x10^7$	$4x10^5$	$1.5x10^8$	$1x10^4$	$2x10^4$	$2x10^5$	$5x10^7$
Loss Factor: At 1 mcs/sec	–	.0005	.00016	.00007	.00005	.00008	.00008	.00030	.0004	.0003	.000055
At 5 mcs/sec	–	.0007	.0011	.0008	.0012	.002	.00075	.00155	.001	.005	.0004

*Measurements made on D.C. Ballistic Galvonometer with Hmax=25 oersteds. Above data is based on nominal values.

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STEATITE INSULATORS

occur in the application of cores (short-circuit, lightning, etc.) and its influence has been investigated[14] by applying a strong magnetizing force of 100-300 oersteds to the core and then measuring its properties. A temporary change in μ and Q were observed and recorded.

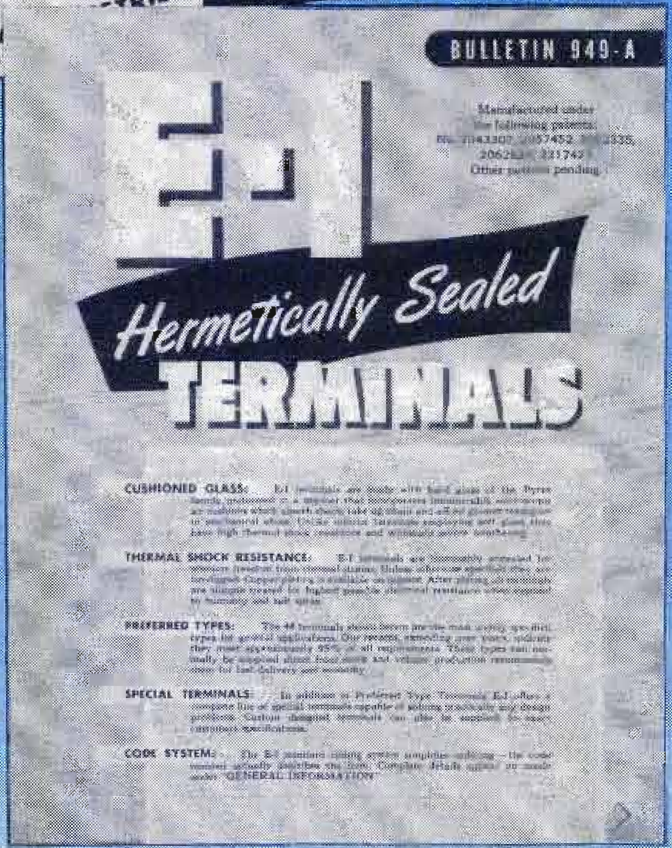
From the standpoint of stability, it is very important to learn the behavior of cores at elevated temperatures encountered under actual conditions. There, for various reasons (mostly of economy), the permissible temperature rise is limited to 180-200°F. maximum. Several other components: wax-impregnated coils, paper condensers, power transformer impregnation, plastic insulators and parts are *not* designed to withstand higher temperatures. In line with that there is no justification to operate powdered cores beyond those limits of temperature. We are therefore interested at present in the behavior of cores within this normal range up to +100°C. We should known what happens to μ and Q′ of the core material subjected to this wide range of fluctuations.

A Quick Test

First, we must consider a suitable testing equipment, second the behavior of the coil associated with core for testing and finally the core itself. For a quick test within a wide temperature change one can use almost any available instrument. Observing the change of inductance and dividing same by increment of temperature one may quickly compute the temperature coefficient. However we have found that this coefficient is not constant, as it increases with temperature. To study the minute changes caused by small temperature increments step by step, one requires more elaborate equipment. A beat-frequency oscillator method was found quite suitable for this purpose; it should be stable in operation, capable to operate within a wide frequency range. All its parts must reach an equilibrium manifested by zero beat, except one component which includes a coil and core under test in a heated compartment. The heat is applied to the sample which results in a change of inductance and consequent change in the frequency causing a beat note which can be measured for each successive temperature rise until 100° is reached. The oven is then switched off and cooling cycle starts, during which beat notes are observed at the same temperatures as in the heating cycle. A heat inertia

(*Continued on page* 118)

E-I Presents 48 Preferred Types of HERMETICALLY SEALED TERMINALS for 1953



Available now from stock!

Forty-eight types of E-I sealed terminals are now standardized as stock items for customer convenience. These items represent the most commonly used types based on customers' orders over the past years. As a group they are capable of solving all but the most unusual sealing problems with the combined advantages of low cost due to volume production, and prompt delivery direct from stock.

For complete information including mechanical and electrical specifications, call, write or wire today for the new E-I Bulletin 949-A. You'll find it a valuable addition to your data file.

E-I . . . your Headquarters for Hermetically-Sealed Multiple Headers, Octal Plug-Ins, Terminals, Color Coded Terminals, End Seals, etc.

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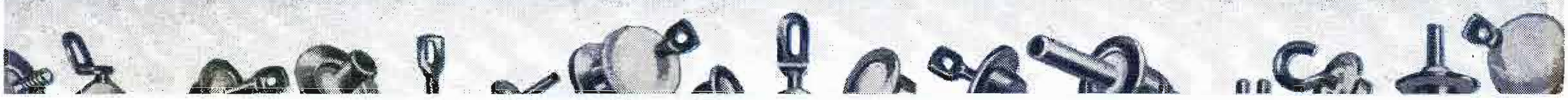


of the core causes considerable difference in readings so that an average reading for each temperature is computed. At a given frequency of the master oscillator the inductance change per degree C is $(2\Delta f)/(f\Delta t)$ and is expressed in parts per million per degree centigrade. This is called the temperature coefficient.

If L_o is inductance of the coal and μ_e is its effective permeability the increments ΔL and $\Delta\mu$ being due to the temperature rise, the relative change may be expressed:

$$\frac{(L_o + L_o)\ (\mu + \Delta\mu)}{L_o\ \mu} =$$

$$1 + \Delta L/L + \Delta\mu/\mu + \Delta L/L . \Delta\mu/\mu = 1 + \tau_o + \tau_i + \tau_o\tau_1$$

where $\tau_o = \Delta L/L_o$ and $\tau_i = \Delta\mu/\mu$. The product $\tau_i\tau_o$ being many orders smaller than τ_o or τ_i we may assume that coil and core temperature coefficients *add algebraically.*

Core Coefficients

It follows that to obtain the core coefficients one must know first one of the coil. The obvious way of designing a coil, measuring its characteristics and then inserting the core does not work, as we encounter then another variable: change of effective permeability due to different

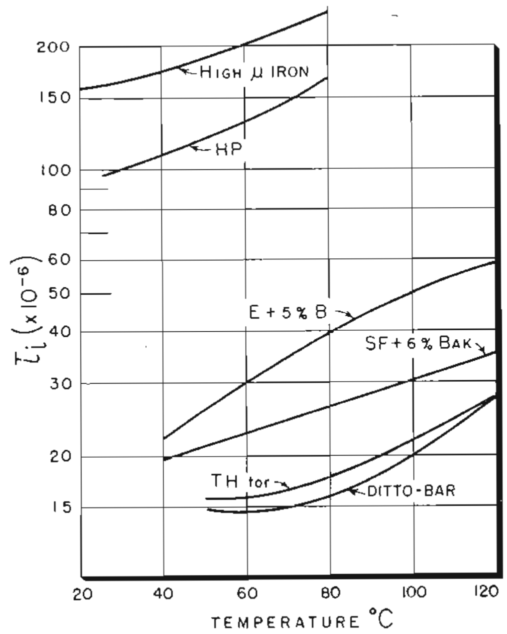
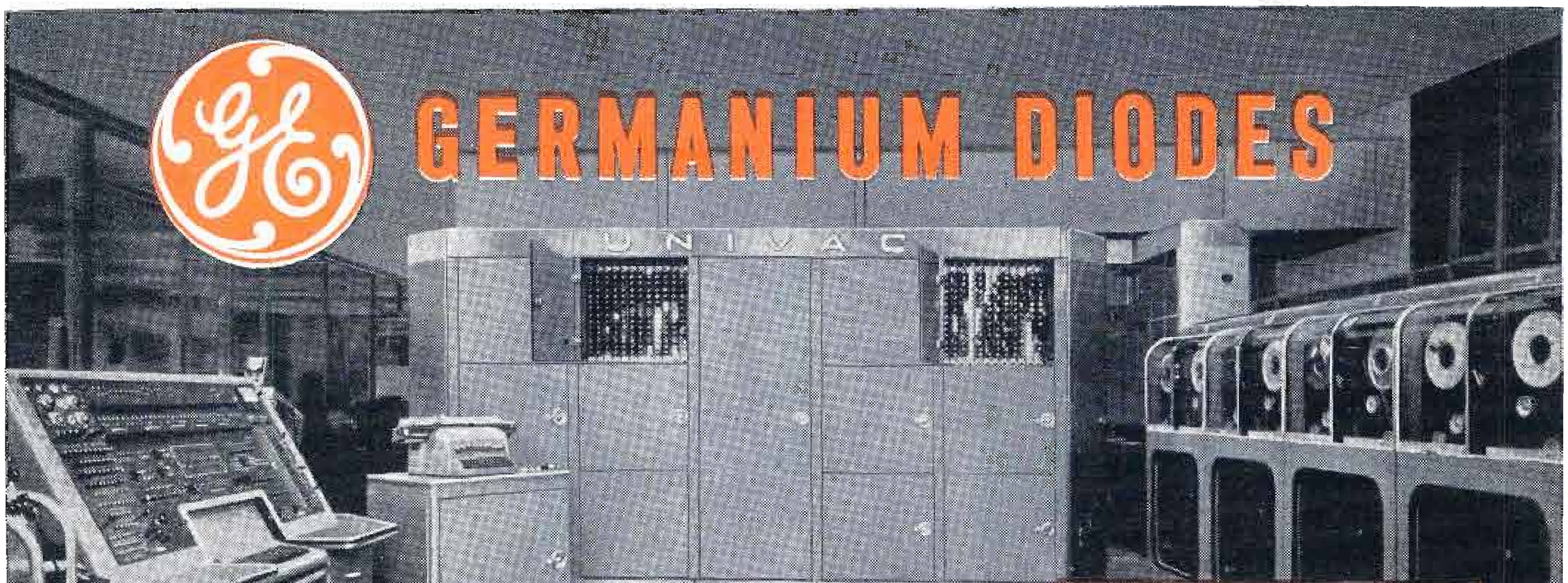


Fig. 5: Powdered core temp. coefficients

expansion of coil and core. To eliminate this effect, the most convenient way is to wind the coil directly on the test core cement the winding and core together and then measure the total change.

The coil change, still unknown, remains to be subtracted. This change was determined by using a winding on a non-magnetic core of similar expansion coefficient. Furthermore, it can be shown that according to the

(*Continued on page 120*)



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For use where size, long-life, and reliability under all weather conditions are important factors. General Electric is the largest supplier of germanium diodes in the country today.

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Univac election prediction proves 99% accurate!

JUST two hours after the first polls had closed, Remington Rand's giant electronic computer predicted the election results *almost to the actual electoral vote!* UNIVAC accepted a mere three million vote count at 9:15 p.m. and juggled it with available "trends" over the past 25 years to uncork an answer since proven 99% correct!

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What does this amazing mechanical mind consist of? Univac's makers in Philadelphia tell us that "90% of diodes used in the system are G-E, and without them, the equipment couldn't operate."

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Recently announced G-E Diffused Junction Germanium Rectifiers open the door to even greater advancement in circuit design for this and similar equipment. G-E Junction Rectifiers feature extremely low forward resistance, high inverse voltage, hermetic seal, and miniature size. Their application may result in units that will do more work . . . . . more efficiently . . . . . less expensively.

DIFFUSED JUNCTION GERMANIUM RECTIFIERS

Developed for radar and military communications. May be applied to computers, magnetic amplifiers, TV receiver power supplies, telephone switchboards, and many other electronic fields.

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G-E scientists have tested specially made germanium junction rectifiers and transistors at 140°C. Results indicate new products may be usable at higher temperatures.

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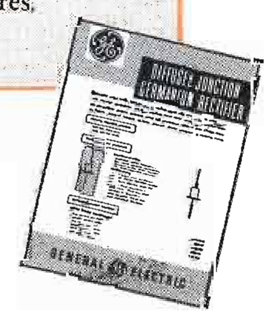
. . . on G-E Diodes and Junction Rectifiers. General Electric Co., Section 4823, Electronics Park, Syracuse, New York.



GENERAL ELECTRIC

inductance formula for a solenoid the inductance change due to the temperature is proportional to its linear expansion.

The expansion of a typical core is of the order of $+15\times10^{-6}$ which is also the temperature coefficient of the coil, as measured on a "dummy" core. In this way the effect due to the coil is eliminated.

Fig. 5 shows a set of measurements obtained with test samples in the form of square cross section bars $0.2\times0.2\times1\text{-}1/2$ in. for several cores made with carbonyl iron powders. It is to be observed that at lower temperatures the coefficients are quite small, approaching that of the best coils made, while at about 100° C they double their initial values. The group of low permeability materials ("E", "TH", "SF") have coefficients of the order of +10 to +50 $\times10^{-6}$. The higher μ materials may have same of the order of + 100 and more parts per million per deg. C. In all cases of metallic powder cores and coefficients are positive, i.e. μ increases with temperature which is easily explained by the fact that the particles are bound by an insulating matrix so that the minute gaps between the particles close together. Only in the case of ferrite powders where the material itself may be strongly negative the effect of the material overwhelms the "gap-bridging" effect.

Influence of Temperature

The influence of temperature on core losses present a problem which is more complicated. The investigation is best made on a h.f. bridge, after the coil is studied by itself. The inductor is then measured for its h.f. resistance at several frequencies. Here we have a case where different losses are differently affected by the temperature. Thus, it is generally known that after effect-loss resistance R_c increases with temperature; the same may apply to R_g. The eddy current loss, on the contrary diminishes with temperature as particle resistivity increases with temperature. Since the first power loss is more pronounced at lower frequencies the loss resistance at the lower frequency pact of the investigation was increasing with temperature. Thus at 200 KC the coefficient for resistance was found to be $+70\times10^{-4}$ for hard carbonyl powders and $+10\times10^{-4}$ for soft annealed powder. At about 2 MC the resistance ceased to increase so that temperature coefficient became zero. This is a region in frequency when increase of resistance due to first

(*Continued on page* 128)

CUES for BROADCASTERS

(*Continued from page* 83)

audition" switch is placed in the audition position (the pot has to be turned up); cueing is accomplished through the recorder amplifier.

The two leads to the primary of the transformer can be picked from the proper contacts on any of the switches. The most convenient is the Monitor Input Audition Switch. Only a single pair of shielded wires is added to the console. The transformer is best placed near the amplifier, as the unbalanced line is subject to noise pick-up.

Any transformer can be used provided a proper impedance match is maintained at the output of the audition buss. The switch (S1) prevents bridging both the added transformer primary (500 ohms) and the monitor input transformer (500 ohms) when audition is used on the console monitor.

By feeding into the recorder amplifier the system may be used for recording without interrupting the program on the monitor amplifier. On the Magnecord, there is a 500 ohm output to feed lines, such as special auditions, remote lines, etc.

Two Heads (Pickup) Better Than One

W. M. GREEN, Chief Engineer, KEEN, San Jose, Calif.

WE decided to use two pickup arms, one equipped with 1 mil and the other with 2.5 mil diamond stylus in GE reluctance heads, for the playing of intermixed 33 rpm LP and 33 or 78 rpm standard groove recordings. It was found that it is faster to change pickup arms than to change the needle position (particularly valuable when a needle error is made).

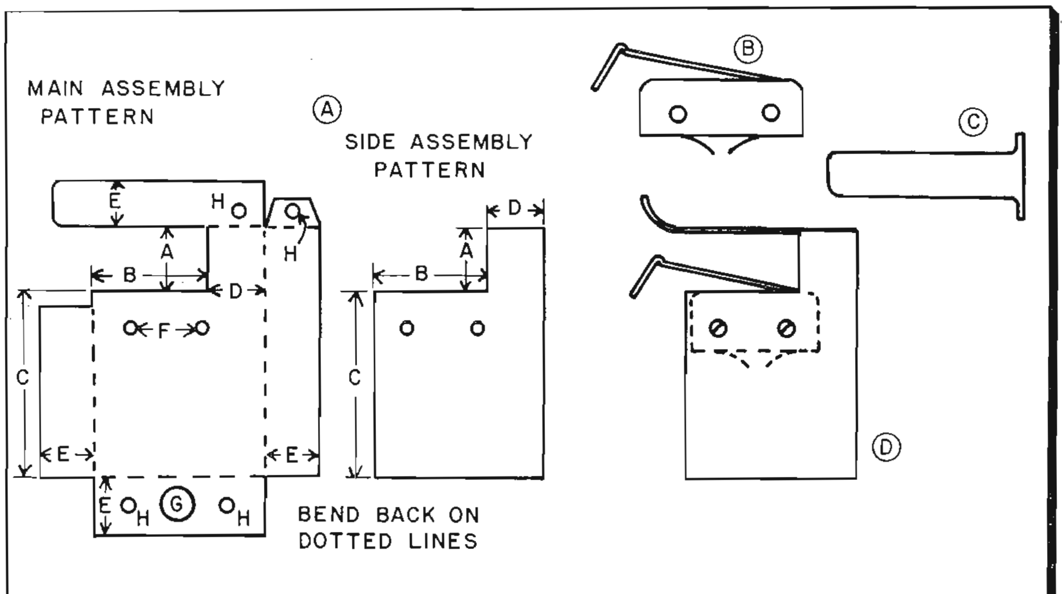
Electrical switching of the preamp input circuit was originally done by using a SPDT switch mounted between the arms. This left the problem of remembering to flip the switch. We now use an automatic switch actuated by the LP arm and installed as an integral part of the arm rest.

Materials are an SPDT "micro-switch," two one-in. 6-32 bolts, a used aluminum base recording disc and some elbow grease. Actual dimensions depend on the pickup arm used and height of the arm above the turntable cabinet. See A.

Leave acetate on the disc while shaping the parts and bending. It can then easily be peeled by putting the parts in a steam bath or boiling water for a minute or so. This leaves the unit with an unmarred polish. Some "micro-switches" have an ac-

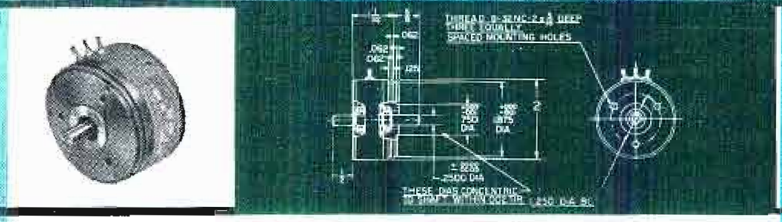
(*Continued on page* 126)

Construction details for pickup arm automatic switching assembly



DIMENSIONS:

A — THICKNESS OF PICKUP ARM PLUS 1/8"
B — WIDTH OF PICKUP ARM
C — HEIGHT OF ARM AT REST ABOVE TURNTABLE CABINET
D — 3/4" APPROX.
E — WIDTH OF "MICRO-SWITCH PLUS 1/16"
F — "MICRO-SWITCH" MOUNTING HOLES
G — HOLE FOR LEADS TO PICKUP AND PRE-AMP
H — MOUNTING HOLES



MODEL J HELIPOTS

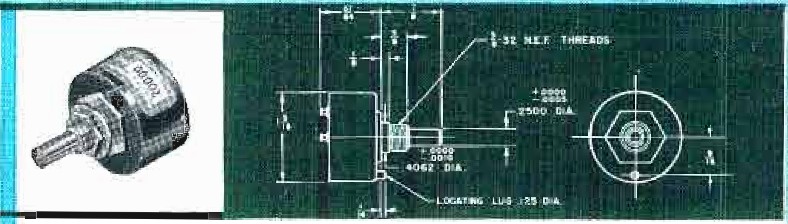
First production potentiometer equipped with ball-bearing shaft supports as standard and 3-way servo-type mounting. Ganged assemblies can be independently phased after installation without external clamps or brackets.

1-turn . . . Power rating 5 watts . . . Coil length 5½". . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% . . . Starting torque 1.0 ± .25 oz. in.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-JZ	100	630	.00002
1,000-JZ	1,000	875	.00017
5,000-JZ	5,000	1,300	.00017
10,000-JZ	10,000	1,475	.00017
20,000-JZ	20,000	1,900	.00017
30,000-JZ	30,000	1,975	.00017
50,000-JZ	50,000	2,260	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.



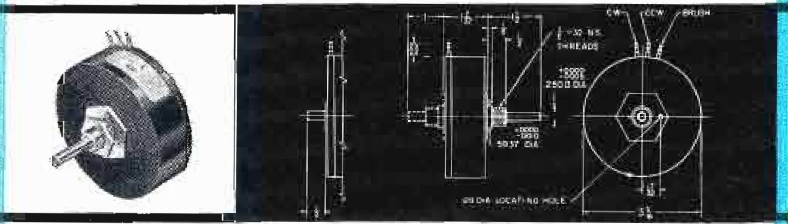
MODEL G HELIPOTS

A small, extra rugged single-turn pot developed initially for aircraft servo mechanisms. Its compact size, high accuracy, long life make it ideal for many instrumentation and servo-mechanism applications.

1-turn . . . Power rating 2 watts . . . Coil length 3¼". . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% (Std.) . . . Wgt. 2 Oz. . . . Dia. 1-5/16".*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
10-GZ	10	300	.00071
100-GZ	100	400	.00002
500-GZ	500	500	.00013
1,000-GZ	1,000	650	.00013
5,000-GZ	5,000	750	.00013
10,000-GZ	10,000	950	.00013
20,000-GZ	20,000	1,200	.00013



MODEL F HELIPOTS

A 3" dia. single-turn high-precision potentiometer with continuous mechanical rotation and minimum dead spot between electrical ends. Versatile in application. Ideal where continuous rotation simplifies circuitry.

1-turn . . . Power rating 5 watts . . . Coil length 9¼". . . Linearity tolerance ±0.5%.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-FZ	100	800	.00002
500-FZ	500	1,300	.00002
1,000-FZ	1,000	1,200	.00013
5,000-FZ	5,000	2,000	.00013
10,000-FZ	10,000	2,500	.00013
20,000-FZ	20,000	2,700	.00013
50,000-FZ	50,000	4,000	.00013
100,000-FZ	100,000	5,000	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.

NOT CARRIED IN STOCK but quickly available on order

MODELS AN and CN HELIPOTS

Mechanically precise, highly linear potentiometers of same general dimensions as Models A and C, except have servo-mountings, ball-bearing shafts and are built to highest precision possible. Have approximately 2:1 advantage in linearity accuracies over corresponding A and C Helipots. (Model AN linearity tolerances as close as ±.025% in values of 5K and above.)

AN (10-turns) resistance ranges, 100 to 250,000 ohms . . . **CN** (3-turns) 30 to 75,000 ohms.

Write for full details on linearity tolerances, special features, etc.

MODELS D and E HELIPOTS

Large diameter (3-5/16"), wide range Helipots with extremely long resistance windings for highest possible resolutions coupled with close linearity tolerances.

Model D has 25 turns, 234" coil length, 9000° of rotation, is 4-9/64" deep behind the panel, and is available in ranges from 100 to 750,000 ohms.

Model E has 40 turns, 373" coil length, 14,400° of rotation, is 6-1/64" deep behind panel, resistances 200 to 1,000,000 ohms.

Write for full details on linearity tolerances, special features, etc.

OTHER UNIQUE HELIPOT PRODUCTS

MODEL RA Precision DUODIALS

A beautiful, precision-built, multi-turn dial of compact dimensions (1-13/16" dia.) for all types of quality multi-turn installations. Features unique "jump" mechanism that keeps secondary dial stationary until primary dial has completed a full turn —then secondary dial "jumps" to new position. A vibration-proof lock holds dial settings whenever desired.

Black nylon knobs, satin aluminum dials, quality "feel" and appearance throughout. Available in 10-turn design for use with 3 and 10-turn Helipots and in RAJ version for use with small AJ Helipots.

Write for full details.

MODEL W DUODIALS

A large diameter (4¾") multi-turn dial ideal for primary control applications. The inner dial shows the exact position of the slider on any multi-turn Helipot while the outer dial shows the particular turn on which the slider is moving. Thus with 10-turn units, readings can be made directly in decimal equivalents of total resistance winding.

Since primary dial is direct-connected to shaft, backlash is eliminated.

Available in 10:1, 15:1, 25:1, and 40:1 Ratios for use with various Helipot models as well as with other multi-turn equipment.

Write for full details.

LABORATORY HELIPOT—MODEL T-10A

This unit combines in a handsome walnut case a 10-turn Helipot, an "RA" Duodial, and three-way binding posts for quickly setting up and changing experimental or temporary circuits. Ideal for laboratory and instruction purposes . . . is far more compact, simpler and 5 times faster to set than decade boxes.

Power rating 5 watts . . . Linearity 0.1% . . . Standard Resistance Ranges 100 . . . 500 . . . 1,000 . . . 5,000 . . . 10,000 . . . 20,000 . . . 50,000 . . . 100,000 ohms in stock. Other ranges on order.

Write for full details.

1. NEW YORK
B. B. Taylor
241 Sunrise Highway
Rockville Centre, New York
ROckville Centre 6-1014—6-1015
TWX: Rockville Centre NY 3685

2. ROCHESTER
E. A. Ossmann Corp.
3 Juniper Street
Rochester 10, New York
CUlver 7640

3. SCHENECTADY, N. Y.
E. A. Ossmann Corp.
DElanson 2319

4. BOSTON
Harold Gerber
25 Huntington Avenue
Boston 16, Massachusetts
COpley 7-1961
TWX: BS 168

5. PHILADELPHIA
James C. Muggleworth
506 Richey Avenue
Collingswood 6, New Jersey
COllingswood 5-3515

6. CLEVELAND
Howard N. Heasley
1940 East Sixth Street
Cleveland, Ohio
PRospect 1552

7. CHICAGO
Roy J. Magnuson
4258 West Irving Park Road
Chicago 41, Illinois
PAlisade 5-1170
TWX: CG 913-X

8. ST. LOUIS
Harris-Hanson Company
5506 South Kingshighway
St. Louis 9, Missouri
SWeetbriar 5584

9. FORT MYERS
Arthur H. Lynch & Associates
P. O. Box 466
Fort Myers, Florida
FOrt Myers 5-6762

10. LOS ANGELES
G. S. Marshall Company
40 South Los Robles
Pasadena 1, California
RYan 1-8345; SYcamore 5-2022
Helipot Home Office
TWX: Pasa Cal 7193

11. SEATTLE
Samuel N. Stroum
1612 Broadway
Seattle 22, Washington
FRanklin 7515—7516

12. DALLAS
J. Y. Schoonmaker Company
2011 Cedar Springs
Dallas 1, Texas
STerling 3335

13. DETROIT
S. Sterling Company
15310 West McNichols Rd.
Detroit 35, Michigan
Broadway 3-2900

14. SOUTH CENTRAL
Bivins & Caldwell
Security Bank Bldg.
High Point, N. C.
High Point 3672

15. CANADA
J. S. Root
290 Lawrence Ave. W.
Toronto 12, Ontario, Canada
ORchard 3003

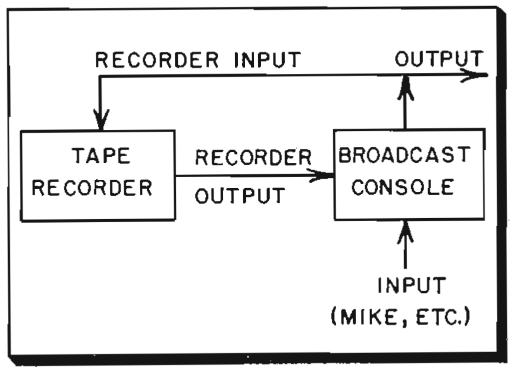
EXPORT AGENT: Frathom Company, 33 West 42nd Street, New York 36, New York, BRyant 9-1296 tuating leaf about two in. long which should be bent (see B) to hold the arm in place aided by the spring tension of the switch. A flat leaf can be fabricated to operate pin actuated switches (see C) then bent on the end to retain the advantage of holding the pickup arm in place. D shows the assembled switching arm rest with the "micro-switch" position shown by the dotted line.

Our switches have been operated for many months without breakage or failure. Bending the switch actuating leaf and the top leaf as shown in D makes the rest just as easy to use as a conventional arm rest and prevents damage to the pickups caused by accidental bumps. A piece of felt on the underside of the top leaf prevents marring the pickup arm.

Controlled Echoes

JAMES M. HALL, JR.,
Tell City, Ind.

THE equipment shown in the figure can be used to produce an echo that will grow or diminish in intensity and echo indefinitely as desired, due to the time delay between the record and playback heads of certain types of tape recorders.



Equipment diagram for controlled echoes

The output from the mike or turn table is fed to the console, amplified, and then fed to the tape recorder where the sound is recorded. After a time lag, depending on the tape speed and spacing between the record and playback heads, the sound is fed back to the console where it is amplified and again fed to the recorder. Here it is again recorded and after another time delay sent back to the console. The growing or diminishing echo effect can be controlled by the recorder play back input volume control on the console. The echo will continue until the feed-back network has been interrupted. Echoes can be put on the air as made or played back later from the tape. If one continues to speak in the mike the effect is somewhat changed. A good deal of experimentation must be done to learn the full extent of use of this idea.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Burton Browne advertising

Powdered Cores

(*Continued from page* 120)

power loss was compensated by the decrease of resistance due to eddy current loss. Further increase in frequency of measurements up to 10 MC when eddy current loss is predominant showed a negative temperature coefficient of from $+7$ to -30×10^{-4} depending on specimen. It is expected that at still higher frequencies the temperature coefficient may again reverse its sign and become positive, as third power loss becomes a predominating factor.

Thus according to these findings the coefficients of loss resistance change with temperature can vary greatly and are entirely dependent on frequency.

This of course excludes such high temperature which will cause breakdown of the insulation and binder, one of which or both may be of organic nature. In such case decomposition may start resulting on a greatly lowered core resistivity and permeability, as a free carbon may unite with the iron thus destroying its magnetic properties. In addition free oxygen in the oven may cause oxidization of outer surfaces of the particles, also reducing their permeability.

Such tests, which may be called destructive have ben carried by Signal Corps Laboratories. The cores were placed in the oven for several hours at the temperatures much higher than they were ever designed. Obviously after this "treatment" the cores became useless.

We realize of course the necessity for the Defense equipment to have highly stable components, including magnetic cores, which will withstand continuous operation at 200°C with tolerable temperature coefficients. In 1948 the writer did considerable development work on heat-stable cores. At first glance it might appear that ferrites may offer a solution. They are sintered at temperatures well about 1000° C and are certainly heat proof. However their temperature coefficients, particularly near their rather low Curie points are such that compensation presents real difficulties. To reduce their temperature effects the makers recommend reduction of the effective permeability by interposition of magnetic gaps. Eventually the number of gaps will approach that of powdered cores in order to make it possible to produce stable cores, both from a standpoint of temperature and megnetization which of course nullifies their other advantages over iron powder.

The work done in the direction of

(*Continued on page* 131)

NEW TV STATIONS on the AIR

State and City	Call Letters	Channel No.	Date On Air
ALABAMA			
Mobile	WKAB-TV	48	12/52
Mobile	WALA-TV	10	1/53
COLORADO			
Colorado Springs	KKTV	11	12/52
Denver	KBTV	9	9/52
Denver	KFEL-TV	2	7/52
INDIANA			
South Bend	WSBT-TV	34	12/52
NEW JERSEY			
Atlantic City	WFPG-TV	19	12/52
OREGON			
Portland	KPTV	27	9/52
PENNSYLVANIA			
Wilkes-Barre	WBRE-TV	28	1/53
York	WSBA-TV	43	12/52
TEXAS			
Austin	KTBC-TV	7	11/52
El Paso	KROD-TV	4	12/52
El Paso	KTSM-TV	9	1/53
Lubbock	KDUB-TV	13	11/52
VIRGINIA			
Roanoke	WSLS-TV	10	12/52
WASHINGTON			
Spokane	KHQ-TV	6	12/52
HAWAII			
Honolulu	KGMB-TV	9	12/52
Honolulu	KONA	11	11/52

high temperature iron cores resulted in a U. S. Patent of recent date[15] in which our methods are described. It was found that to preserve inter-particle insulation one must provide a "cushion" of heatproof insulator between the particles. This, of course, reduces the packing factor or density of the magnetic core; however, the binder, formerly made of phenol resin which is a bulky material, now is replaced by a fluid silicone varnish which completely penetrates all the space between the particles during the compression. The cores after compression are cured at the temperature prescribed for the varnish, which ranges from 200° to 300° C. The resultant cores, already subjected to a high temperature during their making are immune to the subsequent "destruction tests." The outer layer of core, as it comes from the mold is devoid of any protective coating and therefore will begin oxidizing during such a test. To prevent this the core, after its cure, should be again covered by a silicone varnish coating and baked anew. The cores otherwise exhibit substantially the same characteristics as the ones now produced commercially.

Commercial production of such cores would present a difficulty in that the cores ejected from the mold have no green strength before their curing. Consequently the breakage before their baking will be so great that the only solution of the productional problem is in pressing and curing the cores in their molds, which will of course considerably slow down the production and involve new heat resisting molds unless, of course, further improvements are discovered. Such production difficulties could no doubt be overcome if a party interested in heat resist-

(*Continued on page 132*)

ing cores is willing to initiate a program to study productional problems. There is at present no incentive to a core maker to adapt new and more costly methods unless such are fully justified in their final requirements. Nor can the research and development problems, such as above described, be carried on indefinitely without an interested sponsor. It is hoped that the progress in the field of miniaturization and other defense requirements may furnish the necessary stimulant.

* Toroidal and bar samples for development were supplied bv General Aniline Works.

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PERSONAL

(*Continued from page* 24)

David H. Ransom, formerly director of research at Bogue Electric Mfg. Co., N. J., has been appointed chief engineer of the electronic division of Karl-Douglas Associates, 3160 W. El Segundo Blvd., Hawthorne, Calif. In his new duties he will direct the design and production of various electrical and electronic products.

R. J. Rockwell, engineering vice president of the Crosley Broadcasting Corporation, Cincinnati, has been appointed to the Ohio Program Commission, an official state body to study the possibility of a state television station. Mr. Rockwell is the only representative from industry to gain appointment. He will advise the committee on technical problems.

Bernard Hecht (Box 258) Little Silver, N. J. has announced his entry into the field of management consulting, with a specialty of quality control for the electronic industries.

John P. Skinner, assistant manager for program development at Armour Research Foundation of Illinois Institute of Technology, has been named manager of the Foundation's Magnetic Recording division.

News of MANUFACTURERS' REPS

Jack Beebe, 5707 West Lake Street, Chicago 44, Ill., has been appointed midwest representative for the Hycor Company, Inc. of North Hollywood, Calif. Hycor manufactures wave and telemetering filters, low pass, band pass filters, toroid coils, decade inductor units and wire wound precision resistors.

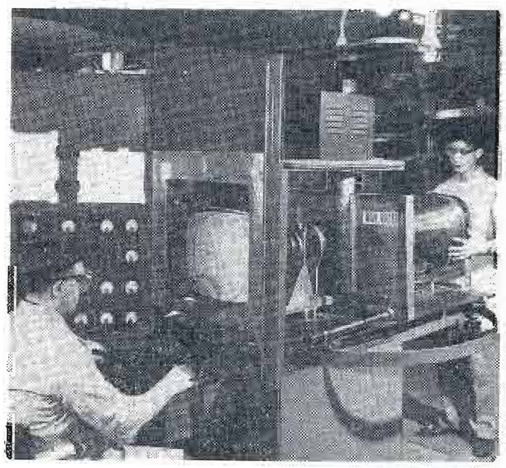
James B. Lansing Sound, Inc., Los Angeles, Calif., has extended the sales territory for Grady Duckett, its Atlanta, Ga., factory representative. He will now include Florida. Previous territory was: Georgia, North and South Carolina, Tennessee and Alabama.

R. B. Barnhill, formerly commercial sales manager of the Radio Division of Bendix Aviation Corp., has announced the formation of his own sales organization, R. B. Barnhill & Associates, Manufacturers' Representatives, 412 Woodbine Ave., Towson 4, Md. The new firm will represent a selected list of manufacturing concerns specializing in electronic components and assemblies, and will cover the middle Atlantic coast area.

Neely Enterprises, Los Angeles, Calif., engineering representative organization with five branch offices in the Pacific Southwest, has inaugurated an official factory-type service department at 7418 Melrose Ave., Los Angeles, two doors west of the home office.

Luce, Brierly, Davis Co., 332 Springfield Ave., Summit, N. J. has been selected to represent the Microdot Div. of the Felts Corp., South Pasadena, Calif.

Testing Gas Leaks



A rotary testing machine, designed by Sylvania Electric Products, Inc., provides rapid checks for gas leaks in TV picture tubes at the company's plant in Seneca Falls, N. Y. This final check is one of a minimum of four, made before the tube leaves the factory. While one man places a tube in the rack on the two-position machine, another operator tests a second tube for screen brightness and uniformity. The final check, which rejects any tube into which any gas has leaked or been generated, compares the final record with those of the several checks made along the line

Industry Meets on Spurious TV Radiation

Recently, at an all-industry engineering conference held in New York City, Dr. W. R. G. Baker, Director of the RTMA Engineering Dept., presented an RTMA plan for implementing and accelerating the reduction of spurious oscillator radiation in TV transmission and reception.

Three task committees from the RTMA Engineering Department were appointed to carry out the plan to cooperation with JTAC and IRE. A Task Committee on Receivers, headed by J. A. Chittick, of RCA Victor Division of RCA, will have responsibility for developing technical data on the limitation of oscillator radiation by television receivers and a timetable for carrying out the recommendations.

A Task Committee, headed by J. E. Keister, of General Electric Co., will perform the same functions in the transmitter field. A third Task Committee, headed by Donald G. Fink, of the Philco Corp., will coordinate the work of the other two Task Committees with JTAC, IRE and the FCC. This Task Committee also will have responsibility for disseminating full information on the developments of the industry.

At the meeting RTMA President A. D. Plamondon, Jr., and General Counsel Glen McDaniel both stressed the importance of prompt industry action to reduce spurious oscillator radiation. Ira J. Kaar reviewed RTMA's development of the recommended 41.25 MC I.F. standard, Lewis M. Clement reviewed the varied activities and progress achieved by the industry under RTMA sponsorship in controlling oscillator radiation, and J. E. Keister reported on efforts of the RTMA Engineering Department to reduce spurious radiation of TV transmitters. The problem of providing facilities for small manufacturers to conduct measurement tests was raised and during a discussion which followed Dr. Baker said that the problem would be given prompt attention by the Task Committees.

"The success of the present program," Dr. Baker said, "depends on the full cooperation of all engineers in the industry and the support of these engineers by their top management. Manufacturing costs may be increased as spurious radiation is reduced, but this industry has a job to do and we will do it to the best of our ability."

RCA Factory in Spain

The Radio Corporation of America has announced plans to erect a factory on a 322,000 sq. ft. highway site overlooking Madrid. Construction is expected to be completed in 1953 and initially production will center around 45-rpm records, record players and television sets. Arrangements for the project were made in cooperation with Gabriel Soria, President and Managing Director of Industria Electronica, S. A., an associate RCA company in Spain.

MICROWAVE INSTRUCTION

J. N. Craver chief radio engineer for the Signal Corps plant engineering agency, and GE instructor Gus Kandaris (right rear) discuss microwave techniques in one of General Electric's month long classes. The classes instruct Signal Corps technicians on the installation and operation of microwave relays

Coming Events

Feb. 4-6—IRE-AIEE Western Computer Conference, Hotel Statler, Los Angeles, Calif.

Feb. 5-7—West Coast Audio Fair, sponsored by the AES, Alexandria Hotel, Los Angeles, Calif.

Feb. 5-7—IRE, 1953 Southwestern Conference, Plaza Hotel, San Antonio, Tex.

Feb. 18—ISA, 6th Annual Regional Meeting, Hotel Statler, New York, N. Y.

March 23-26—IRE National Convention, Grand Central Palace & Waldorf-Astoria Hotel, New York, N. Y.

April 12-16—Electrochemical Society, International Meeting, New York, N. Y.

April 18—Cincinnati Section, IRE, Seventh Annual Spring Technical Conference, Cincinnati, Ohio.

April 20-22—MPA, 9th Annual Meeting, Cleveland, Ohio.

April 26-30—SMPTE 73rd Convention, Hotel Statler, Los Angeles, Calif.

April 28-May 1—7th Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles, Calif.

April 29-May 1—Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.

May 11-13—IRE, National Conference on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

May 18-21—Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.

Aug. 19-21—Western Electronic Show and Convention, San Francisco Municipal Auditorium, San Francisco, Calif.

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

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

AES: Audio Engineering Society
AIEE: American Institute of Electrical Engineers
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
MPA: Metal Powder Assoc.
NARTB: National Association Radio and Television Broadcasters
SMPTE: Soc. of Motion Picture and TV Engineers

Rigid Coaxial

(Continued from page 79)

tion of a 50-ohm standard will not automatically supersede work already underway on installations using 51.5-ohm lines.

The following were among the reasons given for adopting a 50 ohm standard:

a. If a connector, cable, or other coaxial device of a particular characteristic impedance is to be accurately measured, it is essential that the slotted line and other coaxial gear be of the same characteristic impedance. Since the established policy of the Armed Services is that all cables should become 50 ohms, it is important that all rigid coaxial lines be of the same impedance.

b. The existence of a constant characteristic impedance for all line sizes permits the free scaling of components from one line size to another with no redesign. This permits component design work to be carried out in a convenient line size and then scaled to line sizes which may be prohibitively inconvenient mechanically for the original design work. Since the average of all present cables, rigid lines and connectors is 50 ohms, this is a desirable and convenient value. It is a compromise of the theoretical impedance values for minimum attenuation, optimum power carrying capability, and maximum breakdown voltage.

Mechanical Considerations

The line sizes in Table I of the standard were adopted because it was felt that they would adequately take care of the needs of FM, TV, microwave, and other users. Wherever possible, the preferred sizes and thicknesses were selected from the U. S. Department of Commerce publication, "Simplified Practice Recommendation R235-48 for Copper and Copper-Alloy Round Seamless Tube," since these sizes are most readily available. In addition, standard tolerances recommended by the Copper and Brass Research Association, were used wherever possible.

It was decided to adopt a system of dimensioning whereby both diameters of each conductor are specified for the following reasons:

a. The inside diameter of the outer conductor is important electrically, and the outside diameter is important because of manufacturing problems in the assembly of connectors.

b. The outside diameter of the inner

conductor is important electrically, and the inside diameter is important because a tight fit with the inner conductor bullet is desired.

c. By proper specification of tolerances, it costs no more to obtain tubing with specified inside and outside diameters than to buy standard copper water pipe.

If the inside diameter of the outer conductor is eccentric with respect to the outside diameter of that conductor a step can be encountered when two sections of tubing are joined together. The exact computation of the reflection caused by a discontinuity of this type would be extremely complex, and therefore was not attempted. Instead, it was assumed that the reflection would be of the same order of magnitude as that from a symmetrical capacitive step in a coaxial line, with the step equal to the maximum offset because of eccentricity. Using data published by Whinnery, Jamieson and Robbins[1] for coaxial line discontinuities, it was determined that under the worst conditions of eccentricity possible, the voltage standing wave ratio would not exceed 1.02.

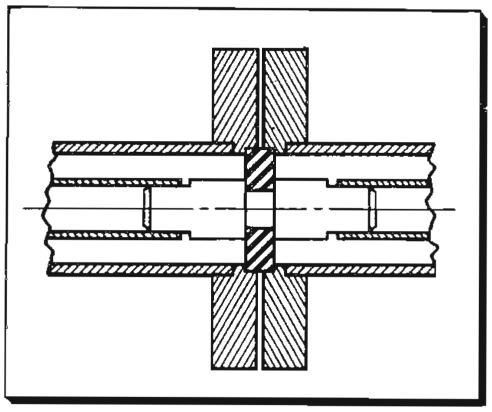


Fig. 4: Anchor section of coaxial transmission line with an overcut-undercut bead support

Out-of-roundness is defined as the difference between the major and the minor diameters at any one cross-section of a conductor. See Fig. 1. The Copper and Brass Research Association Manual states that out-of-roundness shall not exceed 2% of the specified diameter. This was considered excessive by the RTMA for coaxial line conductors. However, it was decided that it would suffice to call for conformance to "best commercial practice" for the following reasons:

a. Since hard or half-hard tubing is used, it never becomes as much out-of-round as annealed tubing.

b. Since thin-wall tubing is used, no difficulty should be experienced with out-of-round tubing, since it can readily be "sprung" into

(Continued on page 138)

collets, receptacles, and ring gauges.

c. Tubing becomes out-of-round primarily because of improper packaging, shipping and handling. It was therefore decided to include packing requirements in the standard to minimize this condition.

Electrical Considerations

In order to determine which electrical terms should be specified and how they should be defined, the following sources of information were carefully reviewed:

a. The terms and definitions used in RTMA standards TR-103-A and TR-104-A.
b. Tentative definitions established by the IRE Standard Committee on Definitions.
c. American Standard ASA C-42

In standards, TR-103-A and TR-104-A, the terms attenuation and surge impedance were defined and used to express the loss and impedance of the cable. Neither term was considered to be adequate.

Insertion Loss

Consideration was given to such terms as insertion loss, specific insertion loss, and transducer loss as possible substitutes for the term attenuation. It was apparent that none of the definitions for insertion loss specified the source or the load impedance. Since it is desirable for the user of transmission line to know the loss of the line in terms of specific terminating impedances, the term insertion loss seemed inadequate. Therefore, the definition of transducer loss, together with the definition of available power as defined by the IRE Standards Committee on Definitions and published in the August, 1951, issue of the IRE Proceedings were accepted. The term "transducer loss" was considered to be an adequate substitute for the term "attenuation" because it required that the loss be measured between specified impedances, which is primarily what the transmission line user is interested in. In addition, since transducer loss[2] is defined in terms of available power, the definition of this term was included as part of the definition of transducer loss.

The term surge impedance was not considered to properly identify the measured impedance of a transmission line and, therefore, such terms as characteristic impedance, image impedance, and iterative impedance were examined. After careful inspection of the ASA definition for image impedance, it was decided that the term was too restrictive. The term iterative impedance,[3] being a more general term, appeared to describe more accurately the impedance which is measured and adequately covers non-uniform lines. For those lines or structures which are uniform, the term characteristic impedance is more satisfactory, since it is a specific type of iterative impedance. Therefore, it was decided to use the definition of the general term and to include the definition of the specific term "characteristic impedance," as part of the definition of the general term.

The term standing wave ratio[4] as defined by the ASA was included, because it was felt necessary to place requirements on the magnitude of the discontinuities.

No adequate ASA or IRE definitions for Power and Voltage Ratings[5] and Upper Frequency Limit[6] were available. The committee, after considerable investigation and discussion, defined these terms. The definitions, therefore, are not ones which have general acceptance.

Transverse Mode

The usual manner of propagation in a coaxial line is such that neither an electric nor a magnetic field exists in the direction of propagation; that is the transverse electromagnetic mode (TEM). It is the mode in which propagation can take place from zero to microwave frequencies. High modes of the TE or TM type are possible, but can be troublesome. In order to avoid or reduce difficulties from higher modes, the operating frequency should be below the cutoff frequency for the first higher mode—the TE_{11} mode. Therefore, the TE_{11} mode cutoff frequencies for various types of supporting structures were included in Table I of the standard to serve as a guide. A detailed discussion of the determination of criteria from which frequency limits can be derived, and the establishment of these limits will be presented in an article prepared by the RTMA group that was assigned this task. In general, it does not seem advisable to use coaxial lines at frequencies greater than 0.95 of the TE_{11} mode cutoff frequency. Uncompensated supporting structures will further decrease this limit. However, in the overcut, undercut, or overcut-undercut insulator portion of line practical experience has indicated

(*Continued on page* 140)

that 0.95 of the TE_{11} mode cutoff frequency will serve as a useful limit for most applications. Figs. 2, 3 and 4 show three coaxial lines with different types of bead supports.

Considerable progress has been made toward the standardization of fittings for these lines, and a supplement to this standard will probably be released in the near future. Manufacturers and users alike have agreed that the fittings should be mechanically and electrically interchangeable.

1. Whinnery, Jamieson & Robbins. "Coaxial Line Discontinuities," Proc. IRE, Vol. 32, No. 11, Nov. 1944.
2. TRANSDUCER LOSS is the ratio of the available power of the specified source to the power that the transducer delivers to the specified load under specified operating conditions.
   Note: The available power of a linear source of electric energy is the quotient of the mean square of the open circuit terminal voltage of the source divided by four times the resistive component of the impedance of the source.
   Note: This loss is usually expressed in decibels.
3. The ITERATIVE IMPEDANCE of a transducer is that impedance which, when connected to one pair of terminals, produces a like impedance at the other pair of terminals.
   Note: The iterative impedances of a four terminal transducer are in general not equal to each other, but for any symmetrical transducer the iterative impedances are equal. The iterative impedance of a uniform line is the same as its characteristic impedance.

   The CHARACTERISTIC IMPEDANCE of a transmission line is the driving point impedance which the line would have if it were of infinite length.
   Note: It is recommended that this term be applied only to a uniform line. For other lines or structures, the corresponding term is "iterative impedance."
4. The STANDING WAVE RATIO is the ratio of the amplitude of a standing wave at an anti-node to the amplitude at a node.
   Note: The standing wave ratio S in a uniform transmission line is given by:
   $$S = \frac{1 + p}{1 - p}$$
   where p is the magnitude of the reflection coefficient of the load.
5. The POWER RATING OR VOLTAGE RATING of a line is that value of transmitted power or voltage which permits satisfactory operation of the line and provides an adequate safety factor below the point where injury or appreciably shortened life will occur.
6. The UPPER FREQUENCY LIMIT is determined by the cut-off frequency of higher order "waveguide" modes of propagation, and the effect which they have on the impedance and transmission characteristics of the normal TEM coaxial transmission line mode. The lowest cut-off frequency occurs with the TE_{11} mode, and this cut-off frequency in air dielectric line is the upper frequency limit of a practical transmission line. How closely the TE_{11} mode cut-off frequency can be approached depends on the application.

California Tower Lighting Firm Relocates

Hughey & Phillips, Tower Lighting Div., has moved its general office to Encino, Calif., under the direction of Mr. Russell H. Smith as General Manager, and its engineering and production plant to 3300 San Fernando Blvd., Burbank, Calif., under the direction of Mr. Harry A. Whittemore, Jr., in charge of production.

High Impedance VTVM

(*Continued from page* 96)

effect of hum on the output dc current and also reduces the feedback of noise from the amplifier to the input circuit.

The ac amplifier consists of a high gain pentode with a bootstrap circuit in its plate load. The cathode follower across the 6AU6 470K plate resistor maintains both ends of the resistor at the same ac potential (insofar as the cathode follower gain is close to unity) giving essentially constant plate current flow. Thus there is essentially no signal voltage drop across the tube internal plate resistance (i.e., $r_p = 0$): The expression for gain, $e_0/e_{in} = \mu R_l/(r_p + R_l)$, which approaches the μ of the tube or more than 2000 in the case of a 6AU6.

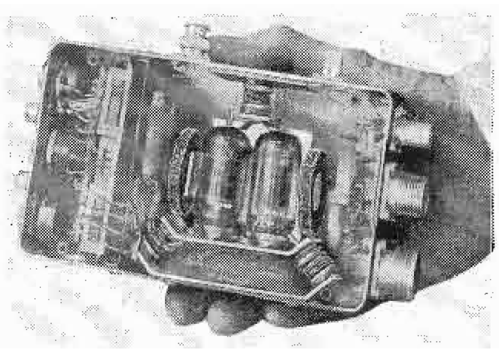
The bootstrap cathode follower output is demodulated by the vibrator and the resultant half wave rectified dc is filtered by a 500K resistor and 0.1 μf capacitor. The succeeding dc amplifier is in this case simply a cathode follower power amplifier which supplies the feedback and meter current. This cathode follower is necessary inasmuch as the contact modulator cannot be used to interrupt circuits in which there is appreciable current flow.

The ac amplifier has a gain in excess of 2000, the contact modulator a gain of approximately 0.25, and the dc amplifier a gain of almost unity, giving an overall gain of approximately 500. There is one phase inversion in the ac amplifier and a second in the modulation-demodulation process resulting in an overall positive gain.

The cathode follower stage is designed to provide current protection for a 100-0-100 microammeter. The 43K plate load and dynamic plate resistance limits the positive current flowing in the meter movement branch and the 130K cathode resistance similarly limits the negative current.

There is no particular stability problem inasmuch as there is only one time constant (that of the demodulator filter) outside of the ac amplifier.

INTERNAL SHOCK MOUNTS



View of Simmonds Amplifier bridge assembly developed by Robinson Aviation Inc., Teterboro, N.J., which features internal vibration and shock mounts. Unit weighs only 1 lb. 3 oz. and can also be mounted in the inverted position

UHF Design Notes

(*Continued from page* 81)

Injection voltage on the grid of the tube should be kept small compared to the plate voltage swing. There are several reasons for this. The first reason is that the rectification loading power loss on the grid of the tube will be roughly proportional to the square of the bias voltage developed. Since stability requires as high an initial Q as possible, a minimum grid loading is indicated. In addition to the loss due to rectification, there may be appreciable transit-time loading at UHF. The effective resistance of the grid may be of the order of a few hundred or less ohms because of loading. The total effective grid circuit impedance is the combination of the grid rectification loading, transit time loading, and tuned impedance loading in parallel. Hence, the voltage amplification equation in complete form would be

$$VG = \frac{g_m \left(R_L \frac{C_1}{C_1+C_2} \cdot R_T \cdot R_C\right)}{\left(R_L \frac{C_1}{C_1+C_2} \cdot R_T + R_L \frac{C_1}{C_1+C_2} \cdot R_C + R_T R_C\right)}$$

$$VG = g_m R_{eb} = g_m / (g_T + g_C + g_L [C_1 + C_2] / C_1) \quad (5)$$

The need for transforming down in the grid circuit requires as a consequence the use of either a tube having a high transconductance or a tube having low transit time loading, or both. Since transit-time loading conductance data as a function of frequency are essential for designs of UHF oscillators, a plot of transit time conductance as a function of frequency should be provided on tubes intended for UHF oscillator application.

The desirability of use of as low a frequency oscillator as possible and doubling or tripling to the final frequency has been pointed out in recent literature.[2] The physical reasons why this choice of a lower frequency oscillator is essential should now be evident. Higher loading capacitances, higher inductance coils, lower transit-time loss, and lower rectification loading are all possible at the lower frequencies. These factors all contribute to better stability. In addition, the effects of tube element leads disappear rapidly as the operating frequency is lowered.

Example: The following typical oscillator designs are included to indicate the full design process. The first design is typical of a UHF television local oscillator design. The second is typical of a grid dip oscillator.

Assume that a section of 6J6 is being used as a local oscillator. The equivalent grid-ground capacitance is 30μμf, and plate-ground is 10 μμf.

The plate supply voltage is 100 volts fed through an r-f choke having ten ohms resistance. Detuning due to the r-f choke is assumed negligible. The oscillator operating frequency is 500 MC. Transit-time grid conductance is 350 ohms. Tuned circuit Q is 100. Slug tuning is being used.

Since the tube element capacitances are of the order of 3μμf each, tube capacitive reactance is of the order of 2.5 times that of the total grid-plate capacitance of 7.5 μμf (series combination of 30 and 10). The grid-plate capacitive reactance can be read from a reactance chart as about 44 ohms. Tube element capacitive reactances should be approximately 110 ohms.

The unloaded impedance R_T (Eq. 3) has a value of 4400 ohms and $R_L = 3300$ ohms (Eq. 4). The grid circuit impedance resulting from the capacitive transformation is 1100 ohms. The transit-line loading conductance and the grid leak conductance must be paralleled with the tuned circuit conductance of 910 micromhos. The total conductance is 0.00091 plus 0.00286 plus the conductance of the grid leak which may be taken as 0.0002 (5000 ohms). The combined conductance of 0.004 corresponds to 250 ohms grid resistance. Consequently, for oscillation to develop, G_m must exceed 4000 micromhos. The amplitude of operation will be determined by selection of the load line giving a mean transconductance of 4000 micromhos (Fig. 3). This load line is called contour *b*. Note that, since on the operating load line the tube cuts off on the negative grid swing, operation of the stage is irregular.

The total effective Q remains to be determined. The effect of grid loading lowers the Q by the same ratio as the impedance is lowered. The active Q before feedback takes effect therefore is 250/1100 Q = 23. Now the plate level impedance is reduced to about 750 ohms. The load lines should be plotted as in Fig. 3 to obtain the correct operating condition. Consequently, in a design problem, the loaded impedance should be determined immediately in order to eliminate duplication of work.

Several comments can now be made based on the design just studied. The first of these is that the transformation ratio should be higher. The ratio of C_1/C_2 should be made as large as is consistent with reliable operation of the oscillator. The leeway available in the problem discussed would require the minimum grid circuit load resistance to

(*Continued on page 144*)

be not less than 220 ohms. For 220 ohms total grid load, the tuned circuit may present a grid load impedance as low as 700 ohms if the grid leak is raised to 10,000 ohms. The division ratio becomes 5.3 to 1 instead of 3 to 1. The tuned circuit loaded Q becomes 32. R_L now is 1166 ohms. The design is plotted in Fig. 5. Identification is the same as Fig. 3.

Low stability of the UHF oscillator is an inevitable consequence of the heavy transit-line loss in UHF oscillators. The difficulty can be minimized, but cannot be eliminated particularly at frequencies very close to the oscillation limit. Only at frequencies where the transit time resistance is large compared to $1/G_m$ can full advantage of tuned circuit stability be taken.

Grid Dip Oscillator

The grid dip oscillator is a device used for testing operation of tuned circuits. It usually is designed to use the same circuit as is shown in Fig. 1. The ratio C_1/C_2 normally is taken as unity for grid dip oscillators since the variation of frequency is accomplished by a two section variable capacitor for C_1 and C_2.

Frequency stability available in a grid dip oscillator is poor as a result of the serious compromises required for the circuit. Stability can improve as frequency is raised. Only the highest frequency ranges can have a favorable ratio, however, and then only if transit-time loading is favorable.

The grid leak resistor should be chosen as low as possible since uniformity of voltage output is improved and meter sensitivity also is improved thereby. Use of the grid dip oscillator as a stable device requires trimming the oscillator tuning against a high-Q wavemeter or a heterodyne frequency meter.

A choice of a 2000 ohm grid leak resistor tapped at 500 to 1000 ohms for the grid current meter should prove a reasonable compromise. If a triode section of a 6J6 tube were used as an oscillator tube, and the 100 volt P supply to the tube were provided through a 5000 ohms resistor, the required static load line would be as shown in Fig. 6. The dynamic load resistance of the oscillator is 2000 ohms. A set of typical load lines is plotted. The average transconductance for a 2000 ohms load for steady state oscillation is 500 micromhos.

As can be seen from the data above, the 6J6 tube is a poor choice of tube for a grid dip oscillator. One having a transconductance ranging up to about 2000 micromhos is better matched to average operating conditions. Where operation at the upper frequency limits of conventional electron tubes is required, a 6J6 triode section may be more satisfactory.

The design of oscillators for service in the 100 to 1000 MC range can be simplified and improved by recognition of some basic underlying principles. One of these is to provide for adequate transformation ratio in the feedback path to yield the unity phasor gain around the oscillator loop as a whole with sufficient gain at the tube plate to utilize the tube's power gain abilities. Another is to keep the dissipation loading on the tuned circuit low enough to permit efficient use of the available tuned circuit Q. A third is to allow the plate load impedance to be high enough to permit efficient development of output power. A fourth is to keep the reactance levels low enough to permit the full circuit Q to be used. In triodes, for example, having the load impedance of the order of magnitude of the dynamic plate resistance may reduce the effective Q. In the cases analyzed, R_L was small compared to $1/g_p$, with the result that the effect of g_p could be neglected. Finally, careful track of the magnitude of the transit angle conductance is required to provide the best possible design at UHF.

Design here has been limited to the oscillator form in commonest use at UHF. The basic principles discussed may be applied to any standard design with routine changes in technique.

[1] Pullen, Keats A., "Using 'G' Curves in Tube Circuit Design." **Tele-Tech**, July and August, 1949.
[2] Whalley, W. R., "Design Considerations for Combination UHF & VHF Receivers." **Tele-Tech**, November, 1952.

Nationwide Teleprompter Service

A nationwide service to make Teleprompter available to all public speakers has been inaugurated. The service, being offered through the RCA Service Co., was begun in New York and Philadelphia and will be extended to major cities throughout the country. The Teleprompter, already widely used in the TV and motion picture industries, is now available for the first time for use by speakers at conventions and similar events.

Core of the Teleprompter is a script typed in large block letters, which unrolls before the speaker and is regulated according to his speed of speech. The speaker is warned of the approaching close of his program time by a system of warning lights. Use of more than one Teleprompter is often desirable to permit the speaker to move about. In such cases, all machines in use are electronically synchronized so that each delivers the same portion of the script at the same time.

UHF-VHF Receiver

(*Continued from page 75*)

from one tuner to the next, due primarily to the tube characteristics. As the frequency of the oscillator is increased, the problem of obtaining adequate injection becomes increasingly difficult.

The 195 MC separation between the signal and oscillator frequency reduces to the greatest extent the amount of oscillator radiation which will appear on the antenna, and the same off-frequency response relation of the oscillator radiation follows the image rejection analysis, on the basis that a 195 MC single preselector circuit is comparable to a 40 MC i-f using double resonant circuits.

The alignment of a UHF tuner utilizing a single preselector stage, can be aligned faster and more efficiently, inasmuch as bandpass and over-coupling characteristics are eliminated. This means that the alignment is greatly simplified, and uniformity from tuner to tuner can be obtained with a minimum effort and cost.

Noise Figure Negligible

In the matter of choice of i-f frequency, the noise figure is deteriorated so little that it becomes nearly negligible. For example, the difference of a UHF converter, working into VHF Channel 5, whose noise factor is 10 db, is only 1/10 db better from an overall application, than the same converter working into VHF Channel 10 having a 14.5 db noise figure. The gain of the two channels is practically equal, and an average of the various manufacturers will show a difference of less than 10 µv between Channel 5 and Channel 10. Mathematics of this comparison is as follows:

$$F=F_1+\frac{F_2-1}{G_1}$$

$$F=79.4+\frac{10-1}{12}$$

$$F=79.4+0.75$$

$F=80.15$ or 19 db combined noise factor on Channel 5.

$$F=79.4+\frac{28.1-1}{12}$$

$$F=79.4+2.25$$

81.65 or 19.1 db combined noise factor on Channel 10.

F=Combined noise factor of UHF converter and VHF set

F_1=Converter noise factor assuming 19 db.

F_2=Noise factor of VHF assumed to be 10 db for Channel 5 and 14.5 db for Channel 10.

G_1=Gain of converter assumed to be 12 db, using power ratios for all quantities.

It is entirely possible in certain locations that both Channels 5 and 6 would not be useable, due to VHF interference or spurious responses susceptible to the double superheterodyne interaction. The high channel response curves of all VHF tuners in general are very much wider in comparison to the steep skirt responses of the low channels, and therefore the selection of a high channel simplifies the problem of tuning a converter into a TV receiver, and allows the selection of 5 VHF channels for conversion, rather than possibly 2 channels on the low VHF channels. This provides mathematically a greater guarantee of performance at time of installation and in the years to come, as more and more stations are added.

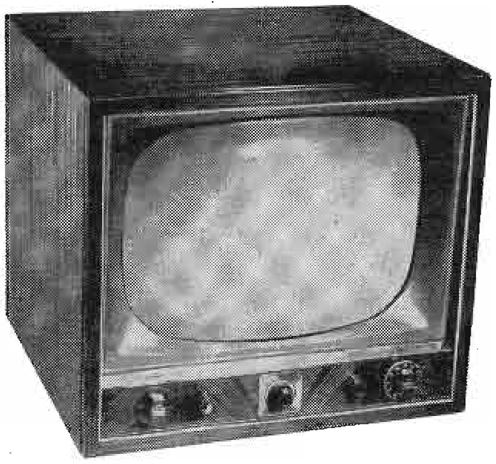


Fig. 7: Double conversion UHF-VHF receiver boasts clean appearance, 25μv sensitivity

One of the greatest disadvantages of a double superheterodyne, is a mechanical problem, and concerns the VHF-UHF switching arrangement and the ability of a customer to change the selected conversion channel in cases of interferences.

Fig. 2 illustrates a mechanical method, by means of which the customer can select the conversion channel by simply lifting a small metal tab labeled "UHF" and setting it into a notch corresponding with the VHF channel into which conversion is desired. This operation is done entirely from the front and outside of the receiver, and would, of course, be done by the installation man at that time. Should interferences develop, such as new stations going on the air, the channel conversion change could be made

(*Continued on page* 148)

immediately and without any effort. Such a switch arrangement automatically switches the VHF-UHF antennas and the B+ by means of a cam connected physically to the tab on the outside of the cabinet, which automatically follows as the tab is set for the various VHF channels.

The use of a high pass filter at the input of the UHF tuner is necessary in order to eliminate signals, lower in frequency than the UHF band, from entering and mixing with the local oscillator. The tuner itself is completely shielded in order that the unwanted signals enter only through the high pass filter. The use of a 195 MC i-f allows the high pass filter to be used at a better advantage over a greater portion of the UHF spectrum.

Fig. 3 illustrates the cut-off frequency and insertion loss which such a filter would provide.

Fig. 4 is a circuit diagram of a high pass filter, giving the approximate values for the various inductances and capacities.

Installation

Fig. 5 illustrates a typical VHF chassis to which UHF is to be added.

Fig. 6 illustrates the installation of the UHF tuner, the antenna changeover switch, and the mechanics involved on the VHF shaft in order to obtain automatic changeover on the channel selected for conversion.

Fig. 7 illustrates the exterior cabinet appearance of such an arrangement, placing the UHF dial in the center of the panel. There are various ways of combining the two dials in order to simplify the appearance. One of the means of accomplishing this is by utilizing the VHF fine tuning knob to simultaneously tune the UHF tuner.

A typical VHF-UHF receiver built on these principles is very sensitive, and has measured as low as 25 µv, whereas the same receiver built on a single superheterodyne principle, may have a sensitivity as high as 150 µv, and in terms of fringe reception, or elimination of antenna, this means the difference between good and poor performance.

From Dishwashers to Radar

In order to fulfill military requirements, the General Electric Co. is converting its Scranton, Pa., plant to the manufacture of hydrogen thyratrons for radar equipment. This plant formerly turned out dishwashers. Production of the 5-lb. tubes, starting in Jan. 1953, will run several million dollars per year. The thyratron measurements are 16 in. long and 5 in. in diameter.

UHF Tuning Devices

(*Continued from page* 68)

set. This permits attaching a milliammeter from the test point to ground, to meter the injection current to the crystal and to ascertain that it stays within the desired limits for best noise and conversion loss. Then the 47-ohm resistor is soldered in place and a scope is attached to the test point. This permits the swept r-f bandpass curves to be examined and the tuner r-f to be aligned continuously throughout the entire frequency range. The coil is a standard slug tuned i-f coil similar to those used commonly in VHF tuners and i-f circuits. The i-f signal is coupled from it through a low impedance line, usually into a 40 MC preamplifier. From there it can go directly into the normal 40 MC i-f system of the TV set. We provide either link coupling or low side capacity coupling to the 75-ohm line, depending on the type of circuit which the tuner is to feed. We tend to lean more toward the link coupling and have used it for the 13th position of our VHF turret which converts the VHF tuner to a 40 MC preamplifier, using the normal cascode circuitry as the first stage and the mixer as the second amplifier stage with B plus removed from the VHF oscillator.

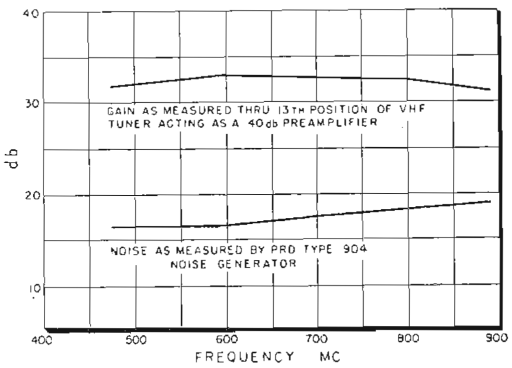


Fig. 7: Averaged noise and gain figures obtained from 10 production UHF tuners

Our VHF tuner can also be provided with a cam-operated slide switch which is thrown only when the tuner is in the 13th position. This slide switch at the rear of the VHF tuner performs all the necessary switching to convert from VHF to UHF operation.

It connects the output of the UHF tuner to the input of the VHF tuner, breaking connection with the VHF antenna. It connects B plus to the UHF tuner. If a single antenna is being used for both VHF and UHF, there are provisions on the switch to transfer the antenna lead from the VHF tuner to the UHF tuner.

In addition to this the VHF tun-

(*Continued on page* 150)

ers can be provided with the necessary gears, pulleys and idlers to permit driving the UHF tuner from the VHF fine tuning sleeve. This requires that the fine tuning control on the VHF tuner be of the 360° type. That is, without any stops in order that its shaft may be used for this purpose. Thus we are able to drive both UHF and VHF tuners from one multiple knob. For convenience of tuning indication, we have added to the VHF tuner an additional sleeve, which is directly driven from the UHF tuner and can be used to give almost any desired type of tuning indication.

Tuner Completely Enclosed

As shown in the left of Fig. 8 the tuner, when installed in a TV set, is completely enclosed with bottom, front and back covers, to reduce radiation, spray and spurious responses. Small holes have been provided in the front cover to touch up the coupling loops and the antenna input. The UHF tuner is mechanically coupled to the 13-position VHF tuner at the right.

In designing the tuner mechanically, it was appreciated very early that since the electrical operation was dependent almost entirely on mechanical configuration, it would be necessary to make the tuner and the relationship of the various component parts as rigid as practicable. The cradle of the tuner is made of 3/32-inch steel formed up on 3 sides. A tie bar is added across the bottom for additional rigidity. The parts

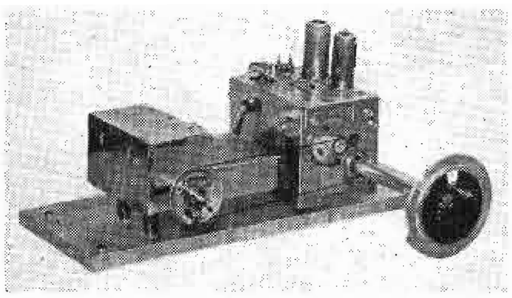


Fig. 8: View shows mechanical coupling for centralized control of the UHF tuner model 60 (left) and 13 position VHF model 48 tuner.

which are mounted on the cradle are either very securely soldered or staked or both. Thus we now have a tuner whose passbands and other electrical characteristics are only very affected by forces which would tend to skew or otherwise distort the unit. In addition, the mounting bosses are provided only in the heavy cradle itself to reduce the possibility of distortion due to mounting of the tuner. The unit as it now stands is extremely versatile both electrically and mechanically. The torque required to drive the tuning shaft is maintained within the same limits as those on production tuning capacitors. Thus it can be mounted in any position to which a string drive can be worked out. Shafts of any reasonable length can be provided and the shaft can be brought out from either or both ends of the tuner without changing our present production dies or techniques. In addition, by taking advantage of the "handles" which are an intrinsic part of the tuner, different oscillator frequencies can be used to obtain different intermediate frequencies quite easily without in any way complicating the normal production alignment and calibration procedure. This permits the same unit with very small changes to be run through on the same type production line and used as the UHF portion of a converter.

Two-Way Radio System for Utilities

The Montana-Dakota Utilities Co. has established a $250,000 radio-telephone network to improve customer service and increase the operating efficiency of its electric power and gas systems in North and South Dakota, Montana and Wyoming. Engineers of the General Electric Co. who assisted in planning the network, said it is one of the largest of its kind in the nation. Radio equipment furnished by GE includes 26 fixed transmitting stations, 45 remote control units for these stations, and 150 mobile radio-telephones. Seven more transmitting stations will be installed when license applications filed with the FCC are approved.

Motorola Announces New Subsidiary

Paul V. Galvin, President of Motorola, Inc., has announced the organization of a wholly owned subsidiary corporation, Motorola Communications and Electronics, Inc. The new company will distribute products manufactured by the Communications and Electronics Div. of the parent corporation. These products include complete mobile two-way radio systems, multi-channel microwave relay systems, power line carrier, supervisory and industrial control equipment.

New Cinema Plant

Ground breaking ceremonies were observed in Burbank, Calif., for the new building of the Cinema Engineering Co. with A. C. Davis, owner, turning the first shovelful of dirt at 1100 Chestnut St. Existing facilities, in several scattered locations, will all be assembled under the one roof with more than 18,000 sq. ft. of floor area, says James F. Fouch, general manager. May, 1953, is the scheduled completion date.

BOOKS

Antennas: Theory and Practice

By Sergei A. Schelkunoff and Harald T. Friis. Published 1952 by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 639 pages. Price $10.

As a comprehensive textbook for college study of the principles governing the behavior of antennas, this book makes a worthwhile contribution to the growing list of publications on the subject. While fully covering the application of theory to antenna design, the book makes little attempt to include much about engineering practice. In the authors' words, "Such details are learned best on the job." This book does not try to avoid the use of the formulas and partial differential equations so necessary for significant analysis of antenna theory. However, it does simplify as much as possible the mathematics which often become interminably involved, thereby making the work quite readable. This is not accomplished without some compromises, among them being the elimination of vector analysis.

After covering the fundamentals of radiation and Maxwell's equations, the text goes on to explain plane waves, spherical waves, directivity and current. The chapter on antenna impedance is followed by clear explanations and mathematical descriptions of the following types of antennas: self-resonant, linear, dipole, rhombic horn, and slot. Lucid descriptions of reflectors and lenses are also given. These latter chapters on antenna types are the ones which will probably prove of greatest interest to practicing engineers.—AJF

Designing for TV

By Robert J. Wade. Published 1952 by Pellegrini & Cudahy, 41 E. 50th St., New York 22, N. Y. 216 pages. Price, $8.50.

Here is a book which should be on the shelves of every engineer connected with television as well as those members of television station staffs who are more directly concerned with production problems. Although called "Designing for TV" the book might even better be called "Mechanics and Design for TV" since there is a tremendous wealth of information which most TV engineers have had to learn by bitter experience.

The name of the book should not frighten any engineer away from its fascinating and essential contents. As executive coordinator of production development for NBC, the author has compiled an amazing amount of information concerning the engineering, production, and staging of a television show. Television engineers will be interested in the section on special effects. The notes on costuming and make-up, and graphic arts including the use of color in monochrome television, provided in the chapter on scenic painting will save the newcomer to television engineering a tremendous amount of time and unnecessary experimentation. —JHB.

Planar Triode

(*Continued from page* 85)

tube elements, the values of cold interelectrode capacities are changed to higher values under operating conditions. The change in the plate-to-cathode capacity is relatively unimportant, but the grid-to-cathode capacity is important. The cold to hot change of the grid-to-cathode capacity is of the order of 100%. This increase in the effective interelectrode capacities of all tubes from cold to hot operating conditions must always be taken into account at high frequencies, but rarely is published due to the difficulty in measuring it in production, and because of the dependence upon electrode operating voltages. Accordingly, allowance was made for these capacity changes by increasing the given cold values by approximately 100% for use in the equations for line length.

The line lengths, and the spacing between the plate and cathode lines are:

Plate (1440 MC)	7.3 cm
Cathode (1440 MC)	6.3 cm
Spacing between plate and cathode lines	0.4 cm
Plate, 2880 MC	2.6 cm

These values include the lengths of the element rods inside the envelope. The lines external to the tubes are supported by grooved polystyrene blocks cemented to the cavity floor and located at the low impedance quarter-wave points. the rods being cemented in turn to the supporting blocks. This precaution is necessary to avoid shifts in line length and position, and to avoid unnecessary strain on glass-to-metal seals of the tubes. Because of the high Q's of the cavities, shifts in the positions of the lines result in changes in their resonant frequencies.

Tuning Adjustment

To allow adjustment in tuning, small washers one quarter inch in diameter are soldered to the end of 8-32 brass screws positioned near the half-wave points of the lines. This capacitive tuning method allows sufficient variation of the resonant frequencies of the coaxial cavities. It should be mentioned, in connection with temperature variations, that no tests of frequency variation as a function of temperature have been made. The multiplier unit has been used indoors and, because the tube seals operate at temperatures up to a maximum temperature of 175°C, seasonal and day-to-day variations in the indoor temperature

(*Continued on page* 154)

have no effect on the multiplier tuning.

The operating conditions of the unit are given in Table II.

A point of interest to remember when the 5768 tube is used as a frequency multiplier is the relationship between driving power and the close electrode spacing. Normally, a frequency multiplier is driven rather "hard," and with all electrodes energized with their proper dc potentials, no arcing difficulty will present itself. However, if the plate voltage is removed, and, if excitation is still applied, arcing between the cathode and the grid structure is likely to take place. This does no harm unless it occurs frequently, or unless it is allowed to continue for several days. If allowed to persist, such arcing will result in serious grid contamination from cathode material being deposited on the grid, resulting in reduced output.

Scalability of Multiplier Circuit

The circuit used in the frequency multiplier may be scaled directly for operation at lower frequencies where the inter-electrode capacities are a small percentage of the total tuning capacities for the circuit line lengths. For this case, the required lengths of line may be obtained directly by multiplying the original line length by the ratio of the new wavelength to the old line length. This was done in one case for a "times-three" multiplier with an input frequency of 250 MC, and an output frequency of 750 MC. The construction of this unit is similar to that of the "times-six" multiplier discussed above. An amplifier at 750 MC. is included in the cavity in order to raise the output of a value sufficient to drive a Sperry type SMC-11 multiplier klystron.

A second "times-three" multiplier followed by an amplifier was scaled from the "times-six" multiplier. A photograph of this unit is given in Fig. 4, showing the line construction. The input frequency is 160 MC and the output is 480 MC. In order to shorten the required line lengths at these frequencies, 1—7.5 μμf trimmers were used at the tube ends of the lines. Small holes in the outer wall of the cavity are provided for tuning these trimmers. The performance is very similar to that of the first unit that was scaled from the original.

The Sylvania Type 5768 planar triode offers a convenient means for frequency multiplication in the range from 150 to 3000 MC for systems that have moderate power requirements.

Among the advantages offered by a

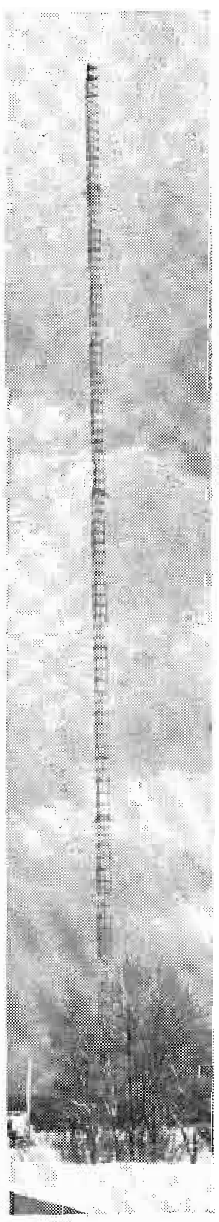
planar triode frequency multiplier are:

1. Double-ended construction simplifies cavity design and construction.
2. Circuitry is small in size and is reliable.
3. Circuits involved are stable and free of oscillation.
4. Circuits are economical in terms of power supply requirements (approximately 1.5 watts plate input power).
5. Circuits are scalable, especially toward lower frequencies.
6. Reproducibility of the circuitry is assured.

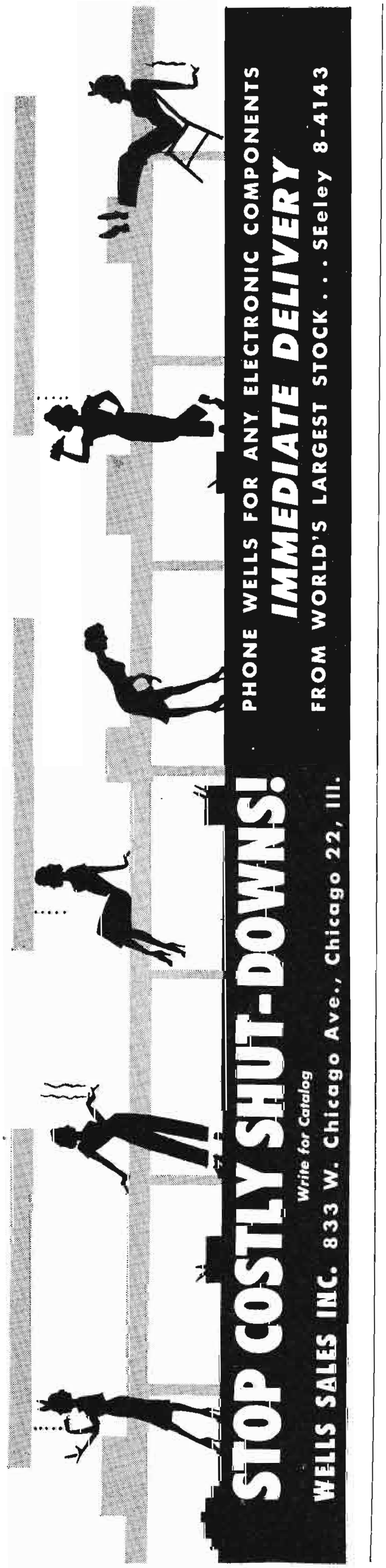
The work reported in this paper was done in connection with Air Forces Contract AF33 (038)-21995. The authors wish to express their appreciation to A. J. Heitner of the Sylvania Product Development Labs. for making available measurements on the tubes, and to H. C. Harris of the Sylvania Physics Labs. for his many helpful suggestions.

(1) Tyson, B. F. and Weissman, J. G., "An RF Amplifier for the UHF Television Band, "Sylvania Technologist," Vol. IV, No. 3, pp. 50-53, July 1951. Presented at the National Conference on Airborne Electronics, Dayton, Ohio, May 1951.

New Tower Among World's Tallest Structures


The Air Force's 1218-foot antenna tower located at Forestport, N. Y.

The Air Force's new 1218-foot radio tower at Forestport, N. Y., is among the world's tallest man-made structures. Utilized for experiments by the Rome Air Development Center, the tower uses four miles of 2.25 and 2-in. guy wires anchored 1051 ft. from the base. It required 772 tons of steel, and is shaped as an equilateral triangle, 15 ft. on a side. The 2,280,077-lb. compression load rests on a pivot base mounted on three porcelain insulators made by Lapp Insulator Co. The antenna structure features an elevator and hydraulic jack contact points. It was produced by Truscon Steel Co. and erected in 75 days by Wickes Eng. and Const. Co. The first wind loading test came just before construction was completed. A 120-mph wind caused under 3.5 ft. sway. For a 150-mph gale it can sway 7 ft.



RADIO-TV STOCK

Price Ranges of 120 Electronic Industries Stocks

Statistical Information Compiled by

Stock Exchange	Company	1945-1951 Price Range High	1945-1951 Price Range Low	1952 Price Range High	1952 Price Range Low	Current Price 1/2/53	Dividends Paid 1952 $ per share	Yield %
U	Acme Electric Corp.			6½	5	5⅞	0.42½	7.2
ASE	Acme Wire Corp.	32⅞	13a	27½	23⅜	26⅞	2.40	8.9
NYSE	Admiral Corp.	39¼	3a	32¾	24¾	30½	1.00	3.3
U	Aerovox Corp.	10½	1⅞a	10⅝	7⅛	10½	0.60	5.7
U	Aircraft Radio Corp.	-	-	8⅝	7⅝	7⅞	0.75	9.5
NYSE	Allegheny Ludlum Steel	61⅛	17⅛	46⅞	31⅞	38⅛	2.00c	5.2c
U	Alliance Mfg. Co.	-	-	23	13	23	2.00	8.7
U	Allied Electric Products Inc.	-	-	2¾	1⅜	2	Nil	-
NYSE	American Bosch	25a	6¼a	15⅜	10⅝	11¾	0.90c	7.7c
NYSE	American Broadcasting Co.	14¼	5½	12¾	8½	10	*	-
U	American Lava Corp.	-	-	-	-	88	*	-
NYSE	American Mach. & Fdry.	45¼	11½	24⅜	16¾	21⅞	0.80e	3.7e
U	American Phenolic Corp.	12⅝	2⅞	17⅜	11	17⅜	0.90	5.2
NYSE	American Tel. & Tel. Co.	200¼	138	161⅜	150⅞	160¼	9.00	5.6
U	American Transformer Co.	9½	2	7	3½	7	*	-
NYSE	Anaconda Wire & Cable Co.	47¾	19⅛	48¼	40¼	49¼	4.25	8.6
NYSE	Arvin Industries Inc.	30⅝a	10⅜a	32¾	25⅛	32⅝	2.00	6.1
U	Automatic Radio Mfg. Co. Inc.	-	-	2¼	1⅝	1¾	*	-
NYSE	Avco Mfg. Corp.	14⅜	4½	8¼	6⅞	8	0.60	7.5
MWSE	Belden Mfg. Co.	27	11	21½	16½	19½	1.60	8.2
NYSE	Bendix Aviation Corp.	63	26	64	45⅛	61	3.75	6.1
NYSE	Blaw-Knox Co.	30⅞	10⅞	18½	15⅞	18½	1.25	6.8
ASE	Breeze Corp.	15¾a	1⅞a	9½	5⅝	6⅛	0.25	4.1
NYSE	Burroughs Adding	21¾	12½	18½	16	16⅞	0.90	5.3
U	Capitol Records Inc.	29⅜	3	5¾	3¾	4½	0.42	9.4
U	Chicago Molded Products Corp.	12⅞a	2½a	14	12	12½	0.75a	6.0
ASE	Clark Controller	32	13⅝	32¼	25⅜	31¼	2.00	6.4
ASE	Clarostat Mfg. Co.	6⅝	1¾	6¼	4½	5	0.30	6.0
ASE	Claude-Neon Inc.	9	1⅛	6	4¼	5¼	*	-
U	Collins Radio Co.	16⅛a	3¼a	22⅜a	13⅛a	22⅝	0.40a	1.8
NYSE	Columbia Broadcasting System "B"	50	16⅝	39¾	32¼	39	1.60	4.1
ASE	Consol. Eng. Corp.	-	-	17½	10¾	15¼	0.40	2.6
NYSE	Cornell-Dubilier Electric Co.	25⅜a	6⅜a	22⅜	17a	20¼	1.27a	6.3
NYSE	Corning Glass Works	78	18	87½	66½	78⅝	2.00	2.5
NYSE	Cutler Hammer	45	18½	44	32¼	39⅜	2.50	6.3
NYSE	Davega Stores Corp. (N.Y.)	31a	10¼a	13	7⅞	8¼	0.50	6.1
NYSE	Decca Records, Inc.	37⅝	4⅝	9⅝	8	9¼	0.70	7.6
ASE	Driver Harris Co.	66	23	44	34½	38	2.10	5.5
U	Dumont Electric Corp.	-	-	2⅞	1⅝	2	*	-
ASE	Allen B. DuMont Labs "A"	21⅝	4½	19¾	15	16¼	0.25	1.5
U	Durez Plastics & Chemicals Inc.	28¼	8⅜	25½	18¼	22¾	1.00	4.4
NYSE	Eastman Kodak	47a	21a	48	41⅞	44½	1.75a	3.9
NYSE	Emerson Radio & Phonograph Co.	20¼a	6⅛a	15¾	11½	13⅛	0.70	5.3
U	Espey Mfg. Inc.	-	-	3½	3	3	*	-
ASE	Fairchild Camera & Inst. Co.	39	7⅛	28¾	22	25	0.25	1.0
NYSE	Fairchild Eng. & Airplane Co.	9	2	7¾	5¾	7½	0.60	8.0
NYSE	Gabriel Co.	15⅝a	4⅛a	8¼	5⅝	5⅞	*	-
U	General Aniline & Film Corp.	148	57½	140	90	100½	1.00	1.0
NYSE	General Bronze Corp.	23⅜a	7⅞a	18⅝	15¾	17¾	1.50	8.5
NYSE	General Electric Co.	63⅞	31¾	72¾	54⅜	72½	3.00	4.1
U	General Industries Co.	18¼	5	13¾	10⅞	12⅝	1.10	8.7
NYSE	General Instrument Corp.	19	4⅝	11⅛	6¼	10¾	0.25	2.3
NYSE	General Precision Equip. Corp.	40½	11⅞	24½	16⅞	22⅞	1.00	4.4
NYSE	General Rwy. Signal	48	15¼	36	25	35½	2.50	7.0
ASE	Globe-Union Inc.	30¼	6¼a	27	19¾	25½	1.25	4.9
MWSE	Hallicrafters	13¼	2⅜	8⅞	5⅛	8¼	*	-
ASE	Hazeltine Corp.	23⅝a	5a	26½	17⅜a	26	1.12½a	4.3
U	Hoffman Radio Corp.	21¾a	⅝a	16	10⅝	15	0.25	1.7
NYSE	International Bus. Mach.	240	79¼a	246½	186	234	4.00e	1.7e
U	International Resistance Co.	6⅝	½	5⅜	4	4⅛	0.30	7.3
NYSE	International Tel. & Tel. Corp.	33	7½	20¾	15	19⅛	0.80	4.2
U	Jefferson Electric Co.	21⅜a	4⅛a	12⅛a	9¾a	10¼	0.80a	7.8
U	Lear Inc.	8½	1⅛	4⅛	2⅝	3⅝	0.10f	2.8f
NYSE	Libby-Owens Ford Glass Co.	41¼a	21½a	42¾	33¾	42⅜	2.00	4.7
NYSE	Magnavox Co.	24¼	5	22½	15⅝	21	1.50	7.1

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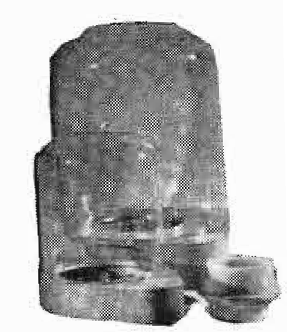
PRICE ANALYSIS

1945-1953, with Dividends Paid and % Yield

Merrill Lynch, Pierce, Fenner & Beone

Stock Exchange	Company	1945-1951 Price Range High	1945-1951 Price Range Low	1952 Price Range High	1952 Price Range Low	Current Price 1/2/53	Dividends Paid 1952 $ per share	Yield %
U	Maguire Industries Inc.	9 1/4	1/4	0.60	0.30	0.44	*	
U	P. R. Mallory Co. Inc.	30 7/8a	9 5/8a	42 3/4a	26a	42 1/2	1.00a	2.4
U	John Meck Industries	–	–	4	2 1/2	4	*	–
NYSE	Minn. Honeywell Reg.	56 3/4	21 1/8a	62 1/2	45 3/4	61 3/4	2.25	3.6
NYSE	Minnesota Mining & Mfg. Co.	54	7 1/2a	48 1/4	39	47 1/2	1.00	2.1
NYSE	Motorola Inc.	28 7/8a	4 3/8a	44 3/4	27 1/4a	41	1.50a	3.7
ASE	Muntz TV Inc.	–	–	5 1/8	4 1/8	4 1/2	*	–
ASE	Muter Co.	10 1/2a	2 1/4a	9 1/2	7 1/2	8	0.60	7.5
NYSE	National Cash Register	59 1/2	30 1/2	61 1/8	49 3/8	57	3.00	5.3
U	National Co. Inc.	7 3/4	1 3/8	5 1/4	3 3/8	5 1/4	*	–
ASE	National Union Radio	14	2	4	2 1/4	2 3/4	*	–
MWSE	Oak Manufacturing Co.	18 3/8	6 3/4	18 1/2	15	17 1/2	1.40	8.0
ASE	Olympic Radio & Television Co.	–	–	9	6 5/8	8	g	g
U	Packard-Bell Co.	10 7/8	1a	15 3/4	10 5/8	14 5/8	1.00	6.8
NYSE	Philco Corp.	27 5/8	10a	36 3/8	26 5/8	35 1/8	1.60	4.6
NYSE	Pittsburgh Plate Glass Co.	54 1/4	28 3/4a	56 1/2	42 3/4	55 1/2	2.00	3.6
NYSE	Radio Corp. of America	25 1/4	7 1/2	29 3/8	23 1/4	28 3/8	1.00	3.5
U	Ray-O-Vac	22 1/8	6 1/4a	18	15	17 3/4	1.20	6.8
NYSE	Rwytheon Mfg. Co.	29 1/8	4 1/8	12 3/4	8 1/8	12 1/2	*	–
U	Reeves-Ely Labs Inc.	4 7/8b	2 1/2b	6 1/2b	4 1/4b	5 7/8b	0.30b	5.1
U	Reeves Soundcraft	–	–	3 1/4	1 1/2	2	*	–
NYSE	Remington Rand	25 1/8a	8 1/8	21 1/4	17 3/4	19	0.75e	3.9e
NYSE	Revere Cooper & Brass	34 7/8	10 5/8	35	28 1/8	34 3/4	2.50	7.2
NYSE	Sangamo Electric	24 3/4a	11 1/8a	24	17 7/8	24	1.50	6.3
U	Scophony-Baird Ltd.	–	–	0.10	0.07	0.09 1/2	*	–
U	Scott Radio Labs Inc.	5 1/8	1	2 15/16	1 7/8	2 1/8	*	–
ASE	Sentinel Radio	10 1/4	1 3/4	6 3/8	4 7/8	5 7/8	0.10	1.7
U	Sight Master Corp.	–	–	0.54	0.30	0.39 1/2	*	–
ASE	Sonotone Corp.	7 1/4	2 1/2	4 7/8	4	4 7/8	0.32	6.6
NYSE	Sparks-Withington Co.	13 7/8	3 1/2	6 3/4	5	5 7/8	0.25	4.3
U	Speer Carbon Co.	–	–	24 1/4	19 1/4	20 5/8	1.00	4.8
NYSE	Sperry Corp.	40 1/2	16 3/4	45 1/4	31 1/2	42 3/4	2.00	4.7
U	Sprague Electric Co.	–	–	58a	26a	58	1.40a	2.4
NYSE	Standard Coil Products Co.	–	–	18 7/8	12 5/8	16 5/8	1.00	6.0
NYSE	Stewart Warner Corp.	26 3/8	9 1/2	22 3/8	18 1/8	22 1/4	1.75	7.9
U	Stromberg-Carlson Co.	24a	7 1/4a	19 3/4	12 3/8	17 3/4	1.00	5.6
NYSE	Sylvania Elec. Products Inc.	43 1/2	17 1/8	41 7/8	32 1/4	39 1/2	2.00	5.1
U	Television & Radar Corp.	–	–	0.80	0.38	0.73 1/2	*	–
U	Tele Video Corp.	–	–	0.48	0.17	0.40	*	–
U	Television Equipment Corp.	–	–	0.17	0.03	0.04 1/2	*	–
U	Television Electronics Fund	–	–	14.30	13.20	14 1/2	0.75 1/2	5.2
U	Trad Television Corp.	–	–	0.25	0.10	0.23	*	–
MWSE	Trav-ler Radio Corp.	–	–	3 1/8	2 1/2	2 3/4	*	–
NYSE	Tung-Sol Electric Inc.	24 1/4	3 5/8	21 7/8	16 1/4	21 5/8	1.25	5.8
NYSE	United Carr Fastener Corp.	40	23	33 5/8	26 1/2	29 1/8	2.00	6.9
U	Universal Winding Co.	13 1/4	7	9 1/8	6	6 3/8	0.25	3.9
U	Video Corp. of America	–	–	0.12	0.05	0.08	*	–
U	Webster-Chicago Corp.	17 1/2	5 1/8a	13 1/2	7 7/8	9 1/8	0.50	5.5
U	Wells Gardner & Co.	12 1/4	2 7/8	8 1/4	6 1/8	7 1/8	0.60	8.4
NYSE	Westinghouse Electric Corp.	42 1/2	20 5/8a	48 3/8	35 1/8	47 3/8	2.00	4.2
NYSE	Weston Elec. Instrument	63 1/4	21 3/4	44 1/2	34	42	2.00	4.8
NYSE	White (SS) Dental Mfg.	44	21 5/8	34 7/8	28 1/4	28 7/8	1.50g	5.2g
U	Wilcox-Gay Corp.	6	3/8	1 3/8	11/16	1	*	–
ASE	Woodall Industries Inc.	22 1/2	8 1/2	15 3/8	11 3/4	15	1.20	8.0
U	R. Wurlitzer Co.	34	3	11	7 3/8	8 5/8	0.80	9.3
NYSE	Zenith Radio Corp.	71 1/2	14 1/2	88 1/2	68	81	3.00	3.7

U- Unlisted - traded "over-the-counter".
NYSE- New York Stock Exchange.
ASE- American Stock Exchanoe (formerly New York Curb Exchange).
MWSE- Midwest Stock Exchange.
* - Dividends, if any, not reported.
a - Adjusted for stock dividends and/or stock splits of 10% or more.
b - $0.30 Cumulative Preferred Stock
c - Plus 2% stock.
e - Plus 5% stock.
f - Also paid 1/20 share of 5% Conv. Preferred.
g - Paid 3% stock.



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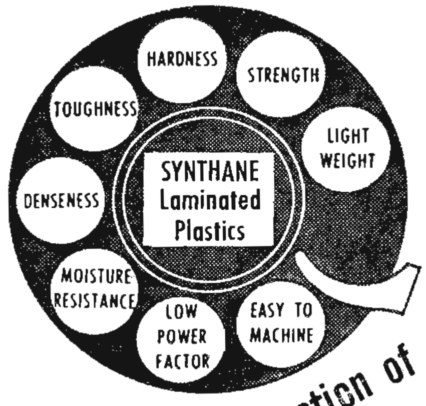

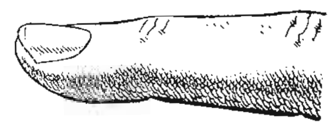

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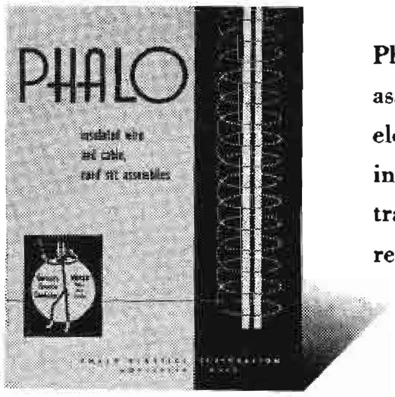

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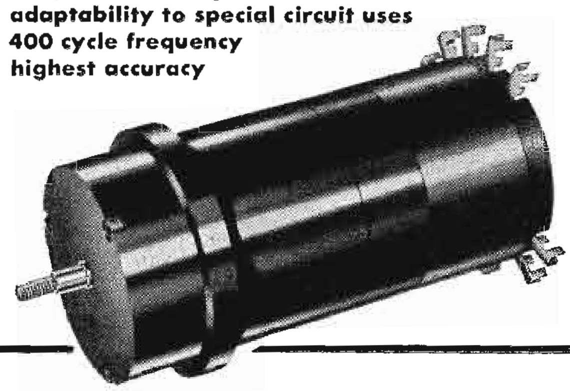

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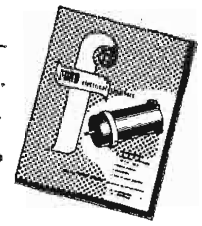

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Shielding Effects

(*Continued from page* 73)

alloy plate. The conventional subminiature shield is made out of 0.010 beryllium copper, silver plated.

In every case the chassis mounting was made from two inch by three inch by 1/32-in. brass plate. The chassis was mounted on two inch legs which allowed air to circulate all over the sides.

Bulb, shield, and chassis temperatures were taken at rated operating conditions on both tube types and at ambient temperatures of 28°C, 100°C, 150°C, and 200°C. The ambient temperatures were maintained constant by means of a specially insulated box containing a heater connected to a thermostatic element which permitted a fluctuation of only ±3°C at a particular setting. On the subminiature type press temperatures were also recorded. The actual temperatures were taken with a chromel-constantan thermocouple, wire size 0.002 inch. This combination was used as a thermocouple since it has greater sensitivity than any of the commercial thermocouples known. The fine wire size was used for the thermocouple assembly in order to minimize heat loss due to thermocouple contact and conductivity. The bulb temperatures on the subminiatures were obtained by drilling a 3/32 inch hole in the shield and attaching the thermocouple directly to the bulb with a small piece of tape. The thermocouples were attached to the shield and chassis directly by means of a resistance weld.

Results and Conclusions

Fig. 6 shows the results of the various types of shields and chassis mountings for the two tube types at various different ambient temperatures. One would normally expect that the subminiature tube would be at an inherent disadvantage with respect to bulb temperature at high ambient temperatures. However, it turns out that when conventional tube shielding and chassis mounting practice is applied to both tube types there is an insignificant difference in bulb temperature between the miniature and the subminiature tubes. This figure gives results for the typical operating conditions of the two tube types. This means that essentially they were both operated at the same total input wattage. When both tubes are in the unshielded state the subminiature bulb runs approximately 40 to 50 degrees hotter than the miniature. However,

(*Continued on page* 160)

when typical shielding is placed around these tubes the opposite effect is seen. The addition of the conventional high frequency shield to the miniature type increases the miniature bulb temperature by about 25°C for all ambient temperatures. On the other hand, the effect of the subminiature shield attached to the chassis reduces the subminiature bulb temperature by about 15 to 30 degrees at the higher ambient temperatures.

Good Thermal Contact

The importance of good thermal contact of the shield to the chassis is also pointed out. The soldered subminiature tube shields caused the bulb temperatures on the 5702 to run between 15 to 25 degrees cooler than the riveted shield.

The importance of shield design is manifested at the lower ambient temperatures. Here it is seen that the specially designed Raytheon T-3 shield will run approximately 15 degrees cooler than the conventional subminiature shield. At the higher ambient temperatures, however, there is no difference in bulb temperatures due to this difference in the shields.

The 5702 press temperature was found to be independent of the type of shielding and chassis mounting.

Although the bulb temperatures are the most important factors in this investigation, it will be interesting to note the chassis and shield temperatures.

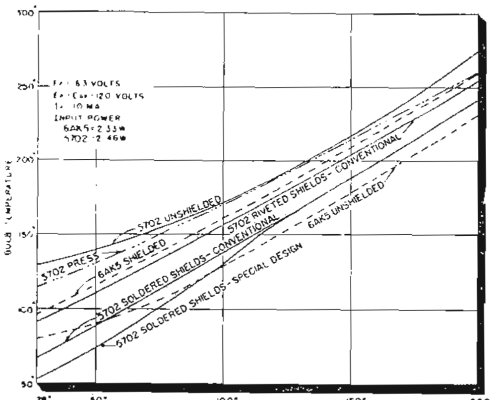


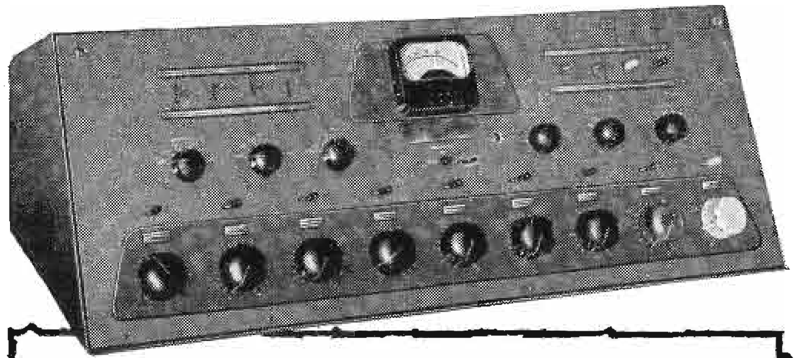
Fig. 6: Bulb temperature characteristics for various types of shield and chassis mountings

Table I shows how the effect of shielding and chassis mounting will cause the total radiant energy from the tube components to be redistributed to give the final bulb temperatures noted in Fig. 6.

Experience has indicated that almost any bulb temperature below the 275°-300° range is a safe one for a properly processed tube. It appears, then, that the 5702 operates at

(*Continued on page* 163)

All Plug-In AUDIO CONSOLE



**Buy only the amplifiers you need—
Add more as station requirements grow**

Answers every program audio facility you'll need for AM, FM or TV. Nine mixers and up to seven pre-amplifiers provide all necessary combinations for handling line, film, transcription or remote shows.

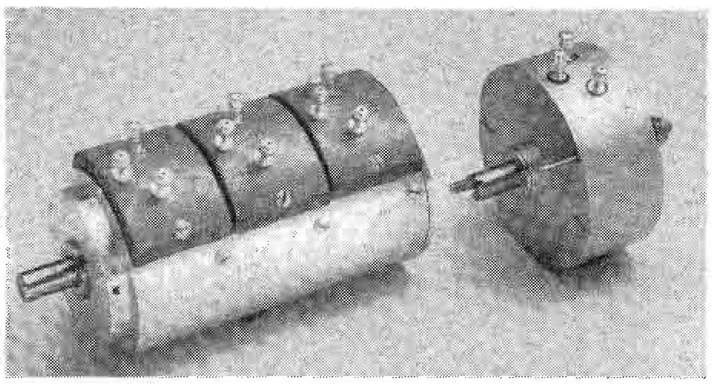
● All amplifiers easily and quickly plugged in. ● External connections plug-in. ● Color coded control knobs. ● Aluminum write-in strips.

For information write: General Electric Co., Section 4823, Electronics Park, Syracuse, N.Y.

GENERAL ELECTRIC

Precision Potentiometers

Designed by CORNELL for application wherever extreme precision is essential requirement.
Linear and NON-linear pots are designed to meet customer's requirements. Taps and special winding angles anywhere up to 360 continuous winding can be incorporated into both linear and non-linear units.

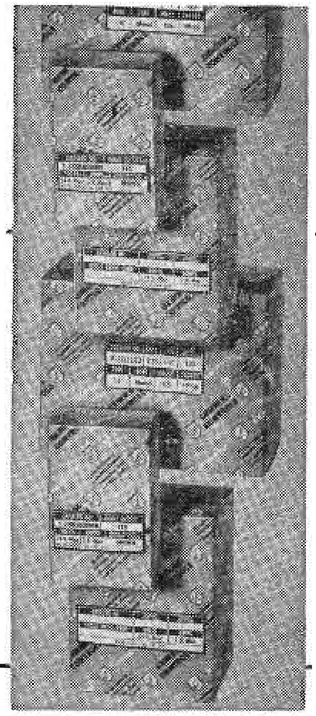


Type DS-6-1 5/8" in diameter. Type RAS-4-1 1/2" in diameter.
Other types available.

Request Additional Information Please.

CORNELL
ELECTRONICS CORPORATION
40-33 Main Avenue • Douglaston, N. Y.

Eliminate topheavy package inventories with **Kum-Kleen** **laid-on** *labels!*



a common problem... General Controls Co. of Glendale, California manufactures automatic controls for widely diversified applications. Warehousing formerly required segregation of more than 100 different boxes. Product changes, from time to time, would make certain pre-printed box inventories obsolete.

solved with Kum-Kleen labels... Now box inventories are maintained by size alone—IN HALF THE ORIGINAL SPACE! A self-adhesive Kum-Kleen label identifies the contents of each box *as it is used.* According to General Controls, "The unique characteristics of Kum-Kleen labels made this new packaging program possible, and they are saving us many thousands of dollars yearly." Their many Avery electric label dispensers "are proving themselves daily to be a most worthwhile investment as a time and labor saver."

how Kum-Kleen labels work... They're *pressure sensitive*—LAID ON *fast* with a finger-touch—no moistening, no mess! They stay neat and attractive—won't dry out, pop, curl or peel. Patented Avery dispensers—manual or electric—feed die-cut, Kum-Kleen labels off roller tape for quick, clean labeling.

Where can YOU use these labels in YOUR business?

For case histories, samples and prices, please mail the coupon below.

Kum-Kleen *pressure-sensitive* **laid-on** *labels*

AVERY *producers of pressure-sensitive products since 1935*

AVERY ADHESIVE LABEL CORPORATION

117 Liberty St., New York 6
608 S. Dearborn St., Chicago 5
1616 So. California Ave., Monrovia
Offices in Other Principal Cities

☐ *Please send case histories, free samples.* — name ______

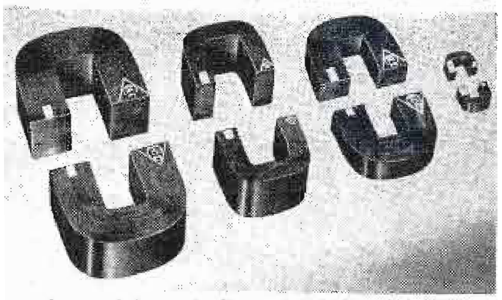
☐ *Have Avery label man call.* — title ______

Our business is ______ — company ______

address ______

Transformer Cores

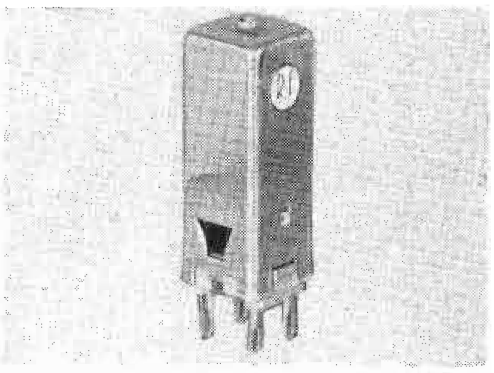
"Cee-Cors" are grain-oriented silicon-iron wound cores for transformer, indicator, and magnetic-amplifier applications. The cores



are formed by winding the thin ribbon-like grain-oriented iron into loops of proper shape and dimensions. Then, after heat treating and bonding, they are halved and supplied in matched pairs. They are available in various sizes, wound from 1-mil, 2-mil, 4-mil, and 12-mil silicon-iron. 12-mil Cee-Cors are normally used at power and low audio frequencies. 4-mil Cee-Cors are normally used at frequencies throughout the audio range, including aircraft, portable and mobile power-supply applications. 2-mil and 1-mil Cee-Cors are normally used for pulse, supersonic, and radio frequency components. —**Permoflux Corp. 4900 W. Grand Ave., Chicago 39, Ill.**—TELE-TECH

I-F Transformer

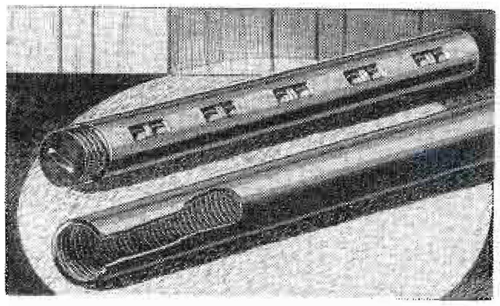
New Series A "RI-trans", i-f transformers are available in two constructions. One is designed for use on standard chassis, with



long, sturdy terminal lugs for conventional wiring and soldering. The other, for use with the new printed circuit chassis, employing short terminal lugs for pressure-fitting into the lug slot openings. Features of the new Series A "RI-trans" include "Torkrite" machine-cut internally-threaded coil forms, a product of Cleveland Container Company. This improvement insures uniform torque of the adjusting core and freedom from stripping on production lines or in field servicing.—**Radio Industries, Inc., 5225 N. Ravenswood Ave., Chicago 40, Ill.**—TELE-TECH

Threaded Coil Forms

A newly designed and constructed coil form tubing is now available that offers many definite advantages over earlier



cloverleaf type tubing. Named "Torkrite," this new internally threaded laminated phenolic tubing withstands more than the required core stripping pressure and permits coils to be wound at higher speeds without wire breakage and/or fallen turns. Core turning torque ranges between 1 to 5 oz. in. Cores cannot move with relation to the coil windings after peaking because of the engagement with internal threads in the coil form. Likewise, after winding, core turning torque does not increase since the heavier wall will not tend to collapse and bind. The heavier wall employed permits deeper threading inside the tube, a desirable feature from the standpoint of core recycling ability.—**The Cleveland Container Co., 6201 Barberton Ave., Cleveland 2, Ohio.**—TELE-TECH a safe bulb temperature without shielding even at an ambient temperature of 200°C.

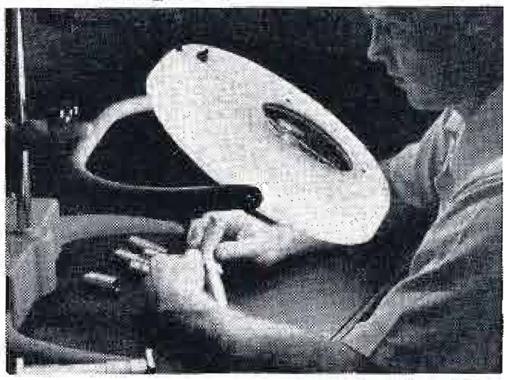
However, perhaps the most important point to note is that the bulb temperature in a subminiature tube with its typical shielding can actually run cooler than the bulb temperature of the miniature counterpart with its typical shielding, provided good thermal contact to the chassis is made.

The author would like gratefully to acknowledge the valuable assistance given by B. E. Hosmer and T. B. Gillis who carried out the experimental detail reported in this paper.

1. Buckland, "Basic Heat Transfer Data in Electron Tube Operation," **Trans. AIEE**, vol. 70, 1951.
2. P. T. Weeks, "Reliability in Miniature and Subminiature Tubes," **Proc. IRE**, vol. 39, no. 5, May 1951.

Visual Aid

"Magnavision," a visual aid for fine inspection and assembly work, provides a distortion-free, magnified, three-dimensional view



of objects. It features cool, shadowless illumination. Lamp and lens on the standard bench model are mounted on a swivelling head, adjustable for all angles. The pan and arm are removable and may be attached to a 12-ft. extension cord. Overall height is 16 in., width is 16 in., and depth is 14.5 in. Maximum extension distance to center of lens is 38 in.—**Engineering Developments 32 W. Pelham St., Newport, R. I.**—TELE-TECH

TV Timetable

(*Continued from page 93*)

State and City	Call Letters	Channel No.	Date On Air
Galveston	KTVR	41	*
Houston (NCE)	KUHT	8	5/53
Houston	*	23	*
Houston	KNUZ-TV	39	3/53
Lubbock	KCBD-TV	11	4/53
San Angelo	KTXL-TV	8	*
San Angelo	KGKL-TV	3	*
Waco	KANG-TV	34	*
Wichita Falls	KTVW	22	5/53
Wichita Falls	KFDX-TV	3	*
VIRGINIA			
Danville	WBTM-TV	24	*
Lynchburg	WWOD-TV	16	*
Lynchburg	WLVA-TV	13	2/53
Roanoke	WROV-TV	27	1/53
WASHINGTON			
Spokane	KXLY-TV	4	1/53
Tacoma	KTNT-TV	11	1/53
Tacoma	KMO-TV	13	5/53
Yakima	KIMA-TV	29	3/53
Yakima	KIT-TV	23	7/53
WISCONSIN			
Green Bay	WBAY-TV	2	*
Madison	WKOW-TV	27	7/53
Neenah	WNAM-TV	42	Summer
Oshkosh	WOSH-TV	48	4/53
HAWAII			
Honolulu	KAMI	11	Early '53
PUERTO RICO			
San Juan	WKAQ-TV	2	Late '53

See page 131 for list of TV stations now on the air.

TELE-TECH

A Caldwell-Clements Publication

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

ELECTRONIC INDUSTRIES

THE MICROWAVE PICTURE–1953

The fast-paced growth of microwave relay systems as an effective means for transmitting television, communication, and control information over long distances has continued to increase during the past few years. The close of 1952 witnessed a total of 1747 stations and repeaters in operation or under construction, covering over 40,000 route miles. About 60% of this number are already licensed and in operation.

The ability of microwave relays to withstand the storms and icing that have plagued pole-supported wire lines is one major reason for microwaves' popularity. Its multi-channel information capacity has also played a vital part.

Although the transcontinental relay of television programs and telephone conversations via common carrier microwave accounts for a large portion of the total number of installations, the lion's share belongs to the petroleum industry. Out of 1606 stations employed in 60 systems over 50 miles long, 886 serve the petroleum industry, 309 serve common carriers, and 245 are used by power companies.

Almost all of the 111 television stations now on the air have one or more remote pickup units employing this technique, but only four of them use microwaves as a means for connecting their transmitters to the networks in lieu of common carrier facilities (this is due in large part to the fact that the FCC has discouraged television station owners from installing these expensive systems with the contention that this is a function of the common carriers).

Features of Microwave Relays

Today, 60 systems are shown on the map on the reverse side. There are many applications for microwave systems in the pending files at the FCC but because these are experimental systems, and/or because they are less than 50 miles in length, they have not been shown on our map. In fact none of the systems shown in any of the categories are less than 50 miles in length since their inclusion would be confusing due to the small scale employed.

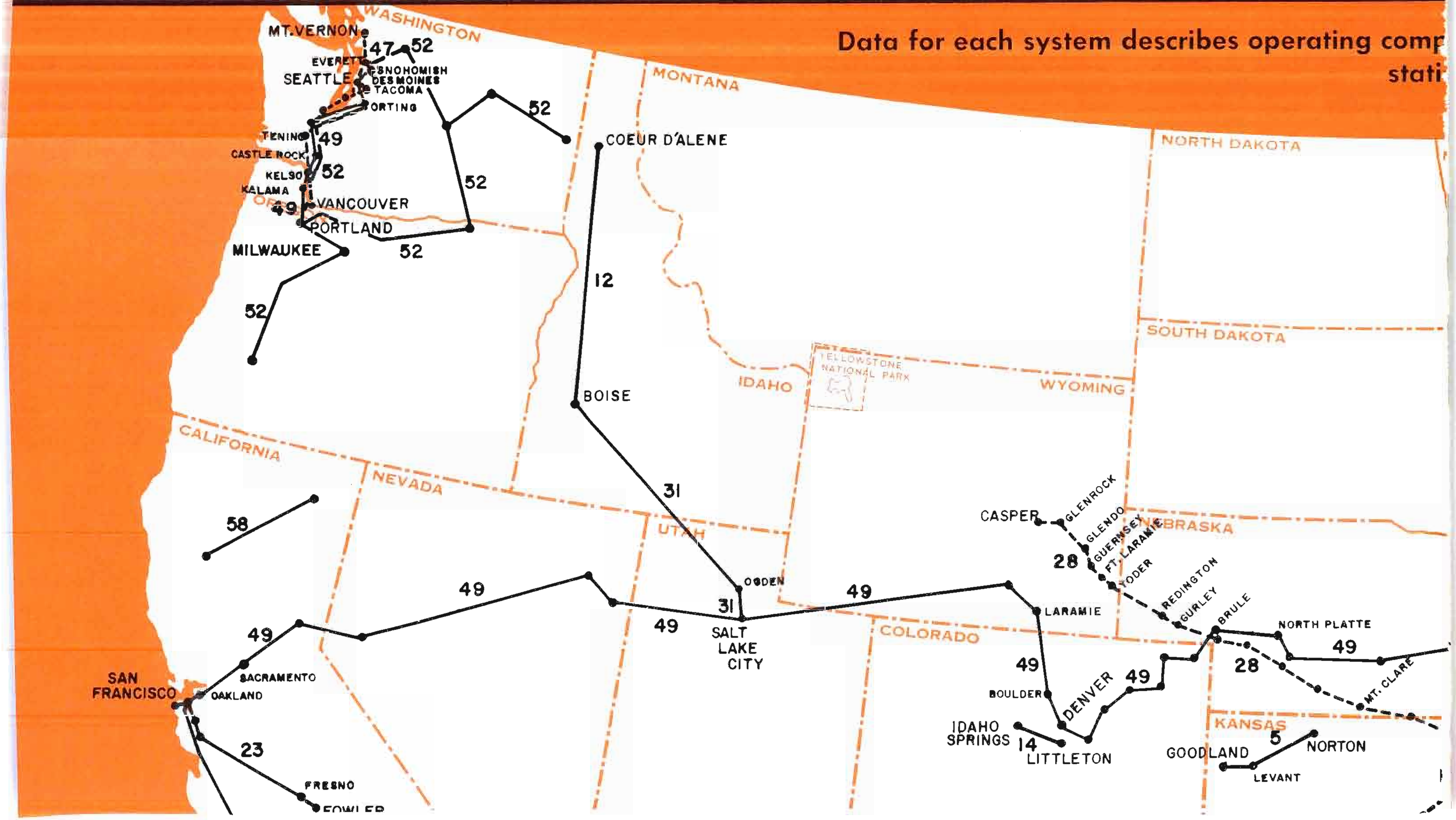
Tomorrow the microwave systems of the world will perhaps girdle the earth in much the same way that today's HF signals do. Already across the upper wastes of Canada the radar ranges that guard our northernmost frontiers exist as a foundation for a microwave chain. Plans are afoot for a microwave-VHF link across the Atlantic, to relay television programs between Europe and this country.

Today the term microwave is used somewhat loosely, but in the chart any frequency over 950 MC is classified as such. It is interesting to note that in most cases as the carrier frequency increases the bandwidth also increases. Of course at the higher frequencies multiplexing is the rule and the increased bandwidth is essential for this. Already the lower frequencies up to 7000 MC are relatively well developed and used, but the upper limits have yet to be explored commercially to any extent. We expect to see considerable progress in the utilization of the 10,000 MC band in the coming years, and as methods of microwave generation improve it is probable that much of todays' operations will shift to the higher regions.

TELE-TECH & ELECTRONIC INDUSTRIES

MICROWAVE RELAY S

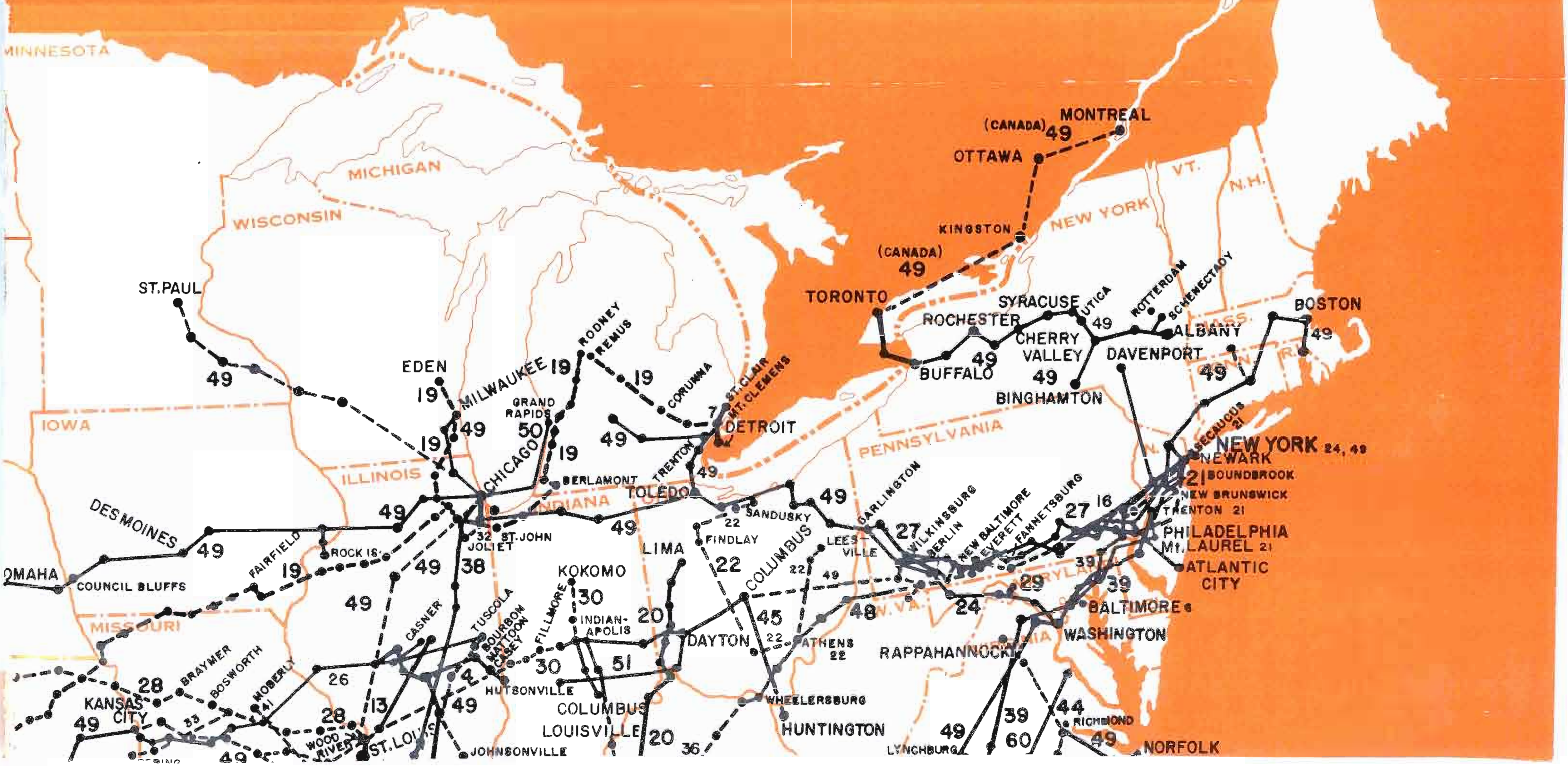
Data for each system describes operating comp
stati



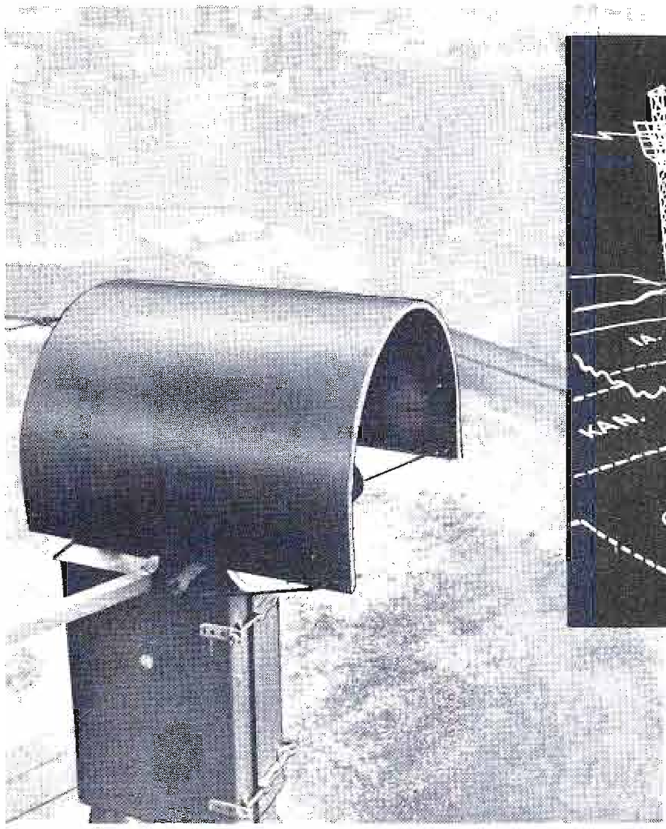
YSTEMS in United States

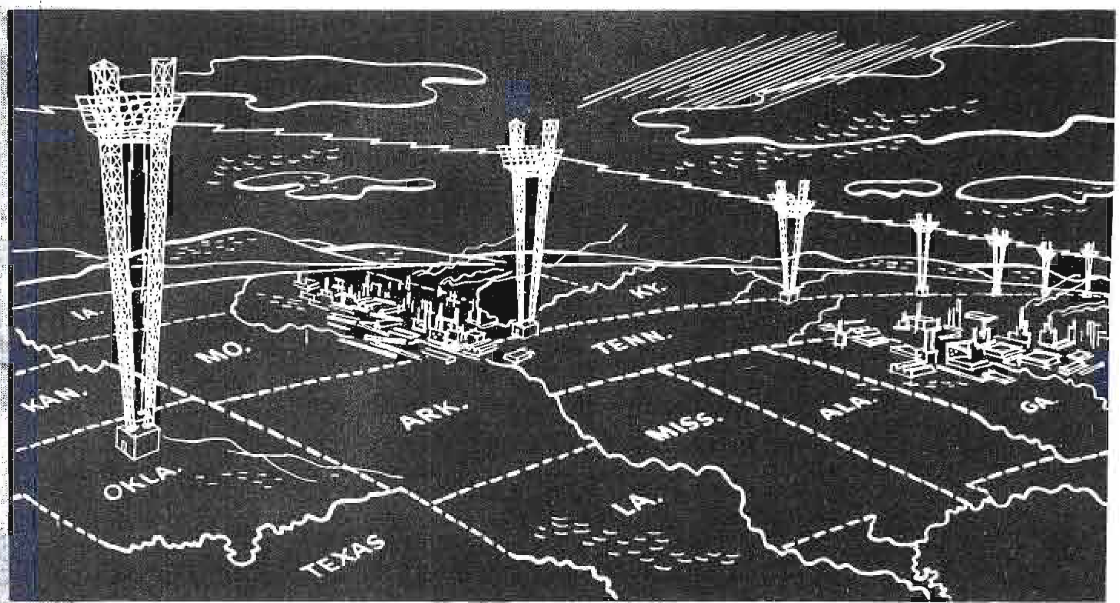
TELE-TECH
& ELECTRONIC INDUSTRIES

pany, type of service, number of
ons and repeaters, nominal operating frequency and r-f bandwidth

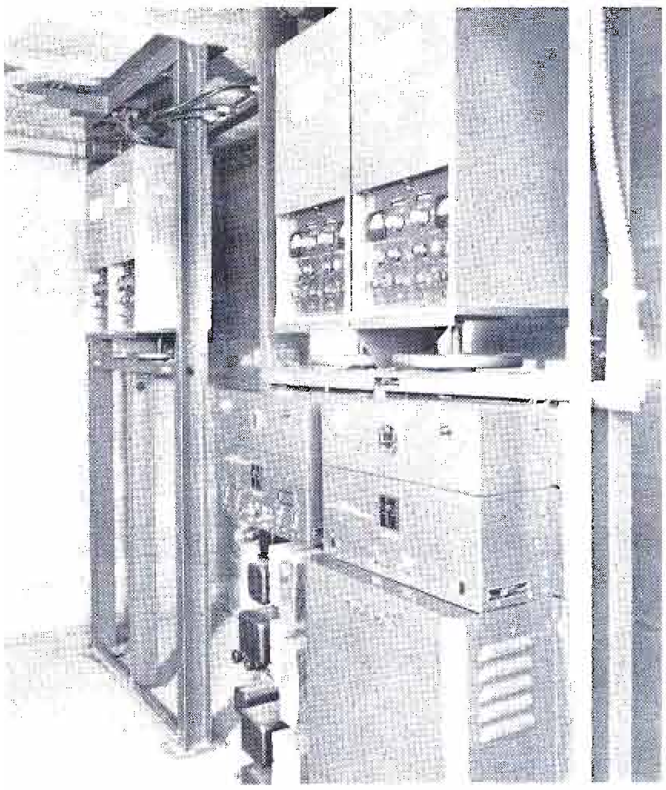


Motorola Proves-Up Microwave





Operating on a round-the-clock basis for Texas-Illinois Natural Gas Pipeline Co., this Chicago roof-top installation terminates a thousand-mile Motorola microwave system that provides the ultimate in highly dependable, extremely flexible, industrial communications.



Completely unattended, fully protected Motorola Micropackage installation insures long-life, trouble-free operation for isolated repeater stations. All r-f, power supply, and standby units are rack-mounted, with unique sensing circuits for automatic standby switchover.

Successful Motorola Engineering has produced the kind of thoroughly dependable Microwave that industry and safety services are adopting with justified confidence.

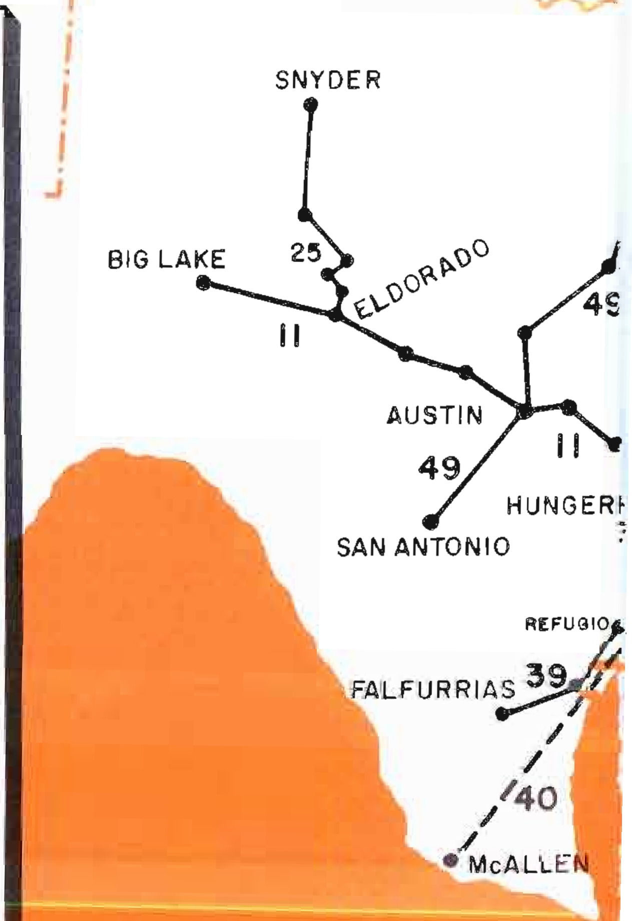
Eight Motorola systems have been operating 24 hours daily, non-stop, for over four years!

Motorola's Frequency Division multiplexing and Double FM System combine simplified circuitry with maximum flexibility. Full duplex service transmits hundreds of telephone, telegraph, teletype, facsimile, telemetering and supervisory control signals over a 24-channel carrier at lowest cost per working circuit. Excellent signal-to-noise ratio and simple routing of individual channels at repeater stations are available in a system that complies with all standard commercial telephony practices.

- **Hundreds of system control and communication signals over one carrier.**
- **Passive reflectors at tower tops, eliminating long transmission lines.**
- **Extremely long-life klystrons for economy and utmost dependability.**
- **Rugged design and plug-in construction for simple maintenance, highest reliability, lowest operating cost.**
- **Full standby facilities with unique automatic sensing, switchover, and alarm circuits.**
- **Complete customer service, including field engineering, installation, parts depots, technician training schools.**

Job Proven Microwave

—by the leaders of the 2-way Radio Industry!



Code numbers on microwave routes refer to systems over 50 miles long indicated on map above. Reverse side lists addresses of operating companies, systems under 50 miles, short-haul Bell System relays, and applicants.

System number	OPERATING COMPANY	Service provided*	No. stations & repeaters†	Nominal operating freq. (MC)	Nominal bandwith (MC)
1	Arizona Public Service Co.	IW	8(C)	950 & 1850	0.3 & 3
2	Atchison Topeka & Santa Fe RR	L	5(L)	6700	10
3	Blueridge Elec. Member. Corp.	IW	4(L)	950	0.04
4	Central Ill. Public Service Co.	IW	27(L)	6700	10
5	Chicago Rock Island Pacific RR	L	14(L)	6700	10
6	Con. Gas, Elec. & Power Co. of Bal.	IW	2(C) & 2(L)	950	0.5
7	Detroit Edison Co.	IW	5(L)	1950	5.6
8	El Paso Natural Gas Co.	IL	16(L)	6700	10
9	Freeport Sulphur Co.	II	11(C)	6700	12
10	Great Lakes Pipe Line Co.	IL	6(L)	6700	10
11	Humble Pipe Line Co.	IL	36(L)	6700	10
12	Idaho, State of	PH	2(C) & 2(L)	950	0.08
13	Illinois Power Co.	IW	8(C) & 17(L)	6700	10
14	Intermount. Rural Elec. Assoc.	IW	4(L)	950	0.08
15	Interstate Petrol. Comm. Inc.	IL	14(L)	6700	10
16	Keystone Pipe Line Co.	IL	5(L)	1900	10
17	Los Angeles Calif., City of	PF & IW	7(L)	950 & 1900	0.24 & 5.6
18	Los Angeles Calif., County of	PP	6(C)	6700	10 & 12
19	Mich.-Wis. Pipe Line Co.	IL	237(C)	1900	5.6
20	Mid-Valley Pipe Line Co.	IL	56(L)	6700	10
21	New Jersey, State of	PP	9(L)	950	0.5
22	Ohio, State of	PO	10(C)	950	0.18
23	Pacific Gas & Elec. Co.	IW	1(C) & 4(L)	950	0.25
24	Western Union	CF	29(L)	4000 & 6000	4
25	Pan American Pipe Line Co.	IL	15(L)	6700	10
26	Panhandle Eastern Pipe Line Co.	IL	3(C) & 23(L)	6700	10
27	Pennsylvania, Commonwealth of	PP	30(L)	950	0.5
28	Platte Pipeline Co.	IL	79(C)	6700	10
29	Potomac Edison Co.	IW	6(C) & 2(L)	950	0.08 & 0.5
30	Public Service Co. of Ind.	IW	11(C) & 2(L)	1900	6
31	Salt Lake Pipe Line Co.	IL	3(L)	950	0.24
32	Service Pipe Line Co.	IL	3(C)	950	0.3
33	Sinclair Pipe Line Co.	IL	32(C)	6700	12
34	Southern Calif. Edison Co.	IW	10(C) & 2(L)	950 & 1900	0.15 & 5.6
35	Sunray Oil Corp.	IL	5(L)	950	0.3
36	Texas Eastern Trans. Corp.	IL	47(C) & 38(L)	1900	5.6
37	Texas Gas Transmission Corp.	IL	3(L)	6700	10
38	Texas Ill. Natural Gas Pipe Co.	IL	74(L)	6700	10
39	Transcontinental Gas Pipe Corp.	IL	70(L)	950 & 1900	0.1 & 6
40	Trunkline Gas Co.	IL	101(C) & 1(L)	1900	0.04 & 5.6
41	Union Elec. Co. of Missouri	IW	8(C) & 7(L)	950 & 1900	0.3 & 3
42	Union Elec. Power Co.	IW	3(C)	1900	3
43	United Gas Pipeline Co.	IL	6(C) & 2(L)	950 & 1900	0.3 & 3
44	Virginia, Commonwealth of	PP	8(C)	950	0.36
45	WSAZ Inc.	BA	6(L)	2000	17
46	WSM Inc.	BA	6(L)	2000	17
47	Washington, State of	PP	16(C)	1900	3
48	West Penn Power Co.	IW	3(C)	950 & 1900	0.5
49	Bell System	CB & CF	47(C) & 249(L)	4000 & 6000	20
50	WOOD Inc.	BA	3(L)	2000	17
51	WTTV Inc.	BA	3(L)	2000	17
52	Bonneville Power Admin.	IW	4(C) & 44(L)	7000	10
53	Shell Pipeline Co.	IL	8(L)	6700	10
54	Middle South Utilities	IW	17(C)	6700	10
55	Plantation Pipeline Co.	IL	7(C)	1900	6
56	Tenn. Valley Authority	IW	19(C) & 6(L)	1900	6
57	Southern Cal. Edison	IW	11(L)	1900	5.6
58	Citizens Utilities Co.	CF	5(L)	950	5.6
59	Peninsular Tel. Co.	CF	3(C)	950	5.6
60	Tidewater Tel. Co.	CF	5(C)	950	5.6

*FCC-designated service symbols:
BA Auxiliary Broadcost
CB—Common Carrier, Television Broadcast
CF—Common Carrier, Domestic Fixed Public
II—Industrial, Special
IL—Industrial, Petroleum
IW—Industrial, Power
L—Land Transportation, Railroad
PF—Public Safety, Fire
PH—Public Safety, Highway Maintenance
PO—Public Safety, Forestry Conservation
PP—Public Safety, Police

†(C) denotes stations under construction. For Bell System represents stations under construction and proposed. (L) denotes stations licensed and operating.

Non-TV Bell System Short Haul Microwave Relays

Operating Company	Nominal Operating Frequency (MC)	No. of Stations & Repeaters	System Location
Chesapeake & Potomac Tel. Co. of Va.	900	2	Cape Charles - Norfolk, Va.
Pacific Tel. & Tel.	4500	2	Los Angeles - Catalina, Cal.
New England Tel. & Tel.	4500	2	Barnstable - Nantucket, Mass.
New England Tel. & Tel.	900	2	Barnstable - Nantucket, Mass.
Bell Tel. Co. of Canada	1850	2	Quebec - St. Henri de Levis, Quebec
Pacific Tel. & Tel.	4000	3	Los Angeles - Ventura, Cal.
Pacific Tel. & Tel.	4500	3	Los Angeles - Ventura, Cal.
Pacific Tel. & Tel.	6000	2	Anaheim - Santiago Peak, Cal.
Southwestern Bell Tel. Co. & A.T. & T. Co., Long Lines Dept.	6000	4	Austin - San Antonio, Tex.

Companies Operating Systems Over 50 Miles

Names & Addresses of Companies & Names of Communication Executives for Systems Shown on Map

1. Arizona Public Service Co., Comm. Dept., Box 2591, Phoenix, Ariz. Mr. R. J. McKnight
2. Atchison, Topeka & Santa Fe RR 80 E. Jackson Blvd., Chicago 4, Ill. Mr. J. A. Parkinson
3. Blueridge Elec. Membership Corp. N. Mulberry St., Lenoir, N. C.
4. Central Ill. Public Service Co. 607 N. Adams St., Springfield, Ill. Mr. H. W. Benning
5. Chicago, Rock Island & Pacific LaSalle Street Sta., Chicago 5, Ill. Mr. C. C. Ellis
6. Cons. Gas Elec. Light & Power Lexington Bldg., Baltimore, Md. Mr. G. H. Koether
7. The Detroit Edison Company 2000 2nd Ave., Detroit 26, Mich. Mr. E. D. Glatzel
8. El Paso Natural Gas Company 1010 Bassett Twr, El Paso, Texas Mr. L. G. Wainman
9. Freeport Sulphur Co. New Orleans, La. Mr. A. J. Lehman
10. Great Lakes Pipe Line Co. Drawer 2239, Kansas City, Mo. Mr. C. C. Keane
11. Humble Pipe Line Company Drawer 2220, Houston 1, Texas Mr. H. C. Clark
12. Idaho, State of
13. Illinois Power Co. 112 E. Washington St. Monticello, Illinois
14. Intermountain Rural Elec. Assoc. 220 West Main Street Littleton, Colorado
15. Interstate Petroleum Comm. Inc.
16. Keystone Pipe Line Co. 260 Broad Street Philadelphia 1, Pa.
17. Los Angeles, City of
18. Los Angeles, County of
19. Michigan-Wisconsin Pipe Line Co. 500 Griswold St., Detroit 26, Mich. Mr. Sam McConoughey
20. Mid-Valley Pipe Line Co. Longview, Texas Mr. C. A. Compton
21. New Jersey, State of NJ Turnpike Auth., Trenton, N. J.
22. Ohio State Highway Patrol 1117 E. Broad St., Columbus 5, O. Mr. C. Elliott
23. Pacific Gas & Electric Co. 245 Market St., San Francisco 6, Calif. Mr. R. H. Miller
24. Western Union 60 Hudson St., New York, N. Y. Mr. J. Z. Millar
25. Pan American Pipe Line Co. 1420 Esperson Bldg, Houston 2, Texas, Mr. H. A. Rhodes
26. Panhandle Eastern Pipe Line Co. 1221 Baltimore Ave., Kansas City 6, Mo. Mr. J. A. Fowler
27. Pennsylvania State Police P.O. Box 871, Harrisburg, Pa. Lt. D. E. Wagner
28. Platte Pipeline Co. Sinclair Bldg., Independence, Kans. Mr. K. T. Feldman
29. Potomac Edison Co. 55 E. Washington St., Hagerstown, Md. Mr. H. B. Pitzer, Jr.
30. Public Service of Indiana, Inc. 110 N. Ill. St., Indianapolis 9, Ind. Mr. D. H. Ashlock
31. Salt Lake Pipe Line Co. Box 117, Salt Lake City, Utah
32. Service Pipe Line Co. Service Pipe Line Bldg. (Box 1979) Tulsa 2, Oklahoma
33. Sinclair Pipe Line Co. Sinclair Bldg., Independence, Kans. Mr. L. E. Cook
34. Southern Calif. Edison Co. 601 W. 5th St., Los Angeles, Calif.
35. Sunray Oil Corporation First Natl. Bldg., Tulsa 3, Okla.
36. Texas Eastern Transmission Co. PO Box 1612, Shreveport 94, La. Mr. H. G. Pegues
37. Texas Gas Transmission Corp. 416 W. 3rd St., Owensboro, Ky. Mr. D. R. Wofford
38. Tex Ill. Natural Gas Pipeline Co. 20 N. Wacker Dr., Chicago, Ill.
39. Transcontinental Gas Pipe Line 3100 Travis, Houston, Texas Mr. H. A. Rhodes
40. Trunkline Gas Company P.O. Box 1642, Houston 5, Texas Mr. M. O. Sharp
41. Union Electric of Missouri 315 N. 12th Blvd., St. Louis 1, Mo. Mr. G. W. Fox
42. Union Electric Power Co.
43. United Gas Pipe Line Co. Box 1407, Shreveport 92, La. Mr. H. G. Pegues
44. Department of State Police P.O. Box 1299, Richmond 10, Va. Mr. W. M. Lee
45. WSAZ Inc. W. Va. Bldg., Huntington, W. Va. Mr. L. H. Rogers
46. WSM Inc. 7th & Union Sts., Nashville, Tenn. Mr. Irving Waugh
47. Washington, State of
48. West Penn Power Co. PO Box 1736, Pittsburgh 30, Pa. Mr. J. G. McKinley
49. Bell System, Long Lines Info Dept. 32 Ave. of the Americas, New York 32, N. Y.
50. WOOD-TV Natl Bank Bldg., Grand Rapids, Mich. Mr. Robert Wilson
51. WTTV 535 S. Walnut St., Bloomington, Ind. Mr. M. L. Weigel
52. Bonneville Power Admin. Portland, Ore. Mr. R. W. Stevens
53. Shell Pipeline Co. Houston, Texas Mr. Littel
54. Middle South Utilities Pine Bluff, Arkansas Mr. R. Brewer
55. Plantation Pipeline Co. Atlanta, Ga. Mr. W. Borland
56. Tenn. Valley Authority Chattanooga, Tenn. Mr. E. Owenby
57. Southern Cal. Edison 601 W. Fifth St. Los Angeles 13, Cal.
58. Citizens Utilities Co. Reading, Cal.
59. Peninsular Tel. Co. Tampa, Fla.
60. Tidewater Tel. Co. Warsaw, Va.

Companies Operating Systems Under 50 Miles

Acme Natural Gas Co.
Aeronautical Radio
Alabama Power Co.
Amicola Elec. Membership Corp.
Arizona, State of
Arkansas, State of
Associated Lumber & Box Co.

Blackstone Valley G. & E. Co.
Brazos River Elec. Trans. Corp.
Bremer Broadcasting Corp.

California, State of
Carolina Power & Light Co.
Center Broadcasting Co., Inc.
Central Broadcasting Co.
Clark, Nev., County of
Cook, Ill., County of

Dayton, Ohio, City of
Duke Power Co.

Electric Energy Inc.
Elm City Broadcasting Co.

Fetzer Broadcasting Co.

General Electric Co.
Grandwood Broadcasting Co.
Greenwood Tel. Co.

Hevens & Martin Inc.
Humble Oil & Refining Co.

Jefferson Standard Broadcasting Co.

KTTV Inc.

LaFourche Tel. Co.
Land Air Inc.

Maricopa County, Ariz.
Mass., Commonwealth of
Memphis Publishing Co.
Michigan, State of
Missouri, North East Elec. Power Coop
Monona County Rural Elec. Coop

National Bureau of Standards
Natural Gas Storage Co.
New Orleans Public Service Inc.
New York, N. Y., City of
Niagara Mohawk Power Corp.

Orange, Calif., Count of

Pacific Gas & Electric Co.
Pacific Power & Light Co.
Paramount Telev. Prod. Inc.
Pennsylvania Elec. Co.
Phila. Elec. Co.
Philco Corp.
Phoenix Radio Mess. Service
Press Wireless Inc.
Public Service Elec. & Gas Co.

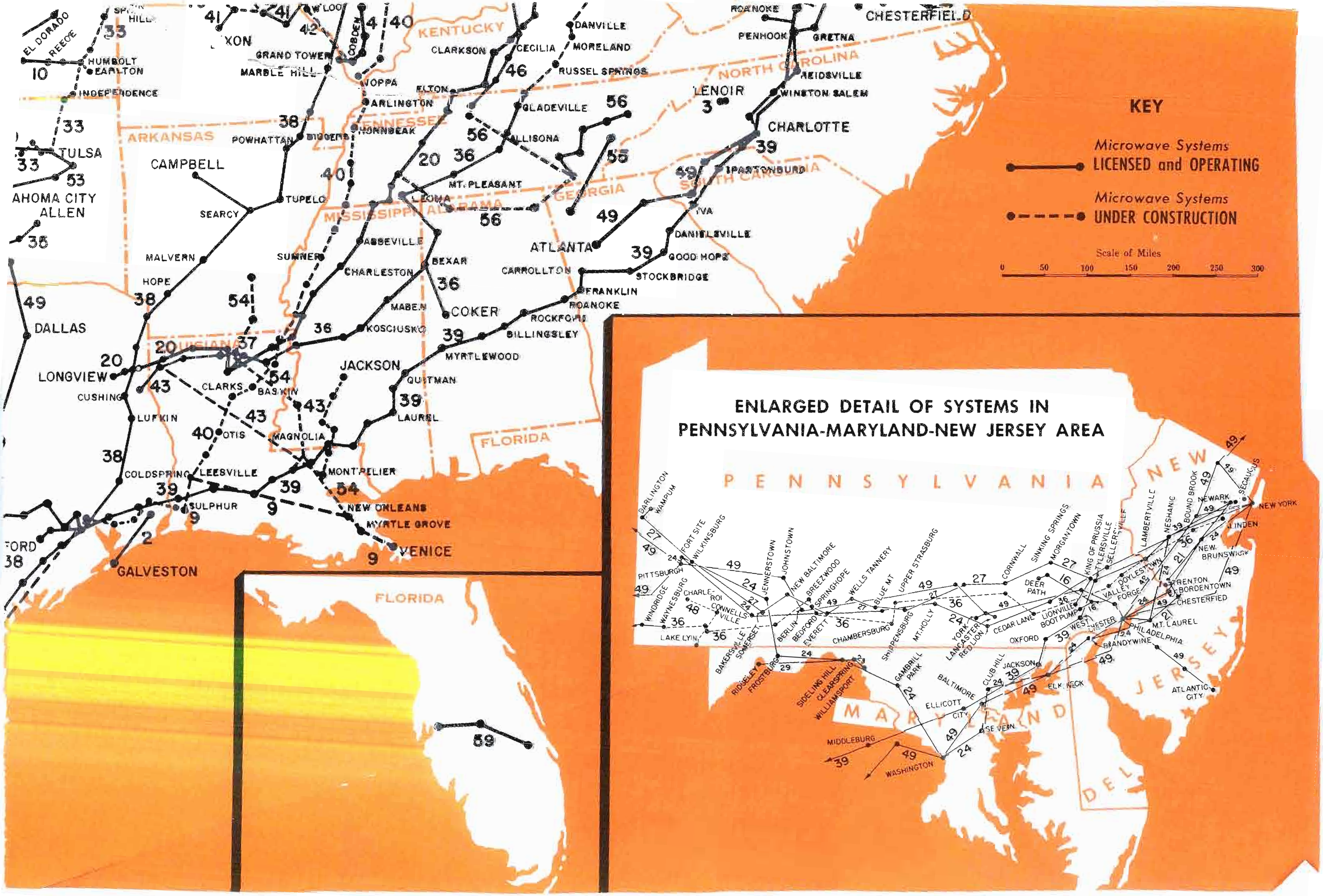
San Diego, Calif., City of
Santa Clara, Calif., County of
Santa Fe Tel. Co.
Scripps Howard Radio Inc.
Seattle, Wash., City of
Southern Counties Gas Co. of Calif.
Storer Broadcasting Co.
Stromberg-Carlson Co.
Sylvania Elec. Products Inc.

Tarzian Sarkes Inc.
Texas Electric Co.

United Gas Corp.
United Radio Communications
Utah, Radio Service Corp. of

Versluis Radio & Telev. Inc.

WBEN Inc.
WJIM Inc.



KEY
Microwave Systems
LICENSED and OPERATING
Microwave Systems
UNDER CONSTRUCTION
Scale of Miles
0 50 100 150 200 250 300
ENLARGED DETAIL OF SYSTEMS IN
PENNSYLVANIA-MARYLAND-NEW JERSEY AREA
PENNSYLVANIA
MARYLAND
NEW JERSEY
DEL
KENTUCKY
ARKANSAS
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
LOUISIANA
NORTH CAROLINA
SOUTH CAROLINA
FLORIDA
EL DORADO
REECE
HUMBOLT
EARLTON
INDEPENDENCE
TULSA
AHOMA CITY
ALLEN
CAMPBELL
SEARCY
POWHATTAN
MALVERN
HOPE
DALLAS
LONGVIEW
CUSHING
LUFKIN
COLDSPRING
GALVESTON
SULPHUR
LEESVILLE
OTIS
CLARKS
BASKIN
MAGNOLIA
MONTPELIER
NEW ORLEANS
MYRTLE GROVE
VENICE
JACKSON
QUITMAN
LAUREL
KOSCIUSKO
MABEN
COKER
BEXAR
CHARLESTON
ABBEVILLE
SUMNER
TUPELO
BIGGERS
HORNBEAK
ARLINGTON
JOPPA
ELTON
GRAND TOWER
MARBLE HILL
COBDEN
CLARKSON
CECILIA
MORELAND
DANVILLE
RUSSEL SPRINGS
GLADEVILLE
ALLISONA
MT. PLEASANT
LEOMA
MYRTLEWOOD
BILLINGSLEY
ROCKFORD
ROANOKE
FRANKLIN
STOCKBRIDGE
CARROLLTON
ATLANTA
GOOD HOPE
DANIELSVILLE
IVA
SPARTANBURG
CHARLOTTE
LENOIR
WINSTON SALEM
REIDSVILLE
GRETNA
PENHOOK
ROANOKE
CHESTERFIEL.D
DARLINGTON
WAMPUM
FORT SITE
WILKINSBURG
PITTSBURGH
WINDRIDGE
WAYNESBURG
CHARLEROI
CONNELLSVILLE
LAKE LYNN
BAKERSVILLE
SOMERSET
JENNERSTOWN
JOHNSTOWN
BERLIN
NEW BALTIMORE
BREEZWOOD
BEDFORD
EVERETT
SPRINGHOPE
WELLS TANNERY
BLUE MT
UPPER STRASBURG
CHAMBERSBURG
SHIPPENSBURG
MT. HOLLY
YORK
LANCASTER
RED LION
CEDAR LANE
CORNWALL
SINKING SPRINGS
MORGANTOWN
DEER PATH
LIONVILLE
BOOT PUMP
OXFORD
WEST CHESTER
KING OF PRUSSIA
TYLERSVILLE
SELLERSVI
VALLEY FORGE
DOYLESTOWN
LAMBERTVILLE
NESHANIC
BOUND BROOK
NEWARK
SECAUCUS
NEW YORK
LINDEN
NEW BRUNSWICK
TRENTON
BORDENTOWN
CHESTERFIED
MT. LAUREL
PHILADELPHIA
BRANDYWINE
ATLANTIC CITY
ELK NECK
JACKSON
CLUB HILL
BALTIMORE
ELLICOTT CITY
SEVERN
GAMBRILL PARK
RIDGELEY
FROSTBURG
SIDELING HILL
CLEARSPRING
WILLIAMSPORT
MIDDLEBURG
WASHINGTON

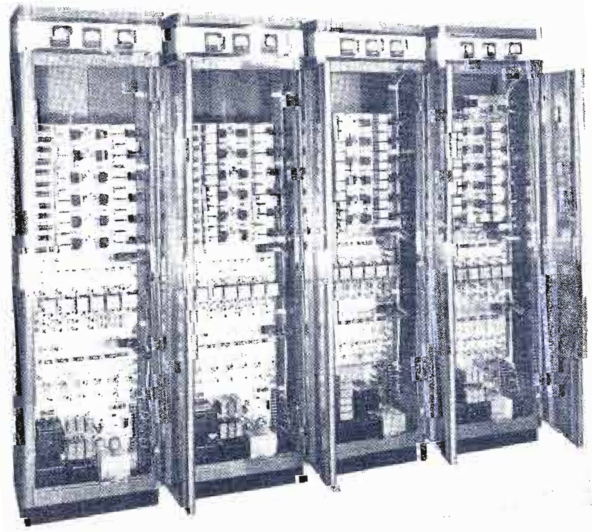
... for Practical Job Worthiness

MOTOROLA SYSTEMS IN AND WORKING

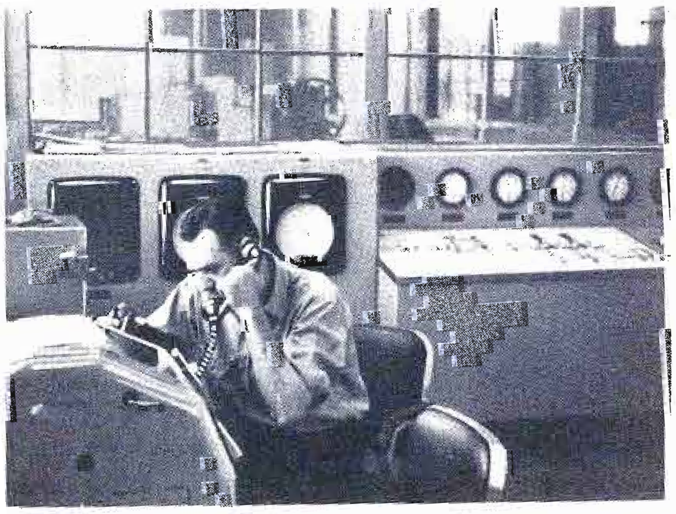
Thousands of miles of multi-channel Motorola Microwave systems, with hundreds of operating stations, have been designed, installed and are in daily operation for many pipeline companies, civil agencies and airlines. With additional major systems under construction, Motorola continues to add to the extensive background of field and engineering experience that has brought outstanding industry acceptance. Here is a partial list of systems installed and operating, and those under construction (*) or under contract (**):

- Pacific Power and Light Co., Portland, Ore.
- Brazos River Electric Transmission Cooperative, Waco, Tex.
- Illinois Power Co., Decatur, Ill.
- Central Illinois Public Service Co., Springfield, Ill.
- Pan American Pipeline Co., Houston, Tex.
- Shell Pipeline Co., Houston, Tex.
- Panhandle Eastern Pipeline Co., Kansas City, Kans.
- Mid-Valley Pipeline Co., Longview, Tex.
- Southern Counties Gas Co., Los Angeles, Calif.
- *La Fourche Telephone Co., Golden Meadow, La.
- *Greenwood Telephone Co., Greenwood, So. Car.
- *Santa Fe Telephone Co., Melrose, Fla.
- *Middle South Utilities, Pine Bluff, Ark.
- *Bonneville Power Administration, Chehalis, Wash.
- *Sinclair Pipeline Co., Independence, Kans.
- *Freeport Sulfur Co., New Orleans, La.
- *Texas Electric Co., Ft. Worth, Tex.
- **West Coast Telephone Co., Everett, Wash.
- U. S. Atomic Energy Commission
- **Dayton Power & Light Co., Dayton, O.
- **Southern California Edison Co., Los Angeles, Calif.

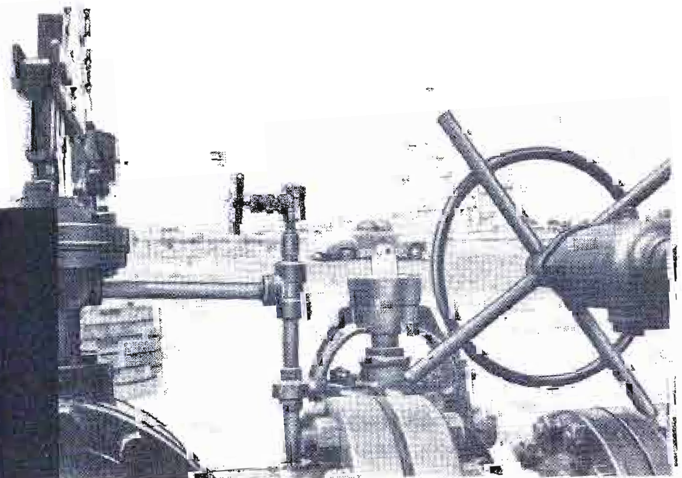
—with 20 additional systems under construction



Proved economy and unusual efficiency in transmission of signal intelligence results from Motorola's 24-channel frequency division multiplexing system. Each cabinet houses six channels, complete with line terminals.



Simultaneous transmission of numerous telemetering and voice signals over one radio-frequency carrier allows positive, instantaneous control over widely separated, remote system facilities.



Industrial control information, transmitted over Motorola Microwave systems, gives operating engineers push-button supervision.

Motorola® Microwave

Motorola Communications & Electronics, Inc.

A SUBSIDIARY OF MOTOROLA, INC.

900 N. Kilbourn Ave., Chicago 51, Illinois

Rogers Majestic Electronics Ltd., Toronto, Canada