FM AND TELEVISION

Price 25 Cents

Feb. 1948

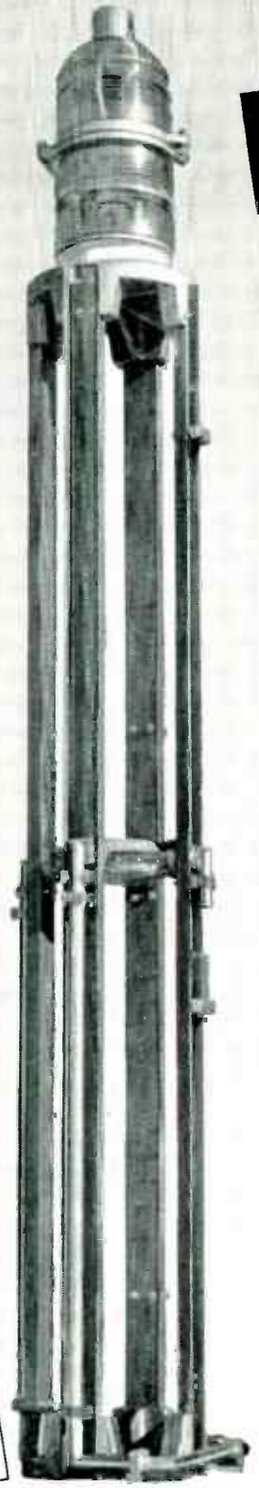
★ ★ Edited by Milton B. Sleeper ★ ★

FM NETWORKER

(See page 3)

8th Year of Service to Management and Engineering

The new RAYTHEON FM ANTENNA



Tops everything for

- **HIGHEST GAIN.** 2.15 for 10′ 6″, single section* compared with nearest competitive gain of 1.5 for 13′ 6″ section.
- **LOWEST COST.** Less than anything approaching its performance and features.
- **EASY TO INSTALL.** Shipped pre-tuned to your frequency — no field adjustments — only one, simple, co-ax feed connection.
- **PERFECT RADIATION.** New "waveguide" radiation principle for perfect circular radiation — horizontal polarization.
- **NO ICING PROBLEM.** Feed elements completely enclosed by weather-proof radome — no de-icing equipment needed.
- **FULL POWER.** A single section will handle 10KW — available in single, double and four-section assemblies.
- **NO OBSOLESCENCE.** Add new sections for increased gain.
- **LOW WIND LOADING.** Simple, open, self-supporting structure — no protruding elements — offers lowest wind resistance.
- **PLUS MANY OTHER IMPORTANT FEATURES**

The new Raytheon Type RFW Antenna is your idea . . . built to answer countless requests for a better, less expensive, trouble-free FM antenna. It's available *now!* Get the whole story from your Raytheon representative today.

*RFW — A (88 — 97 MC.) — single section 11′ 6″.
RFW — B (97 — 108 MC.) — single section 10′ 6″.

RAYTHEON
Excellence in Electronics

LOOK TO RAYTHEON FOR ALL YOUR NEEDS

Transmitters, Speech Input Equipment, Antenna, Antenna Network, Tower, Frequency and Modulation Monitors, Voltage Stabilizers, Transcription Players and Pickups, Recorders, Microphones, Speakers, Relays, Coaxial Cable, Replacement Tubes.

AM · FM · TV

RAYTHEON MANUFACTURING COMPANY

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COZZENS & FARMER
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414 East 10th Street
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VARIACS *for*

Smooth VOLTAGE CONTROL

● THE VARIAC* — the original continuously-adjustable autotransformer — is the ideal device for controlling any a-c operated equipment. VARIACS not only supply perfectly stepless control of voltage from zero, but also supply output voltages 17% above line voltage. VARIACS are correctly designed for many years of trouble-free operation. Data below are for single-phase operation. Polyphase assemblies are available.

SINGLE-PHASE DATA

	LINE VOLTAGE	OUTPUT RATED AMPS.	OUTPUT MAX. AMPS.	OUTPUT VOLTAGE	KVA	CASE	TYPE	PRICE
 TYPE 200-B	115	1	1.5	0-115 0-135	.170	(1)	200-B	$12.50
 TYPE V-5	115	5	7.5	0-115 0-135	.862	(1) (2) (3)	V-5 V-5M V-5MT	18.50 20.50 25.00
	230	2	2.5	0-230 0-270	.575	(1) (2)	V-5H V-5HM V-5HMT	21.00 23.00 27.50
 TYPE V-10	115	10	15	0-115 0-135	1.725	(1) (2) (3)	V-10 V-10M V-10MT	33.00 35.50 40.00
	230	4	5	0-230 0-270	1.15	(1) (2) (3)	V-10H V-10HM V-10HMT	34.00 36.50 41.00
 TYPE V-20	115	20	30	0-115 0-135	3.45	(4)	V-20M	55.00
	230	8	10	0-230 0-270	2.3	(4)	V-20HM	55.00

**The trade name VARIAC is registered at the U. S. Patent Office. VARIACS are patented under U. S. Patent No. 2,009,013 and are manufactured and sold only by General Radio Company or its authorized agents.*

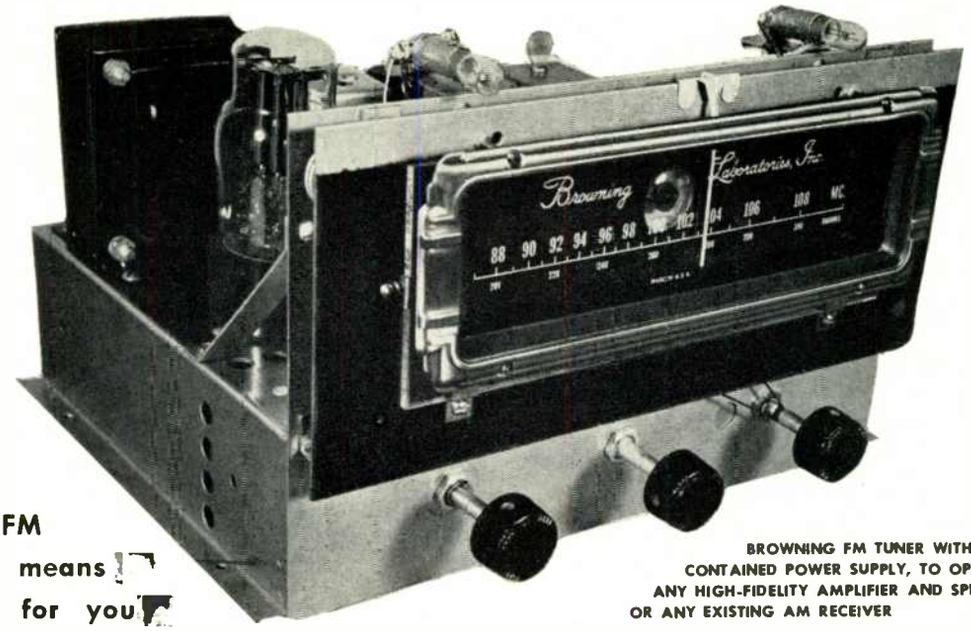
(1) *Unmounted model.*
(2) *Protective case around windings.*
(3) *Protective case, terminal cover, line switch, convenience outlet and 6-foot line cord.*
(4) *Protective case, terminal cover and BX outlet.*
(5) *Two gang assembly — requires type 50-P1 Choke — $10.00*

 TYPE 50	115	40 80	45 90	0-115 0-135	5 10	(4) (5)	50-A 50-AG2(5)	140.00 310.00
	230	20 40	31 62	0-230 0-270	7 14	(4) (5)	50-B 50-BG2(5)	140.00 310.00

GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 | 920 S. Michigan Ave., Chicago 5 | 950 N. Highland Ave., Los Angeles 38



BROWNING FM TUNER WITH SELF-CONTAINED POWER SUPPLY, TO OPERATE ANY HIGH-FIDELITY AMPLIFIER AND SPEAKER OR ANY EXISTING AM RECEIVER

Dealers & Servicemen:

Read here why AM-FM program duplication means new, extra PROFITS for you!

Now—Sell Static-Free Reception of All AM Network Programs on the

GENUINE FM BROWNING RV-10 TUNER

SINCE February 1st, all network programs can be heard with static-free reception over affiliated FM stations. This applies to NBC, CBS, ABC, and Mutual programs.

This means new, extra profits for dealers, servicemen, and custom set-builders who handle genuine FM BROWNING Tuners. Here's why:

In all areas where network-affiliated FM stations are operating, your customers can now get ALL their favorite programs on BROWNING RV-10 and RV-11 FM Tuners—without static, fading, or interference.

When a BROWNING FM Tuner is used with the audio end of an AM set, it isn't necessary to use the old set for tuning any more. There's EXTRA CONVENIENCE.

If a BROWNING FM Tuner is used with a high-quality amplifier and speaker, the lower price of the straight FM tuner reduces the cost of the installation. There's EXTRA ECONOMY.

In either case, the result is static-free reception of network programs, with better quality than on AM. That's EXTRA ENTERTAINMENT.

Order a genuine FM BROWNING Tuner today! Demonstrate its finer reception of AM network programs. Use it to get new, extra-profit business.—Model RV-10, illustrated above. Model RV-11 has 19-in. panel for rack mounting.

SPECIALISTS IN GENUINE ARMSTRONG FM RECEIVERS SINCE 1940

Browning Labs., Inc.

750 Main Street, Winchester, Mass.

In Canada, Address:

MEASUREMENT ENGINEERING, Ltd.

Arnprior, Ontario

BROWNING LABORATORIES, Inc.
750 Main St., Winchester, Mass.

Please send me technical details and prices on the following Browning precision products:

- ☐ FM Tuners
- ☐ FM-AM Tuners
- ☐ Frequency Meters
- ☐ WWV Frequency Colibrator
- ☐ Laboratory Oscilloscope
- ☐ Capacity Relay

Name .....

Address .....

Company Connection .....

FM AND TELEVISION

★ ★ Edited by Milton B. Sleeper ★ ★

FORMERLY, FM MAGAZINE and FM RADIO-ELECTRONICS

VOL. 8 FEBRUARY, 1948 NO. 2

CONTENTS

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MILTON B. SLEEPER, *Editor and Publisher*

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THIS MONTH'S COVER

The finest musical entertainment ever broadcast by radio is now coming over FM affiliates of the Continental Network. President and prime mover in this project is Everett L. Dillard, whose picture appears on this month's cover. Key station in this net is his WASH-FM Washington, D. C. It is freely predicted that Continental will develop into the 5th national network. This may well be the case, for Everett Dillard and his associates have succeeded in meeting problems that would have stopped a less able, experienced, and determined group long ago. There are already 33 affiliated stations. Mr. Dillard is also president of FM Association, comprised of nearly 300 stations and manufacturers.

Entered as second-class matter, August 22, 1945, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Concord, N. H. Printed in the U. S. A.

WHAT'S NEW THIS MONTH

1. SET PRODUCTION
2. AM-FM DUPLICATION
3. FACSIMILE STANDARDS

1. RMA year's end figures on home radio set production disclose facts of great significance to those who are formulating 1948 plans.

Most striking is the breakdown of console and phonograph models, for they represent the real profit gravy:

FM consoles	852,256	66%
AM consoles	385,926	29%
TV consoles	62,256	5%

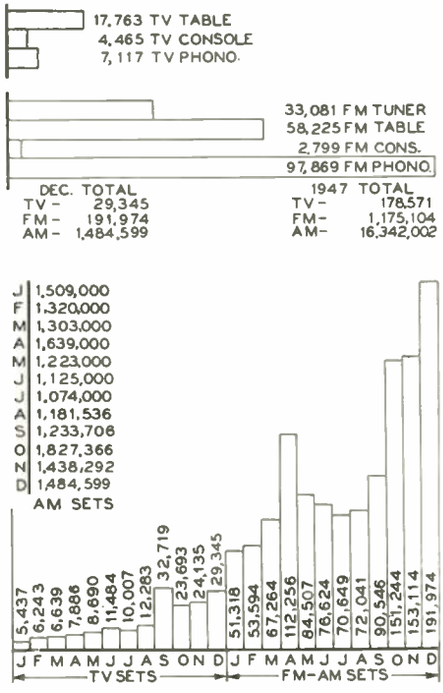
To take the figures a step farther, here is the percentage of consoles in the FM, AM, and TV brackets:

FM consoles 73% of FM production
AM consoles 2% of AM production
TV consoles 35% of TV production

The breakdown of sets made in each category was:

AM sets	16,342,002	92%
FM sets	1,175,104	7%
TV sets	178,571	1%

Percentagewise, FM and TV receivers made a small showing, but their higher unit cost indicates that, although amounting to only 8% in numbers, they accounted for about 50% of the industry's dollar volume!



Manufacturers and dealers can expect a substantial revision in these figures 12 months from now. The following inferences can be drawn:

1. AM set production will drop with a bang in 1948, to a total that may not exceed 8 million sets. FM will be at least double last year's figure, probably climbing to 2½ million. TV production may be up 4 times, to something over ½ million sets.

2. There will be fewer set manufacturers in January, 1949. The going will be tough for those who cannot swing over to concentrate FM and TV. The only reason most manufacturers will have for making AM sets in 1948 will be to start their lines in the low price-bracket.

3. There will be fewer dealers a year from now. We would guess that the total retail radio outlets will drop 20 to 25%. The reasoning behind this estimate is that 50% of the dealers will not or cannot handle FM and TV receivers, and about half that number will find AM sales such slim pickings that they will drop radio completely.

4. Mortality among servicemen will not be as high, even though a relatively small number will be equipped with either the test instruments or the knowledge to handle FM and TV sets. There will be enough AM sets to keep them going. Moreover, service organizations geared to FM and TV will tend increasingly to duck AM table models. They will concentrate on sets priced at levels justifying charges that leave a profit above overhead expense and labor.

2. With 400 FM broadcast stations on the air, the shift from AM to FM has only awaited approval of AM-FM program duplication by the American Federation of Musicians. That approval was announced by AFM on January 30, effective February 1.

Lifting of the ban will have far-reaching effects on broadcasters and set manufacturers alike, for it marks the beginning of the end of AM broadcasting in the United States. Although no agreement was reached on live talent for television, the FM-AM settlement will have a bearing on television, too.

It is much too soon to evaluate the changes, but it is easy to see what will cause them:

1. AFM: The American Federation of Musicians wants more employment for their members in broadcast stations. Working against them has been the progessive cheapening of AM receivers and the resultant deterioration of audio quality. Also, sound recording methods have been improved to the point where, with increasing co-channel interference to cover up the defects of reception on cheap AM sets, few listeners recognize the difference between live and recorded programs.

(CONTINUED ON PAGE 16)

Television stations get programs by telephone lines, too

Thousands of pairs of wire in telephone cables radiate from every central office. That is why cable pairs will be handy to link cameras and transmitters wherever a television program may originate.

Since cable pairs are designed first for voice transmission—top frequency, about 3200 cycles per second—the loss at picture frequencies up to 4,000,000 cycles is high, so an amplifier is inserted about every mile. Equalizing networks are also needed to bring the losses at all frequencies to the same value.

Recently, the Laboratories have developed a "video pair" in which polyethylene string and tape are used instead of paper, and which has a shielding copper tape over all. It is being built into new telephone cables which go to points where television programs are certain to originate. Losses are so much less that amplifiers can be four miles apart.

Inside an all-weather sheath, "video" travels safely and reliably alongside your telephone call, a sound program, telegraph signals, pictures for tomorrow's papers. This service of the telephone cable was ready when television needed it because of Bell Laboratories activity.

BELL TELEPHONE LABORATORIES *PIONEERED IN THE RESEARCH OF FM RADIO AND TELEVISION, AND ARE ACTIVE IN DEVELOPING IMPROVEMENTS IN BOTH FIELDS TODAY.*

TELENOTES

Youngstown, Ohio ★ Station WFMJ has placed an order for television equipment, totalling $250,000, with RCA. This is part of $400,000 to be spent for television facilities.

Table TV ★ Included in Philco's new line of receivers is a table model with a 7-in. tube, priced at $199.50 plus tax and installation. A somewhat larger table model, with a 10-in. tube, is $339.50.

WNBT ★ A new RCA television transmitter is being installed at the Empire State Building, New York City. Power will be 5 kw. on video and 2.5 kw. on audio. The change will be made without interrupting the service.

Television School ★ Evening classes in television theory and servicing are being conducted by the Naylon Television School, 2232 Pennsylvania Avenue, S.E., Washington, D. C. Director is James J. Greene.

Winnie May ★ One of the best-known distributors in radio, and the inventor of the radio-cruise plan for entertaining dealers, has taken on the distribution of Andrea television receivers for northern New Jersey.

WGN-TV ★ Tests on the Chicago Tribune's new station have begun with test-pattern transmission. It is expected that scheduled programs will start some time in March.

Television Clinic ★ Advertising executives are to get facts on television at Yankee Network's weekly meetings, under the direction of general manager Linus Travers. Session will be held in the Princess Ballroom, Hotel Somerset, Boston, February 12, 18, 25, and March 3.

Multiple TV Antenna ★ A system capable of handling 6 to 20 television receivers on one antenna has been announced by Amy, Aceves, and King, Inc., 11 W. 42 Street, New York. It is described as operating on all channels without the use of booster amplifiers. Multicoupler outlets are available for new buildings with wires run in conduit, or for existing buildings with wires run outside.

TVCP's ★ FCC has granted TV construction permits to: Jack Gross Broadcasting Co., San Diego, channel No. 8; Stephens Broadcasting Co., WDSU, New Orleans, channel No. 6; and Cincinnati Times-Star, Cincinnati, channel No. 11.

Hollywood ★ Nassour Studios will erect a theatre and studio for producing television films at 5746 Sunset Boulevard.

PRODUCTS & LITERATURE

So many new instruments, components, and materials are being brought out that space does not permit us to publish illustrated descriptions of them all. Accordingly, rather than selecting a few each month, we have established this new department of Products & Literature so that a great number of brief descriptions can be published. From these, you can select items which interest you, and send for catalogs or bulletins. We'll appreciate it if you will mention FM and TELEVISION in your requests.

Receiving Tube Manual: New edition of the RCA Manual, for use by designers, servicemen, and instructors, contains 256 pages of data on tubes, receiver circuits, amplifiers, and new applications including limiters, ratio detectors, discriminators, and multivibrators. Of great value is the new tube classification chart, giving tube characteristics. Separate section is devoted to miniature tubes. Price 35¢. — RCA Tube Department, Harrison, N. J.

Condensers: Hermetically-sealed, high-voltage, low-current power supply for television receivers and oscilloscopes. Operates on 118 volts, 60 cycles, delivers 2,400 volts D.C. Case measures 3¾ by 3 3/16 by 5½ ins. — Bulletin CPS, Condenser Products Co., 1375 N. Branch St., Chicago.

Service Encyclopedia: The 6th edition of the Mallory Radio Service Encyclopedia covers all prewar and postwar receivers, listing replacements for volume and tone controls, condensers, and vibrators, and IF peaks, tube complements, and special service notes. Price $2. — P. R. Mallory & Co., Inc., Indianapolis, Ind.

TV Sync Signal Generator: Delivers RMA-FCC standard horizontal and vertical driving signals, composite video blanking signals, and composite sync signals for television studio and film cameras, control units, and monitors, as well as factory production testing and laboratory work. Rack-mounted units are contained in a steel cabinet 83¼ by 22 by 18¼ ins. — Bulletin BA, Dumont Laboratories, Inc., 42 Harding Ave., Clifton, N. J.

Ceramic-Cased Resistors: Values up to 5,000 ohms rated at 7 watts are wire-wound on fibre-glass core, with 2-in. axial leads. Sealed in steatite tube 1¾ by 5/16 ins. Smaller 4-watt size, with resistance up to 1,000 ohms, is enclosed in tube 1 by 5/16 in. — Bulletin C7, Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn, N. Y.

Microphones: Series of low-priced microphones for communications services. Can be used with desk stand or fitted with hang-up hook. Crystal, dynamic or carbon types available. Bulletin A37, Electro-Voice, Inc., Buchanan, Mich.

Time Switch: Compact, wall-mounted time clock has simple setting for switching lights or other equipment on and off at any desired time of day or night. Single- or double-pole contacts break 15 amps. Operates on 120 volts, 60 cycles. Lubricated for life. — Bulletin S-1050, Sangamo Electric Co., Springfield, Ill.

Constant Voltage Transformers: Designed for low harmonic distortion. Added circuit component neutralizes harmonics, and limits distortion to less than 3%. Available in capacities of 250, 500, and 1,000 VA. Identical units can be operated in parallel for increased output. — Bulletin CVH, Sola Electric Co., 4633 W. 16 St., Chicago 50.

Radio Data Charts: Time-saving charts for the design of coils and transformers, speaker dividing networks, transmission lines, and various components. 93 pages, 8¼ by 11 ins. Price $2. — Iliffe & Sons, Ltd., Dorset House, Stamford St., London S.E. 1, England.

FM-TV Tuner: Pre-calibrated unit, built around the Mallory-Ware Inductuner, provides continuous tuning from 44 to 216 mc. covering 13 television channels, FM, and communications. Unit includes complete RF head. — Bulletin DL, DuMont Laboratories, Inc., 2 Main St., Passaic, N. J.

TV Test Films: Catalog of test films suitable for checking 16- and 35-mm. projectors and sound reproducers used for television broadcasting. Prepared by the SMPE and Motion Picture Research Council. — Society of Motion Picture Engineers, 342 Madison Ave., New York 17.

Variacs: New Models of improved mechanical design and reduced weight, provide continuously variable voltage from 115- or 230-volt line, with frequencies from 25 to 2,400 cycles. — Bulletin NV, General Radio Company, Cambridge 39, Mass.

Bridged T Attenuators: Series of small, 20-step attenuators 2⅛ ins. in diameter, and 2 ins. deep behind panel, or 2 5/16 ins. when detent is used. Attenuation characteristic is rated essentially flat from 30 to 15,000 cycles. Non-inductively wound, and sealed against moisture. — Bulletin T20, Shallcross Mfg. Co., Collingdale, Pa.

Ventilated Tower Beacon: Reduced life of lamps in tower beacons, due to collection of moisture and excessive heat, has been overcome in a new beacon design. According to the manufacturer, a patented dome ventilator reduces internal temperature, while moisture is drained through a port in the concave base. Increase in lamp life of 15 to 200% is claimed, with corresponding reduction in expense of tower-climbing. — Bulletin PG, Hughey & Phillips, 326 N. LaCienega Blvd., Los Angeles 36.

Red Line Tubes: Specially designed for extremely long life and extra stability. Special girder construction holds elements secure against shock and vibration. Life expectancy is 10,000 hours. First tubes of this series are: 5691 high-mu triode, 5692 medium-mu twin triode, and 5693 sharp cutoff pentode. Tubes are identified by red bases. — Bulletin RFM 1000, RCA Tube Dept., Harrison, N. J.

Wire-Recording Heads: Designed for use with all types of auxiliary mechanisms. Recording, play-back, and erasing features are combined in a small unit suited to a variety of shielding and mounting arrangements. Specified impedances and internal connections can be furnished to specification. — Bulletin CH, Shure Brothers, W. Huron St., Chicago 10.

Coded Spaghetti: Extruded thermoplastic tubing in continuous rolls, with coded color strips which are integral with the material. Unlike colored inks applied externally, this type of coding cannot fade or be defaced. — Bulletin ST, Wm. Brand & Company, 276 Fourth Ave., New York 10.

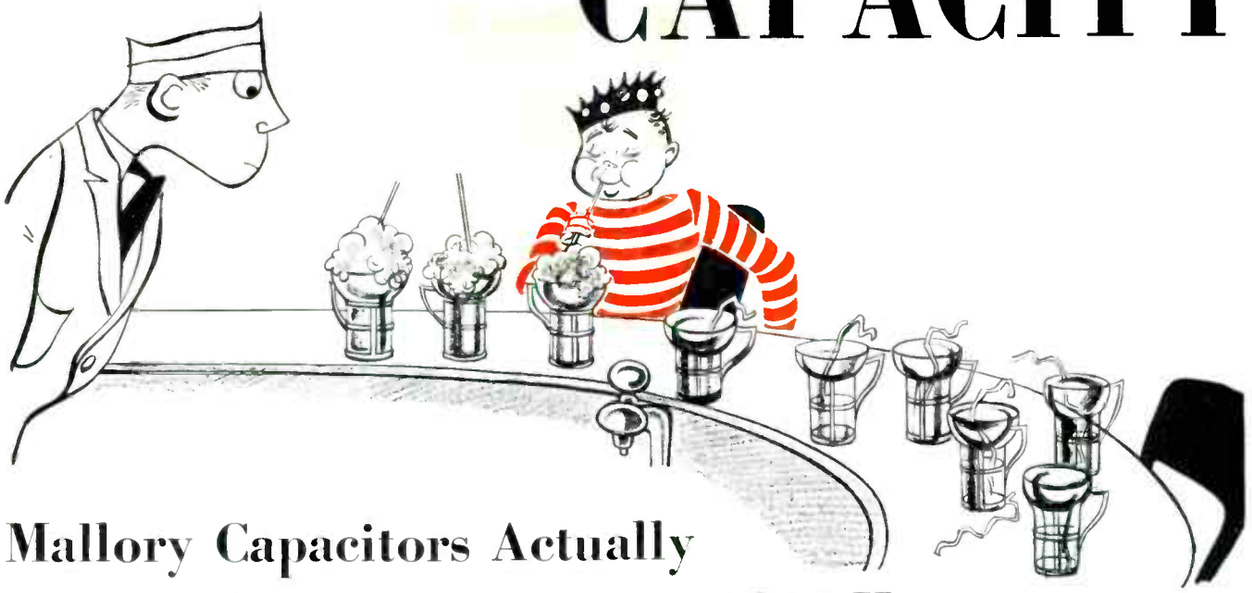
S-T Link: Complete equipment for operating in the 940- to 960-mc. band allocated to S-T service. Comprises transmitter, receiver, monitor, antennas and supports, and transmission line. Can be installed easily and quickly. — Bulletin GH, Radio Engineering Labs., 35-54 Thirty-Sixth St., Long Island City 1, New York.

Engineering Index: A master index of more than 15,000 articles on radio and electronics published from 1925 to 1945. Titles are cross indexed under 250 subject headings. Cloth bound, 320 pages, 7½ by 10½ ins. Price $17.50. — Electronics Research Pub. Co., 2 W. 46 St., N. Y. 19A, N. Y.

Loudspeakers: Designed for FM sets and other applications requiring a high degree of linearity and low distortion from 100 cycles to more than 10,000 cycles. A seamless parabolic cone is driven by a new magnet design which concentrates the flux density in the working air gap, with minimum leakage. The 8-in. type is rated at 12 to 15 watts. Two 12-in. types are rated at 15 to 20 and 25 to 30 watts. Voice-coil impedances are 4 to 5, 6 to 8, and 6 to 8 ohms, respectively. — Bulletin HS-13, Radio Music Corp., Port Chester, N. Y.

Sensitive Relays: Multiple-arm relays for AC or DC operation are available in 3 different mounting styles. These are: Octal base with removable dust cover, octal base with hermetically sealed cover, and hermetically sealed case with soldering terminals. — Bulletin 50-91, Signal Engineering & Mfg. Co., 154 W. 14 St., New York 11.

Sustained CAPACITY



Mallory Capacitors Actually Increase in Capacity After 2,000* Hours

Install Mallory FP Capacitors with the knowledge that they will last in a "hot set" with temperatures up around 185° F.—they will last on the shelf or in an inactive set without needing reaging—and they will last without loss of capacity.

Mallory is never satisfied to produce parts that just get by. In all Mallory Parts you will find a generous margin in *your* favor. Mallory capacitors will operate at 185° F. —that's 35° hotter than R. M. A. requirements.

Their RF impedance—their ability to withstand ripple current, are other plus values that make Mallory capacitors popular with radio service men, as well as with manufacturers of radio equipment.

THE MALLORY "GOOD SERVICE FOR GOOD BUSINESS" PLAN

will increase business and profits in your shop.

A unique follow-up file makes it easy to keep customers.

You tie in with Mallory acceptance to develop new business—ask your distributor about it.

***2,000 HOURS OF OPERATION**

An actual test of Mallory capacitors operated in an oven at 185°F. and 450 volts DC. plus 10 volts of 120 cycle ripple, showed them still going strong and with increased capacity at the end of 2,000 hours. Typical results:

At Start of Test		*After 2,000 Hours*	
Capacity	*Resistance*	*Capacity*	*Resistance*
20.9 mmf	6.16 ohms	23.5 mmf	6.5 ohms
20.1 mmf	6.5 ohms	23.1 mmf	6.55 ohms

BUY MALLORY ASSURED QUALITY AT REGULAR PRICE LEVELS

P. R. MALLORY & CO. Inc.

MALLORY

CAPACITORS . . . CONTROLS . . . VIBRATORS . . .
SWITCHES . . . RESISTORS . . . RECTIFIERS . . .
VIBRAPACK* POWER SUPPLIES . . . FILTERS

*Reg. U.S. Pat. Off.

APPROVED PRECISION PRODUCTS

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

Receiving positions for the incoming lines where Western Union switching clerks push buttons on the switching turrets and, in a flash, telegrams are speeded onward to their destinations. This push-button telegraphy opens a new era of faster, finer Western Union service.

Professional Directory

Jansky & Bailey
AN ORGANIZATION OF
Qualified Radio Engineers
DEDICATED TO THE
SERVICE OF BROADCASTING
•
National Press Bldg., Washington, D. C.

Andrew Corporation
Consulting Radio Engineers
363 EAST 75th STREET, CHICAGO 19
Triangle 4400

• TELEPHONE BRIDGEPORT 5-2055 •
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Consulting Radio Engineers
991 Broad Street, Suite 9-11
Bridgeport 3, Conn.
LABORATORY: Hilltop Drive
Stratford, Conn. — Phone 7-2465
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IN THIS DIRECTORY
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$10 Per Month for This Standard Space. Orders Are Accepted for 12 Insertions Only

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development and research
transmitters, receivers
communications systems
352 Pequot Avenue New London, Conn.
New London, 2-4824

THE WORKSHOP ASSOCIATES
INCORPORATED
Specialists in
High-Frequency Antennas
66 Needham St., Newton Highlands, Mass.
Bigelow 3330

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

Why, CBS could add the sound of audience applause to recordings of concert music and still please the discriminating devotees who faithfully tune their radios to the Sunday Philharmonic program.

But that's not true of FM. The great complaint against FM broadcasting in the past has been: "Your live-talent programs are wonderful, but there aren't enough of them." FM brings out the best in live talent, and the worst in recordings. Thus, it is the first development in broadcasting that offers a reason for employing musicians instead of platters.

2. BROADCASTERS: The AM network broadcaster who already owns an FM station is now sitting pretty. He has everything to gain, and nothing to lose. Some will gain enormously. Witness, for example, the 250-watt AM operator with a 50-kw. FM affiliate. CP holders who placed transmitter orders with the manufacturer who offered the longest delay in delivery are suddenly worried that they may have selected second-rate equipment. As for the AM holdouts, it is safe to predict that the next few months will set a new record in FM applications filed with the FCC!

Independent FM operators are in a different position. Their potential audience will increase rapidly, because AM-FM duplication will accelerate the sale of FM receivers enormously. Whether or not they gain in number of listeners is a matter of programming. Those who continue to grind out records will find their audiences dwindling away. Independent FM stations will not be welcomed as affiliates of the major AM nets. So they must choose between building live programs of special, local interest, or joining an FM network. This puts the Continental Network in a very favorable position, not only because it can fill a need but because it provides program quality greatly superior to the 5,000-cycle lines used by AM nets. Very interesting developments can be expected in the immediate future, with allout efforts by the established nets to head off any threats of new competition.

All this puts the independent AM operator who cannot get into FM at the tail of the procession of progress, where he can only expect to be starved out within the next year or two.

3. TRANSMITTER MANUFACTURERS: The new look that has come to broadcasting presents a very favorable picture to manufacturers of FM transmitters and high-quality sound equipment. Already the estimate of 1,000 FM stations on the air in 1948 is being revised upward. Transmitters ordered but still held in warehouses will move out quickly. Many CP holders who have been asking "how long can we stall" are demanding "how soon

(CONTINUED ON PAGE 17)

Professional Directory

RAYMOND M. WILMOTTE Inc.
Paul A. deMars
Associate
Consulting Engineers
Radio & Electronics
1469 Church St., N. W. Decatur 1234
Washington 5, D.C.

RUSSELL P. MAY
CONSULTING RADIO ENGINEERS
★ ★ ★
1422 F Street, N. W. Wash. 4, D.C.
Kellogg Building Republic 3984

LYNNE C. SMEBY
Consulting
Radio Engineers
820 13th St., N.W. EX 8073
WASHINGTON 5, D. C.

CONSULTING
RADIO ENGINEERS
DIXIE B. McKEY
&
ASSOCIATES
1730 CONNECTICUT AVE. N.W.
WASHINGTON 9, D.C. ADAMS 3711

FM AM
NATHAN WILLIAMS
Consulting Engineer
20 Algoma Blvd.
Oshkosh, Wis.
Phone: Bl'khawk 22

FREQUENCY MEASURING SERVICE
Exact Measurements - at any time
RCA COMMUNICATIONS, INC.
64 Broad Street, New York 4, N. Y.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 16)

can we get on the air with FM." This is not a matter of sudden conversion to a new point of view, but to the urgent need for preparing to meet whatever competitive situation may develop.

As to audio facilities, even many of the FM stations already on the air have felt that second-rate equipment was good enough for platter programs. All that takes on a different aspect as program quality becomes a factor in competition for listeners.

The advent of AM-FM duplication does not mean the end of transcriptions, but it does mean a shift to high-fidelity transcriptions, and replacement of a great many of the turntables now in use. From now on, listeners will have live-talent FM as their standard of program quality.

4. RECEIVER MANUFACTURERS: The RMA has taken the position that FM promotion which characterizes AM sets as obsolete will hurt the set manufacturers without benefiting FM. That was a reasonable and logical attitude prior to AM-FM duplication.

Now, that picture has changed. As of February 1, there is very little reason for buying a straight AM model, unless it's a portable. And new FM portables will soon eliminate even that reason.

Of course, there may be some areas where listeners must still depend on AM, but not for very long. In population centers, where set sales are concentrated, the straight FM set is virtually an all-program receiver now!

Here's another factor that must not be overlooked. Omitting the AM band effects a considerable saving over the cost of FM-AM designs. It is easier to attain high FM sensitivity when the circuits are not complicated with AM tuning. Going a step farther, it is possible to build straight FM sets to retail for $50 that will run rings around straight AM receivers at the same price.

5. RADIO DEALERS: Two problems confront radio dealers. First, there is the question of moving AM sets on hand, making a wise decision about buying any more, and getting ready to shift sales efforts from AM to FM.

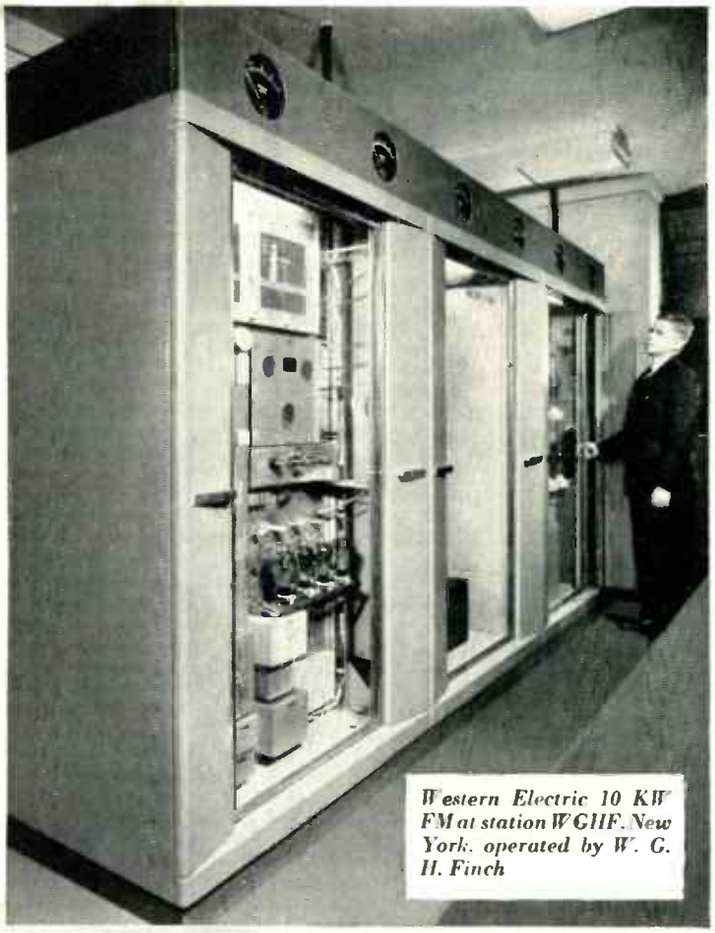
Such plans must be based on individual, local conditions. It won't be safe to steer customers away from FM with such old answers as: "I wouldn't advise you to get an FM set. It isn't perfected yet, and there aren't any decent FM programs."

Each dealer needs to make a careful study of FM stations operating in his area, and the CP's already granted. It would be well to check with the CP holders to find out how soon they will be on the air. This will give timetable information for scheduling further AM set commitments.

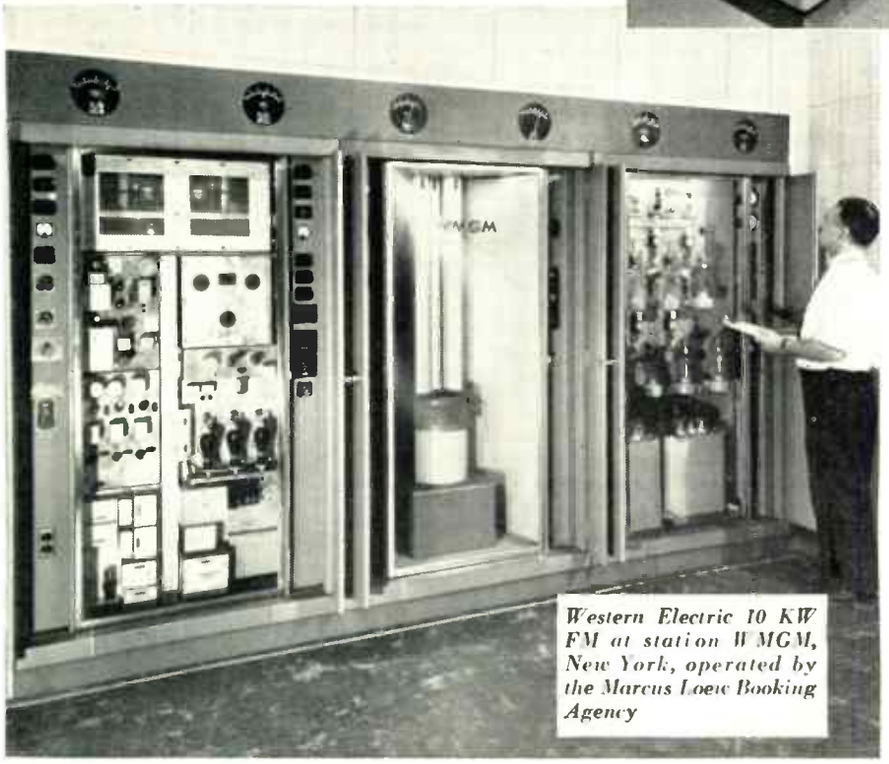
(CONTINUED ON PAGE 44)

WGHF AND WMGM NOW 10 KW FM

They've had their power and their faces *lifted!*



Western Electric 10 KW FM at station WGHF, New York, operated by W. G. H. Finch



Western Electric 10 KW FM at station WMGM, New York, operated by the Marcus Loew Booking Agency

Here's how . . .

WMGM and WGHF first went on the air with Western Electric 1 KW FM transmitters—WMGM in 1942 on the old frequency band, WGHF in 1946 on the new band.

With the change in FM frequencies, WMGM's transmitter was converted to the higher band and modernized to make it equal in every respect to the later model installed at WGHF.

Now both these 1 KWs—housed in new "TRANSVIEW" design cabinets—serve as drivers for the latest 10 KW amplifiers.

These modernized transmitters are equal in every respect to 10 KWs coming off the line today.

Working with broadcasters to keep their equipment up to the latest standards has long been a custom with Western Electric. That's worth remembering when you are ready to buy. For details on Western Electric's full line of AM and FM equipment, call your Graybar Broadcast Representative or write to Graybar Electric Co., 420 Lexington Avenue, New York 17, N. Y.

Western Electric

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FM IS ON ITS WAY TO REPLACE AM

An Explanation and a Message to the Trade from the President of the Continental Network

BY EVERETT L. DILLARD*

EVERY major enterprise must overcome a tremendous inertia before it can achieve wide-spread public acceptance. No matter how superior a new service may be compared to the older one it replaces, every major invention has encountered this initial opposition. There are always the skeptics who believe that security lies in maintaining the Status Quo. Owners of sailing fleets were solidly opposed to the development of the steamboat. Carriage-makers said the speed of the automobile was ungodly, and sought to make it illegal. Thomas Edison waged a bitter battle against the shift from his DC power systems to the use of AC. No doubt it was a similar fight when the wheel was proposed as a successor to the drag.

It is perfectly natural for those who have a firmly intrenched position in any industry to oppose a radical improvement. If it gains acceptance, large sums must be spent to replace the facilities rendered obsolete, and invariably the process of change opens the door to the entrance of new competitors.

FM has been no exception. For over a decade, Frequency Modulation has been known by technicians to be a better system of broadcasting. Yet because of the earlier obstacles which it had to overcome, and the inertia of industry to adopt its superior transmission and reception qualities, FM did not become available to the public on a nation-wide basis until after 1945. It goes without saying that FM would today be the "standard" system of broadcasting had not a World War intervened.

VJ-Day inaugurated the second era of FM development. Since then, acceptance of FM by industry and the public alike has slowly but surely accelerated until, in 1948, we can say "FM is here!"

Post-war FM receiver set production did not get under way until late in 1946 — too late that year to achieve a sizable total. In round figures, 186,000 FM-AM sets were produced. That was but the beginning! 1947 was a different story. More than 1,175,000 FM-AM sets rolled down the production lines.

In 1948, if the present rate is maintained but not increased, manufacturers will roll up a total of 2,500,000 sets.

But FM-AM set production will not remain constant. *It will increase.* An estimated production of FM-AM units between 4,000,000 to 5,000,000 or more is not an over-optimistic figure for 1948. In dollar volume, the FM receiver set business will exceed $500 million, while overall investment in transmitting equipment and stations will go over the $100 million mark.

It is logical to ask the question, "Why this estimated increase in set production for 1948?" To understand the answer, we must again take a look at the 1947 figures. Last year, 17 million radio sets were manufactured, representing a retail value of $800 million. With radio receiver production stopped in 1942, and a high obsolescence factor occasioned because of the intense listening and usage of sets during the war years, a tremendous replacement market for broadcast receivers of all types was built up by 1945. Of the total 1947 production, 2,500,000 sets were automobile radios. About the same number were manufactured for export. Several million sets were the so-called "expendable" types. By *expendable* is meant the type of receiver which is junked when something goes wrong, since the cost of repair, in a high percentage of the cases, closely approaches the original cost of the receiver. It is easy to see that the more than 1 million FM sets produced in 1947 represented a substantial percentage of the dollar volume in domestic home receivers. One reason for this lies in the fact that 66% of the radio-phonograph consoles were FM-AM models!

Radio manufacturers are enthusiastic about FM production in 1948. Excepting the expendable models and the automobile and export radios, the demand for AM-only sets has practically reached saturation. Those familiar with industry problems realize that virtually every set retailing for more than $100 and certainly most console sets to be manufactured in 1948 will incorporate FM. While 1947 saw only a few good FM table models priced below $100, at least five manufacturers plan volume production of good FM-AM table models under $50 in 1948. Furthermore, the FM set market is now nation-wide, with 400 stations already on the air.

There will be a demand for FM sets in every major city as well as the majority of the smaller communities. FM is not only doing a better job in the big cities, but is giving many rural listeners a type and grade of radio service heretofore unknown to them. FM set production must be high in 1948 to meet nation-wide demand. Sales are not confined to a few metropolitan districts. Thus, the manufacturers and distributors can use their nation-wide distribution, built up since radio began, to sell FM receivers.

Set production and public demand are closely allied to radio station activity. The more FM stations on the air, the greater the demand for FM receivers throughout the country. FCC records indicate that 1,000 FM stations will be in operation by the end of 1948. It was predicted that 700 stations might be on the air by the end of 1947. Slightly less than 400 were actually completed. That is the principal reason why FM set production did not reach the predicted 2 million mark in 1947.

But it was not lack of interest that held back FM stations. New FM broadcasters had many problems to overcome. Among these were shortages of equipment, towers, antennas, building difficulties, lack of building materials, and legal delays in securing zoning permissions. Those delaying factors are now largely behind us. New FM stations should now be coming on the air at an average rate of about 50 per month.

FM activity compared to other types of broadcasting can be quickly gauged by industry figures for broadcasting transmitters sold in the first 6 months of 1947 (latest available information). FM orders totaled $3,325,570, while AM orders amounted to only $2,402,768.

It is only logical that the majority of AM broadcasters are now anxious to see FM become an established medium of sound broadcasting as quickly as possible. The reasons are obvious when it is realized that of 1,989 AM broadcasting stations for which construction permits have been granted, 840 are local 250-watt stations, with severely restricted night time coverage due to the added co-channel interference, and 426 are daytime stations which go off the air at sundown.

All FM stations are licensed for full-time operation. No FM station suffers from reduced coverage at night. Only by shifting to FM can broadcasters regain the nighttime coverage they used to deliver on AM before the band became so crowded, and justify the continuation of their high nighttime rates. Finally, the broadcasters have come to realize that with medium power on FM they can give the listeners a higher grade of service than is possible with high power on AM.

* General Manager, WASH-FM, International Building, Washington, D. C., President, FM Association, and President, Continental Network.

GENERATOR FOR VISUAL FM AND TV ALIGNMENT

Generator Covers 2 to 226 Mc., With Sweep Range of .5 to 9 Mc.

BY ALBERT WELLES*

IT is axiomatic today, among those qualified to speak with authority, that satisfactory and rapid alignment of wide-band RF and IF amplifiers must be accomplished by visual means. In days now fortunately past, receiver manufacturers provided instructions for non-visual alignment. It seems a quite safe assumption that such were made only because of the unavailability of satisfactory wide-range sweep signal generators essential to visual alignment. There is neither profit nor satisfaction in the exasperating, time-consuming, and fatiguing job of IF alignment of FM sets without benefit of sweep generator and 'scope. And even with a multitude of repetitious and tiresome checks, there is no certainty that wide-band amplifier alignment, by other than visual means, will come within the minimum degree of accuracy required.

Generator Characteristics ★ Practically any standard type of oscilloscope can be used for aligning FM and television receivers. The problem has been to find a suitable sweep signal generator priced within the means of the average serviceman. The instrument illustrated here represents a new and rather unique approach to the solution of that problem. The model 909 Silver generator provides a source of RF voltage adjustable as to magnitude and as to the extent of center-frequency deviation. The sweep rate is 2 × power-line frequency. The center, or carrier, frequency range is adjustable from 2 to 226 mc. without band-switching, although there are three frequency ranges calibrated on the 5-in. vernier-driven dial.

Output voltage is variable from less than 100 microvolts up to not less than .5 volt on all bands. Sweep range is from approximately 40 kc. to slightly over 10 mc., controllable by a panel knob calibrated from .5 to 9mc. Saw-tooth voltage at 2 × power-line frequency is provided for application to the horizontal amplifier of the 'scope.

Sweep Circuit ★ In any sweep generator designed for research, production test, and service usage, it is desirable if not mandatory that the order of frequency sweep obtained at any given adjustment of the control shall be substantially the same at all center-frequency settings. This automatically rules out the direct frequency modulation of any variable frequency oscillator. That is because the very operation of applying frequency modulation to an oscillator necessitates variation of either the inductance, the capacitance, or both of its frequency-determining circuit. The C or L variation which can be utilized to produce frequency modulation is quite small, but in any case will be an inescapable variable with respect to the circuit element it is intended to modify if the latter is tunable over any appreciable range.

Thus it has become accepted practice in sweep generator design to use the beating oscillator principle. If two oscillators are employed, one may be operated at a fixed frequency and modulated by either mechanical or electrical means. The second oscillator may be tunable. The sum or difference frequency, obtained through a suitable mixer, can then be taken to provide carrier frequency modulation. This system requires but a single scale to indicate the magnitude of frequency sweep, since the sweep remains constant as carrier frequency is varied.

Frequency modulation can be applied to an oscillator by mechanical means, as through the agency of a vibrating capacitor; or by the seemingly more desirable reactance-tube modulator. The latter appears to have the dual advantages of lending itself more readily to operational control of sweep range, as well as insuring better and more easily attained linearity of sweep. Since, however, the effective C or L variation possible to a reactance modulator is quite small, and as it is necessary to translate such small variation into a quite large frequency change for TV work, it follows that the reactance-tube-modulated oscillator must be operated at a high frequency, and with very low circuit-tuning capacitance. This requirement, coupled with the ever-present problem of frequency stability, has taxed ingenuity in the past. The advent of a new UHF dual triode of extremely low and stable inter-electrode capacitance, together with the designer's dream of high Gm, high Mu, and low Rp has made it possible to obtain stable, linear electronic sweep of over 10 mc. in this new instrument.

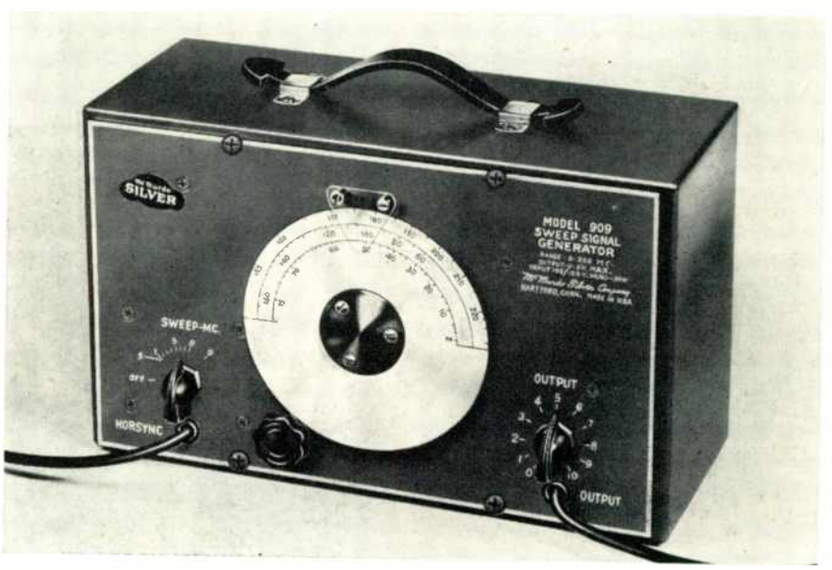


FIG. 1. THE CIRCUIT OF THIS SWEEP GENERATOR PROVIDES 3 FREQUENCY RANGES, COVERING 2 TO 226 MC., WITHOUT THE USE OF BAND-SWITCHING

The model 909 sweep signal generator, Fig. 1, employs but three tubes (actually 6 independent electron streams), yet it provides important advantages in greater carrier frequency range, sweep range, output voltage, and frequency stability than have been available for FM and TV visual alignment work in the past. It does this with the utmost mechanical and electrical simplicity, and at a modest price. Certainly the need for such an instrument is indicated by the rapidly increasing sales of FM and television sets.

Arrangement ★ The interior view, Fig. 2, does not present the complicated assembly of components that might be expected. However, this is a virtue both as to convenience and price. At the lower

* McMurdo Silver Co., Inc., 1240 Main Street, Hartford 3, Conn.

right is the power supply transformer, with a phenolic panel projecting upward from its core mounting. Only the 6X4 full-wave rectifier tube is visible on this panel, the electrolytic filter capacitors and filter resistor (replacing the conventional choke with considerable saving in space) being mounted upon the reverse side.

At the center is the very compact capacitor for the variable-frequency oscillator. A phenolic panel to its left carries the 12AT7 tube functioning as a variable-frequency oscillator and mixer. Directly above this tube appears the tubular concentric air-trimmer required to set the dial calibration at the high-frequency end, with the low-frequency core-adjusting end of the ceramic VFO coil form at upper right.

At the extreme left of this panel is the 12AT7 fixed-frequency oscillator/reactance-modulator tube, with the adjustable-core coil for this circuit immediately above it. Below the fixed-frequency oscillator tube the molded-carbon output control potentiometer is visible, with the co-axial output cable passing diagonally beside it at the left.

Three Bands, No Switch ★ Of the 3 carrier frequency ranges, the outer scale is calibrated in the opposite direction from the 2 inner scales. This may be a little difficult to understand, in view of the absence of band switching, and the obvious simplicity of the variable frequency oscillator. The 3 ranges are attained in this manner: The fixed-frequency oscillator, operating at 114 mc., is varied at the power-line frequency rate by the reactance modulator triode. The single 12AT7 dual triode accomplishes both these functions. The variable-frequency oscillator covers 112 to 37 mc. It is evident that the resulting difference-frequency range is 2 to 77 mc. This is range No. 1, calibrated upon the inner arc of the dial. Range No. 2 is the second harmonic of range No. 1, present in amplitude comparable with the fundamental frequency by virtue of the short excitation-cycle of both oscillators and through mixer-circuit conformation. Range No. 3 is where ingenuity comes into play. It is well known that two beating oscillators produce simultaneously both sum and difference frequencies in the output of a mixer to which they are fed.

Range No. 3, calibrated upon the outer arc of the dial and in reverse slope to the two inner scales, is the sum frequency of the two beating oscillators. Thus, the 114-mc. FFO *added* to the range of 37 to 112 mc. provided by the VFO yields a useful range of 151 through 226 mc. This perfectly obvious system provides 3 ranges with the superior frequency stability possible only to single-range UHF oscillators.

At least 5 frequencies are present simultaneously in the output of this sweep generator. They consist of the fundamental frequencies of the FFO and the VFO, the difference frequency, its second harmonic, and the sum frequency of the two oscillators. This may at first thought appear undesirable. It is of no moment whatsoever in practice, for no wide-band FM or TV amplifier will be so wide, even if badly misaligned, as to fail to reject the far-separated, unwanted frequencies in the output of the sweep generator.

Marker Oscillator ★ The engineer familiar with previous sweep generator designs will note the absence of a marker oscillator or absorption wavemeter circuit. This is intentional, on the apparently sound theory

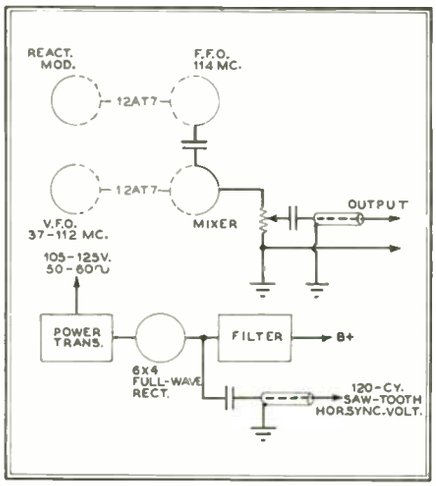


FIG. 2. THIS BLOCK DIAGRAM SHOWS THE 4 FUNCTIONS OF THE TWO 12AT7 TUBES

that any user will have at least one signal generator or calibrated test oscillator handy. By using such instrument as marker oscillator when one is required, the cost-penalty of having to buy a duplicate in the basic sweep generator is eliminated.

Calibration ★ It is evident that, even though the two beating oscillators in any sweep generator are of unusual excellence in themselves, a low difference-frequency output cannot possess the same percentage of accuracy in dial calibration as the two oscillators individually. This is exemplified by the condition at 2-mc., produced by beating 114 mc. against 112 mc.

In this particular instrument, neither short- nor long-time stability has proven a problem. Over 8-hour operating periods, the 2-mc. output has never been found to drift more than 3 kc. This speaks volumes for the stability of the two UHF oscillators. The only remaining problem is that of dial calibration accuracy. This the manufacturer recognizes in recommending that each instrument be checked immediately it is put into use. Specifically, the factory dial calibration should be checked at most-used frequencies against a known-accurate test oscillator, and correct dial readings for IF and RF points spotted on the dial.

Saw-Tooth Voltage ★ No review of this new generator would be complete without reference to the method of obtaining 120-cycle saw-tooth horizontal synchronizing voltage to produce a super-imposed mirror-image trace when an oscilloscope is used. It is of the utmost simplicity, and contributes the new advantage of restoring the horizontal base-line trace to the 'scope picture against which to align the cross-over discriminator S-curves. This voltage is handily present at the output of the full-wave power supply rectifier, where it is picked off through an insulating-coupling capacitor.

This instrument is not merely an inexpensive type of sweep-signal generator, but a new tool by means of which service work can be done with great speed and certainty. Many new methods are described in the instruction book accompanying the generator. As familiarity is developed through practice, apparent complications introduced by FM and TV sets are met by simple, routine procedures.

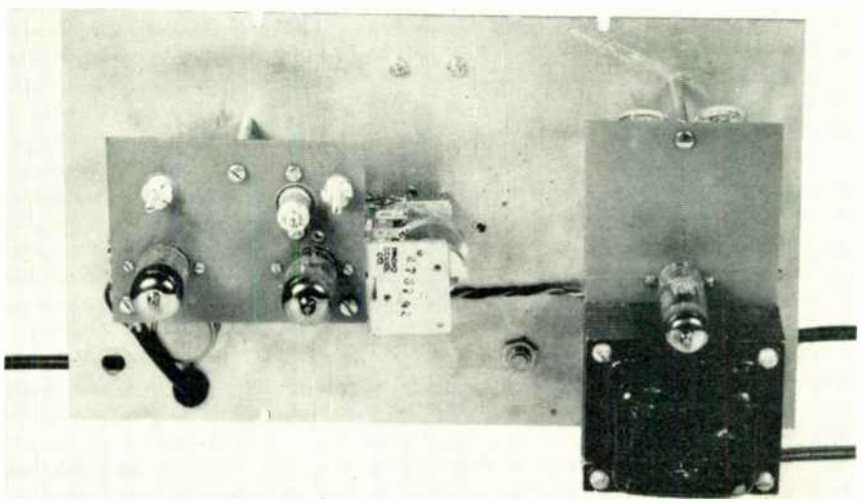


FIG. 3. EXTREME SIMPLICITY RESULTS FROM THE NOVEL CIRCUIT OF THIS GENERATOR. ELIMINATION OF BAND-SWITCHING CONTRIBUTES SUBSTANTIALLY TO THE STABILITY

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

It Can Happen There: Federal Judge Walter J. LaBuy found AFM's president innocent of violating the Lea Act in the WAAF case. Now Chicago's reputation as a place where anything can happen has been made secure. There's no doubt but what the Administration's best brains participated in the prosecution. It took smart legal talent to conceive the loophole that was left for a verdict of not guilty!

15,000-Cycle Lines: Following the informal hearing at the FCC on the subject of 15,000-cycle lines, AT & T agreed to furnish such facilities for an experimental test on February 19 between WASH-FM Washington, key station of the Continental Network, and Major Armstrong's station at Alpine, N. J. One of the principal questions to be determined in this test is the level of noise on the line. We'd like to have comments from our readers on this program: 9:00 to 10:00 P.M., February 19.

Charles V. Brown: Program manager of KFI, writing in *Printer's Ink*, issue of January 30: "Television, once properly started, will expand at a rate to confound the conservative, shame the die-hards, and alarm the sit-tights. . . . Remember, if you are not with television, television is going to be against you."

Unit of Resistance: The *Absolute Ohm*, adopted by the International Committee of Weights and Measures when it met in Paris in October, 1946, is about .05% smaller than the International Ohm (U. S.) now used. Actually the International Ohm is 1.000495 Absolute Ohms. I.R.C. has announced that its resistors of .1% tolerance will comply with the new standard, identified by the mark ABS.

URSI-IRE Meeting: Annual joint meeting of the American Section, International Scientific Radio Union, and the I.R.E. will be held May 3–5 in Washington, D. C. For further information, address Dr. Newbern Smith, secretary, National Bureau of Standards, Washington 25, D. C.

FM Antennas: The waveguide type of broadcast antenna developed by Workshop Associates (*FM* & TV, July '47) will be manufactured and sold by Raytheon, under an agreement recently concluded between the two concerns.

IRE-RMA Spring Meeting: To be held at Hotel Syracuse, Syracuse, N. Y., April 26–28. Sessions will be devoted to technical discussions on transmitters. J. J. Farrell of G.E. will be in charge of the program. Further details can be obtained from the Institute of Radio Engineers, 1 E. 79 Street, New York.

AM Grants Dropped: First wholesale cancellations of AM grants made by FCC on January 9. Permits were allowed to lapse or were withdrawn by eight applicants. These were for two 1-kw. AM stations and six 250-watt stations.

Live Talent for TV Music: Jack Poppele, testifying before the House Committee on Labor and Education: "The self-elimination of the AFM from a field in which it should be a major participant has harmed many and, we believe, helped no one."

IRE Television Conference: To be held at the Engineering Society Headquarters Building, Cincinnati, April 24, 1948. For further information, write W. D. Montgomery, 1290 Coolidge Ave., Cincinnati 2.

Oscilloscope Vs. Ohmmeter: We can't go along with those who would have servicemen believe that they can align FM and television sets with a signal generator and an ohmmeter, any more than we believe that radio men would agree that they can get their cars serviced properly at a garage where the mechanic's only tools are a monkey-wrench and screwdriver. The sooner the oscilloscope becomes standard equipment for radio service work, the better for the set manufacturers, the servicemen, and the customers.

Alignment procedure without an oscilloscope is so slow, and the results so uncertain that the serviceman will either take a loss on his time or the charge will be excessive. In either case, the customer will probably get a poor job.

Working with an oscilloscope, the serviceman can make an adequate charge for his time, and still give the customer better work for less money. We predict that it will soon become as out-of-date to align receivers without an oscilloscope as it is to judge the inflation of automobile tires by kicking them.

IRE Show: Biggest radio show of all times is assured when the IRE Convention opens at Grand Central Palace, New York, on March 22. Already 163 exhibitors have engaged the entire main and second floors. Now the indefatigable Will Copp announces that 48 additional booths will be made available on the 3rd floor. It is expected that last year's attendance of 12,000 will be considerably exceeded.

Armstrong of Radio: Is the title of a most interesting and well-written article in *Fortune* for February. Telling the story of inventions which "qualify Armstrong for the dual titles of the greatest American inventor since Edison and the most important of all radio inventors," many little-known and long forgotten incidents of radio's amazing history are recalled. As for the future, the article reveals for the first time that "Armstrong is currently preparing to take his (FM patent) case to court — a test whose outcome will be awaited with burning interest by the entire radio industry."

FM in Pakistan: Although other countries are sticking to AM for broadcasting, U. S. manufacturers are exporting FM communications equipment in increasing volume. For example, Pakistan will soon have a 5-station AM broadcast system using RCA equipment. Studio-to-transmitter connections, however, will employ FM.

Paste Makes Waste: Motorola's returned parts department reports an alarming increase in breakdowns due to the use of soldering paste by communications maintenance men. We suggest that a sticker, bearing the following slogan, be put on all mobile equipment:

Paste makes waste!
Use rosin-core solder.
Then you'll have no further bother.

More Production: Major changes are being made in the Bendix Radio plant at Baltimore to accommodate full-scale television receiver production. Television research projects are being carried out at the Detroit and Teterboro, N. J., plants, with special emphasis on projection optics for large-screen reception.

FM Service Data: An important improvement in FM receiver service data is being incorporated in Howard Sam's Photofact folders. All sheets on FM sets now show visual alignment procedures for using an oscilloscope, and the VTVM method, also.

On AM, Too: Harvey Radio Laboratories, operating FM station WXHR Boston, has been granted a CP for an AM daytime station on 740 kc.

MW System Weathers Storm: When the January ice storm carried away the main pole line between New York and Philadelphia, Western Union's RCA microwave system took over the load. A total of 100 carrier telegraph channels were in operation, some of which were multiplexed. This system, now being extended to Washington and Pittsburgh, operates on 3,900 to 4,200 mc., with double FM to handle up to 1,152 printers in each direction.

400 FM Stations: Will be on the air by the end of February. On January 16, there were 382 operating, 632 authorized, and 121 pending or in hearing. Total: 1135.

Tariffs for 15,000-Cycle Lines: On January 19, AT & T filed with the FCC a schedule of proposed tariffs for 15,000-cycle lines between New York City and Washington.

1. PLOTTING FIELD AROUND 5 ELECTRODES. 2. MODEL OF SYLVANIA'S RESEARCH CENTER. 3. KYDL SALT LAKE CITY STARTS TV

NEWS PICTURES

1. This setup at North American Philips' laboratory employs an electrolytic plotting tank to measure the configuration of the electric field around five electrodes. This field can be used to represent magnetic, electrostatic, or thermal conditions.

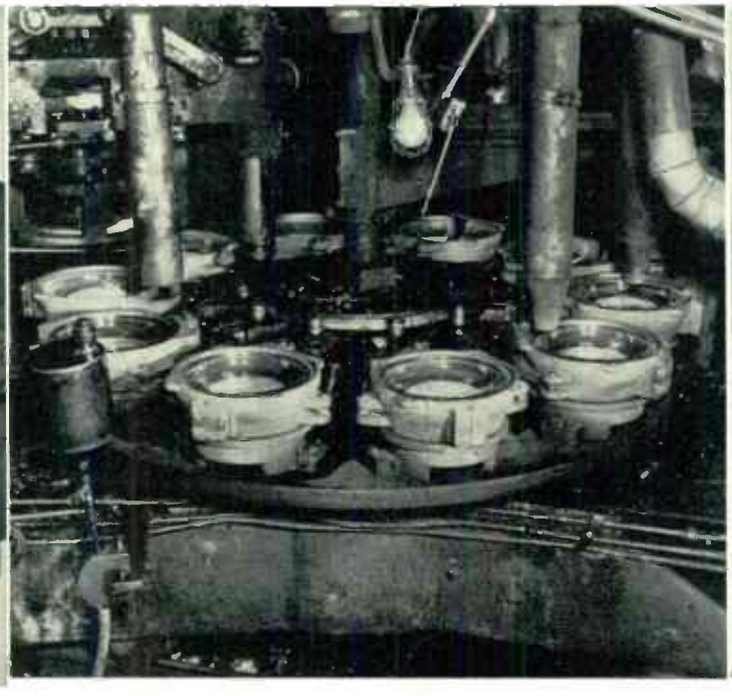
2. E. Finley Carter, right, vice president in charge of engineering, explains the plans for Sylvania's research center now under construction at Bayside, New York. His guests, left to right, are Don G. Mitchell, president of Sylvania; Robert Moses, Commissioner of Parks; Sylvania board chairman Walter E. Poor; and M. A. Fitzgerald, Queens Commissioner of Borough Works.

3. KDYL, Salt Lake City, first television station between St. Louis and the Pacific Coast, is now on the air with experimental programs. This RCA installation, owned by Intermountain Broadcasting Corporation, is operating on channel No. 2, with 400 watts video and 200 watts aural power. General manager is S. S. Fox.

4. Two Armstrong Medals were awarded by the Radio Club of America for 1947 in recognition of outstanding contributions to the radio art. One was presented by Radio Club president Prof. Hazeltine to John V. L. Hogan, right. The other was awarded posthumously to Charles Stuart Ballantine.

5. This machine originally designed to handle borosilicate glass cooking

(CONCLUDED ON PAGE 52)



4. JOHN V. L. HOGAN AWARDED ARMSTRONG MEDAL. 5. BAKING DISH MACHINE MAKES TV REFLECTORS. 6. LATEST IN VACUUM TUBES

Now...

This RCA Switching System consists of a master "on-the-air" monitor and oscilloscope, a waist-high control panel (enlarged view, above) and mixing amplifier, below. This equipment becomes one of the standard-size sections of RCA's unit-built video console (top of page). Any combination of camera-controls and monitors is possible to fit your particular station.

split-second selection

of all television program material

New RCA Camera Switching Unit provides convenient, push-button control at your video console

FADING CONTROL

MONITOR SWITCH
3-position: program line, either of two remotes

GAIN FOR REMOTE INPUT (#6)

REMOTE INPUTS

RELEASE BUTTONS

TALLY LIGHTS
and switches for remote sync

CAMERA SWITCHES
(2 rows) handle 4 inputs from studio and film cameras and 2 remotes to permit fading, instantaneous switching, special effects.

TALLY LIGHTS
for six inputs

GAIN FOR REMOTE INPUT (#5)

HERE, in one compact unit, is a control center for your television programs. Into it can be brought as many as six video inputs—from studio cameras, film cameras, relays, and network. *One* operator can handle the lot!

Twelve different types of switching are your assurance of a smooth, dramatic presentation, whatever the program. Look at the possibilities:

Your operator can *instantly* switch: (1) between two local camera signals; (2) between two remote signals; (3) from local to remote; (4) from remote to local; (5) from local to black screen (no signal); (6) from remote to black (screen); (7) from black to remote. With the special manual fader control he can, *at any desired speed:* (9) fade out local to black; (10) fade in local from black; (11) lap-dissolve between any two locals; (12) superimpose two locals and adjust the level of each. All sorts of trick effects are possible by moving the two levers that make up the fader control.

Tally lights provide an instant check on which input is being used and whether a remote signal is being received. If remote sync fails for any reason, local sync automatically takes over.

The monitor in the top of the console section allows the operator to either view the on-the-air signal or preview one of the two remote signals.

An unusually flexible intercom switching system (not shown) is included to permit private, special-group, or conference communication between practically all personnel. All have access to program sound through one earpiece of their headsets.

Here, we believe, is a switching system that represents the most advanced engineering in television station techniques. It will help you simplify television station routine—bring new possibilities to television programming. Be sure to get the complete story. Write Dept. 38-B, Radio Corporation of America, Engineering Products Department, Camden, N. J.

PROGRAM SOURCES

RCA Studio Camera (Switching Unit handles up to four)

RCA's Mobile Studio (Switching Unit can handle two remotes)

RCA Film Camera (Switching Unit handles two with 2 studio cameras)

TELEVISION BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

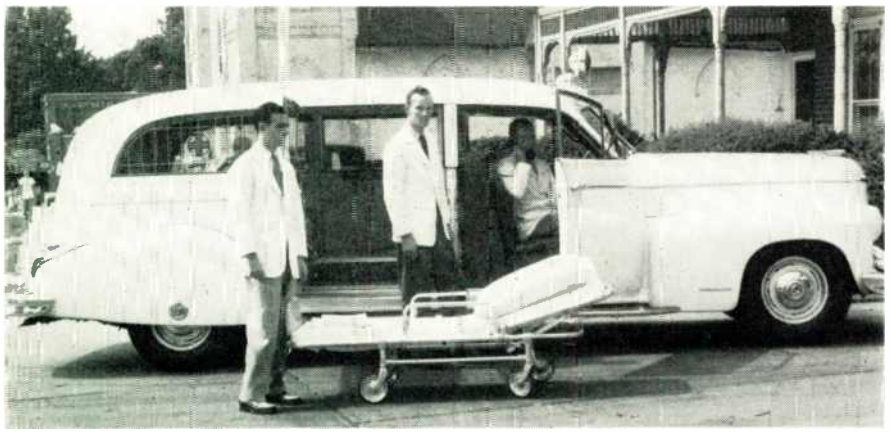


FIG. 1. E. O. JOHNSON, AT THE WHEEL OF ONE OF THE SECHREST AMBULANCES, TAKES A CALL FROM THE DISPATCHER AT TRANSPORTATION COMMUNICATION SERVICE

OPERATING AN L.C.C. SYSTEM

Success at High Point, N. C., Shows Big Field for Limited Common Carrier Service

BY JOHN M. SITTON*

ONE of the new fields for mobile radio communications, and a field that shows great possibilities for successful development, is that of limited common carrier service. This is illustrated by the experience of J. Frank Beck, owner of the Blue Bird Cab Company of High Point, N. C., and operator of Transportation Communication Service Corporation.

High Point, a city of 39,000 population, is a furniture and hosiery manufacturing center. Long before taxi radio became a reality, J. Frank Beck figured out that if he could dispatch his cabs by radio, he could effect a great improvement in service rendered the public, and at a substantial reduction in operating cost. That goes back to 1934.

It was not until 1945, however, that he was able to test the plan in practice. Then, Bendix Radio engineers offered to set up a test system, with the idea of eventually designing special 2-way FM units for taxicabs. The first tests were made with surplus military aircraft units, operating on VHF. Results showed a reduction of 20% in operating expense, compared with his non-radio cabs. Subsequently, development work was completed on Bendix mobile equipment, and units specifically designed for this service were put into production.

Their performance was so successful that Beck decided to equip not only his own cars, but to supply service to others. Under this plan, he could not only have the benefit of radio dispatching for his Blue Bird Cab Company, but he could operate his radio system at a profit by serving others.

Accordingly, he formed the Transportation Communication Service Corporation, and applied to the FCC for a limited common carrier license. He was assigned a frequency of 152.03 mc., with the call letters W4XLA. Under this license, covering 50 mobile transmitters, he can furnish communications service to local individuals or companies whose activities require 2-way radio, including the police and fire departments.

His first subscriber was the J. W. Sechrest Ambulance Service. One of their radio-equipped ambulances is shown in Fig. 1. This may seem like an unusual application of 2-way radio, but it has proved extremely valuable in numerous instances. On one occasion, for example, a Sechrest ambulance was dispatched to a rural section where two linemen had come in contact with high-tension wires. On arrival, the driver found that an iron lung would be needed for one of the men. Knowing that the iron lung was kept on the opposite side of the city, he called ahead by radio, and the equipment was in readiness at the hospital before the patient arrived! Only a few incidents of this sort were

(CONCLUDED ON PAGE 33)

* Director of Public Relations, Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.

FIG. 2. W. H. TAYLOR, DISPATCHER AT T.C.S. HEADQUARTERS STATION, RELAYS CALLS BETWEEN THE TELEPHONE LINES AND THE RADIO-EQUIPPED CARS, TAXIS, AND TRUCKS

FIG. 3. BENDIX MTR-3 UNIT LEAVES REAR COMPARTMENT FREE FOR LUGGAGE

DESIGN OF STUDIO SPEECH INPUT SYSTEMS

Plans Which Strike a Balance Between First Cost, Flexibility, and Maintenance Expense—Part 1

BY JOHN A. GREEN*

SMOOTH, efficient operation of our modern radio stations today is effected in a very large measure by the choice of speech input equipment used at the studio location. Better programming can be accomplished if the equipment allows completely flexible operation, and assures a high degree of reliability. Before a new station is installed, or an established station re-equipped, all the problems involved in the complete operation should be analyzed and considered very carefully with reference to the speech input facilities.

It is the author's purpose to discuss in some detail typical installations of speech input equipment suitable for the smaller stations, the larger stations, and stations which are operating two program schedules at the same time. Standard, commercially available equipment will be selected to satisfy the design requirements as far as possible. In practice, it is difficult to draw the line just where one set of equipment will best fit, and where another is preferable. For purposes of illustration here, Collins Radio units will be specified.

Gearing Equipment to Programs ★ Program policy is a major factor in the choice of proper studio speech input equipment. Just what type of programs are planned? That is a question that the chief engineer of every new station should first ask his management before he starts any design work on studio facilities. The chief of a station already operating has the advantage, in planning new facilities, of knowing from experience what types of program material must be handled. With this information at hand, the whole operation can be laid out.

There are, of course, other factors which must be considered, such as the size of the staff that will be available to operate the station, and just how able this staff is likely to be. Finally, and inevitably, there is the factor of cost and, in some cases, a budget limitation which calls for simplifying the plan in order to use high-quality components, or using a more elaborate arrangement built up of cheaper units.

In all cases, imagination must be used in planning the installation. Imagination is a very important tool in engineering, and when combined with sound judgment it pays very big dividends, not only to the station but to the engineer doing the work. There are always special operations which must be handled in every station. Advance thinking must allow for these specials when the equipment is originally specified. Installation of what may at the time seem to be an extra will, in most cases prove to be economical in the end. Many hours of rework may be saved — rework that usually has to be done after midnight in most instances. Many stations are required to pay premium wages to the staff doing the work, plus the cost of sleep lost by everyone concerned.

Many times, all the program questions cannot be answered accurately before actual operation has begun. In these cases, the management must rely on the judgment of the chief engineer to assure the purchase of equipment to cover whatever program requirements may develop. If the chief engineer can foresee the major problems, and install equipment to meet them, with a margin to take care of emergencies, he will have performed a real service to his company.

This paper will cover only the engineering design of the speech input system. The physical design of the studios and the details of actual installation are complex subjects by themselves, requiring separate treatment. However, typical examples to be described will be related to modern studio design practice.

The Small FM or AM Stations ★ Let us consider first the requirements of a small AM or FM station. Fig. 1 is a typical example of a reasonably complete and well-arranged plan. There is included a good size lobby, permitting the public to observe the different shows produced at the station, with the minimum of interference with the staff. The view into both the studios as well as the control room is unobstructed. Office space is provided for the manager, program director, sales department, continuity department, and for the general office. Sufficient closet space is allowed for storage of stationery, sales promotion material, operational supplies and records. A music library, handy to both the continuity department and to the control room, allows storage for transcriptions and records. Office space is provided for the chief engineer, and connecting to this office is the work shop, a very necessary item in every station design. A well-equipped shop is a real incentive for the engineers to keep the equipment in shape, and to build new

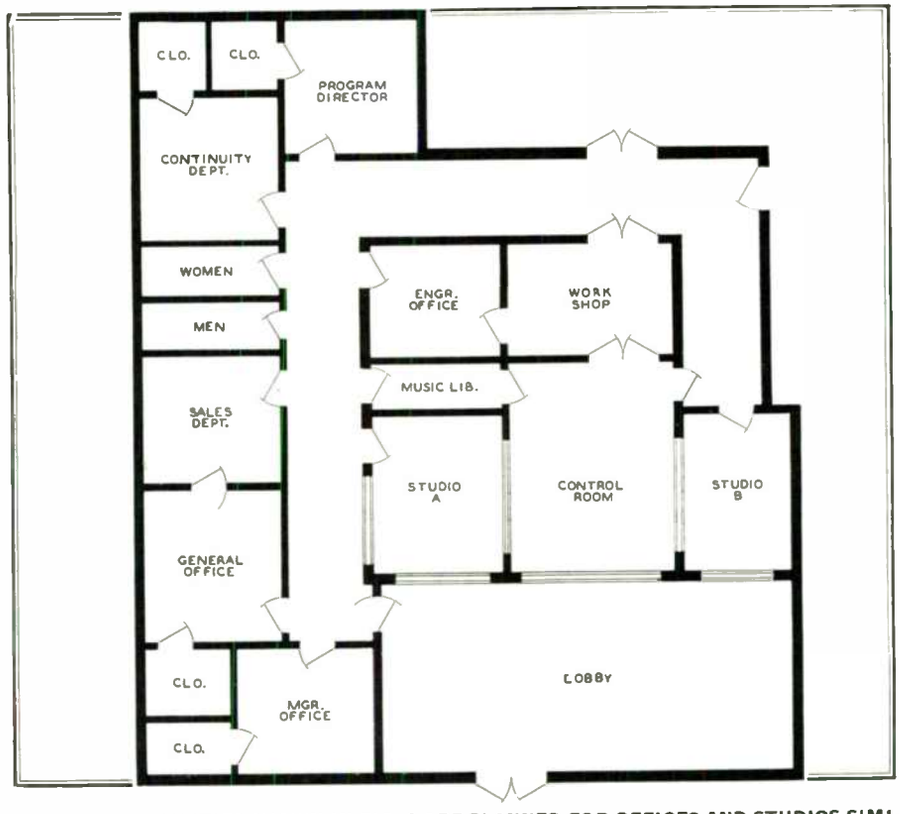


FIG. 1. THE FACILITIES SHOWN IN FIG. 2 ARE PLANNED FOR OFFICES AND STUDIOS SIMILAR TO THE LAYOUT SHOWN HERE FOR A SMALL FM OR AM INSTALLATION

* Engineer, Collins Radio Co., Cedar Rapids, Ia.

equipment, designed for specific operational requirements, in less time and at less expense than it can be obtained outside.

Now let us assume typical operating conditions which the equipment must be able to handle:

1. The station will operate an 18-hour schedule each day.

2. A large part of the programs will be transcribed or recorded.

3. There will be a few studio shows each day, limited perhaps to a small orchestra, a drama or so plus, of course, the standard newscasts.

4. A few remote pickups will be included in each day's operation.

5. Provision must be made for connection to a net work, even though operation is to be independent initially.

6. Some recordings must be made each broadcasting day for use not only on the air, but for the reference library and for auditions. With these operational points, consideration must be given to just what the equipment must be able to do to cover each requirement, and allow for some special situations.

The 18-hour operation requires that the equipment be reliable in performance over a long period of time. Maintenance is a necessary item in every station's operation, but this maintenance can be done only during the six hours the station is off the air. This requires that all components in the equipment be readily accessible for inspection, and that a minimum amount of tear-down is required for servicing each part of the entire equip-

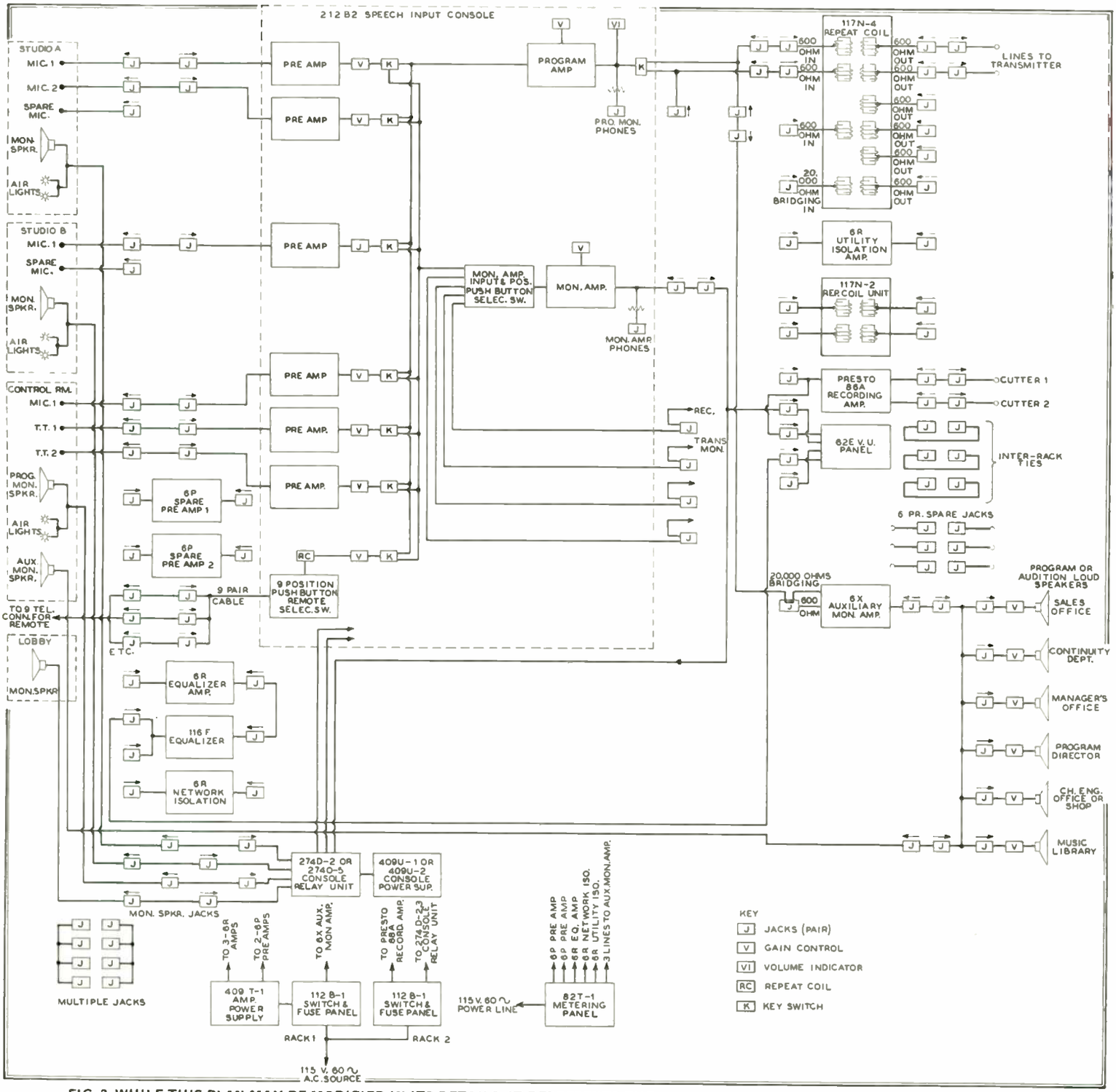


FIG. 2. WHILE THIS PLAN MAY BE MODIFIED IN ITS DETAILS, IT REPRESENTS THE REQUIREMENTS FOR A SMALL, UP-TO-DATE STATION

ment. Six hours can pass rapidly while hunting trouble.

Provision must be made for at least 2 high-quality transcription turntable assemblies, preferably equipped with universal-type pick ups. This will allow the station to use both vertical and lateral transcriptions and records. It may be that a third transcription turntable should be provided so that, at times during the day when the recorded load is high (for example, singing commercials) this extra turntable can be used to help simplify the operation, and to eliminate errors due to confusion.

To produce local studio shows, properly, it is necessary to choose the right type of microphones and stands, so that the microphones can be used in a variety of situations to facilitate program continuity. Good monitor speakers and an ample number of studio warning lights are also important to insure trouble-free studio productions. The monitor speakers will allow the performers to hear what is going on, and the warning lights are necessary as a guide to people walking in and out of the studios.

The network connection, in most cases, can be handled to best advantage as another remote connection into the studio speech input console. That is the manner of connection suggested for this particular layout. Facilities for auditioning shows, cueing records, and talking-in remotes are necessary items for every studio speech input system. Recording on-the-air performances for reference or for audition is another important part of radio operation today. Good recorders should be used. The first cost is greater, but they will soon pay for themselves in the quality and reliability of recordings that can be made with them.

Fig. 2 is a block diagram prepared to represent, or perhaps better to specify, the equipment required to do the job for this theoretical station operation we have set up. The equipment necessary for the basic operation is provided, plus some equipment to handle the specials which come up every now and then at any station.

Two microphones in Studio A, and one microphone in Studio B are normally connected to the console. In the control room, one microphone and two transcription turntables are normally connected to the console. An extra receptacle in each studio and in the control room, are terminated at the jack strip on the racks, so that extra equipment can be connected and patched into the system as required. There is a monitor speaker in each studio, and in the control room and lobby. Warning lights are required outside each studio and the control room, so that people will not walk in when the microphones are open. Audio circuits throughout the complete installation are brought up on jacks to insure flexible operation of the entire equipment under all conditions of program loading. Two rack-mounted preamplifiers are used in the system. These permit the operation of any combination of additional microphones and transcription turntables in the studios or in the control room. The outputs of these preamplifiers are brought into the console in the same fashion as a remote would be handled.

A program equalizer is provided for use with telephone circuits on remote pickups. This provides equalization of both the low and high frequencies. An amplifier is required in conjunction with the equalizer to make up for the insertion loss. A second amplifier is included as a utility amplifier, or as an isolation amplifier in the network circuit. Plate and filament power for the amplifiers is obtained from a rack-mounted power supply.

All AC power for the studio installation is routed through the two circuit-breaker and fuse-panel assemblies, so that each and every piece of equipment is separately fused and protected from damage should it or other pieces of equipment fail.

Part 2, describing the individual units for this installation, will appear in a forthcoming issue.

COMMENT ON DUPLICATION

THE First comment we received from a set manufacturer came from Arthur Freed, general manager of Freed Radio Corporation. This company was one of the first to produce FM receivers, and is still the only one to manufacture FM-AM sets exclusively. Just back from a coast-to-coast survey of FM dealers, Mr. Freed had this to say:

Widespread benefits to the public and to every segment of the radio industry will result from the network-union agreement to end the ban on duplicating live musical broadcasts on Frequency Modulation channels.

Until yesterday's agreement was reached, retailers and distributors throughout the country who have absorbed more than a million FM radio sets manufactured last year were generally pessimistic about the FM radio sales picture. The increase in the sales of FM radios expected by the dealers never fully developed because of the public's disappointment with the limited entertainment fare and the poor quality of musical broadcasts which FM stations were obliged to offer. This condition was forced on FM broadcasters because of their inability to duplicate important network shows, and their complete reliance on recorded music. Now the promises that FM made to dealers and to the public can be realized. Live musical shows on FM stations will provide a quality of reception that standard broadcasts or recordings could never achieve because they have less than half the tonal range possible on Frequency Modulation broadcasting. Perhaps the most important factor in increasing FM sales will be the opportunity now afforded to let prospective customers hear the difference between AM and FM reception of the same program. In this way, people in metropolitan areas who say, "Oh, I get perfect reception on my AM set," will have a chance to hear how far from perfect is the best AM reception.

When the public has an opportunity to hear the immeasurably better musical entertainment that live FM makes available, there will be a great increase in retail activity on FM radios. Moreover, high fidelity FM broadcasting will enable dealers to sell better instruments and increase their unit of sales. There can be no doubt that the public will want to take advantage of this finer radio reception, and that they will be willing to pay for more expensive sets. For the first time, the public will be able to recognize a difference in the reception quality of radios offered to them.

Broadcasters, too, will benefit greatly from the decision to duplicate programs on AM and FM channels. At present, a considerable number of FM independents, many of them ex-GI's, are having difficulty to meet fixed charges because the poor quality of most FM programming has not enabled them to develop audiences which will attract advertising dollars. Now, large numbers will be able to secure network affiliations and audience-building programs.

Independents who cannot negotiate affiliations with existing networks immediately will associate themselves, before long, with new radio networks which are sure to be organized. Networks, conversely, will not be so dependent on a few powerful AM stations.

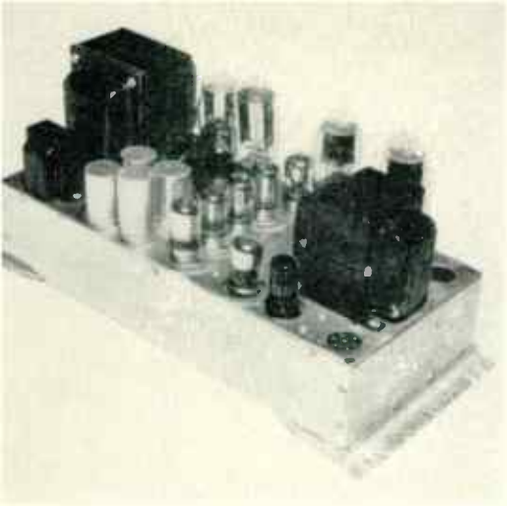
OPERATING AN L.C.C. SYSTEM

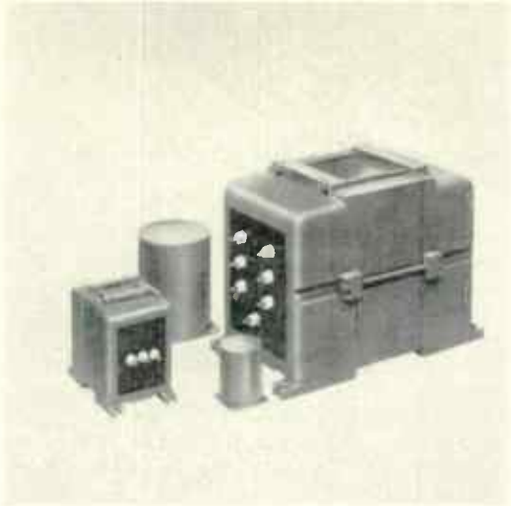
(CONTINUED FROM PAGE 30)

necessary to convince other subscribers of the value of T.C.S. mobile radio.

The main transmitter is a Bendix type MRT-1E, with a biconical antenna installed on the 14 story Southern Furniture Exposition Building. The remote control point, Fig. 2, is at the T.C.S. office. All the mobile units Bendix type MTR-3's, as illustrated in Fig. 3. This is a very compact design, small enough to be mounted in a rear compartment without taking up space needed for luggage. The maximum range of the system is 25 to 40 miles.

At present, there are 49 companies licensed as limited common carriers. But this is only a start. This group will increase rapidly in number as others realize how effectively one radio system can handle 2-way communications for many different kinds of local subscribers. Here is an undertaking that should appeal particularly to radio servicemen.





1. BROOK HIGH-FIDELITY AMPLIFIER. — 2. UTC PROFESSIONAL AUDIO TRANSFORMERS

ITEMS FOR DEALERS

AM-FM Program Duplication and Creating a Vast New Business in

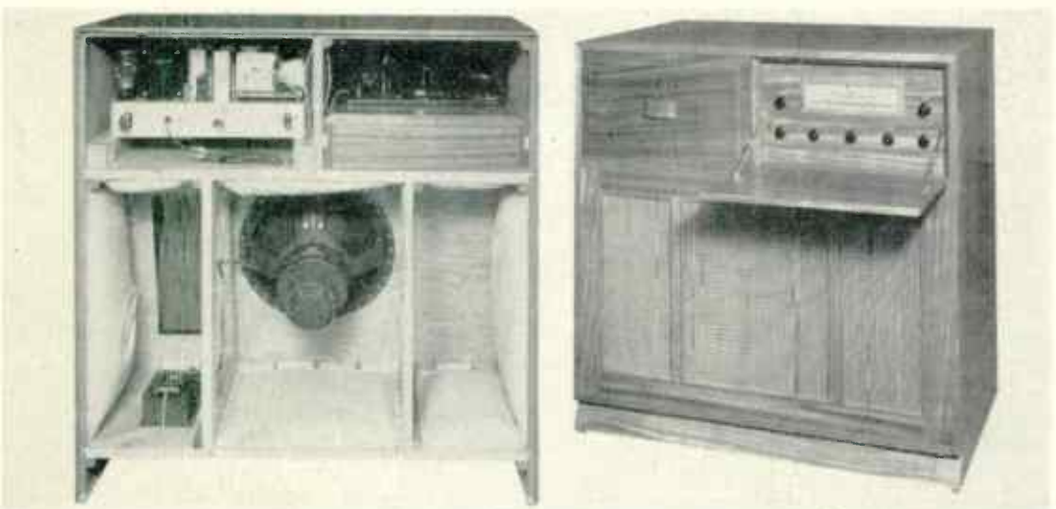
WITH AM network programs now broadcast over affiliated FM stations, and a steady expansion of television transmission under way, 1948 will set a new record of profits for dealers and servicemen who undertake to capitalize on the opportunities which are being created.

Already, in areas where good FM or TV programs are available, sales curves on FM and TV sets are climbing steadily, with AM sales definitely dropping off. The steeper the up grade on the former, the sharper the down grade on the latter.

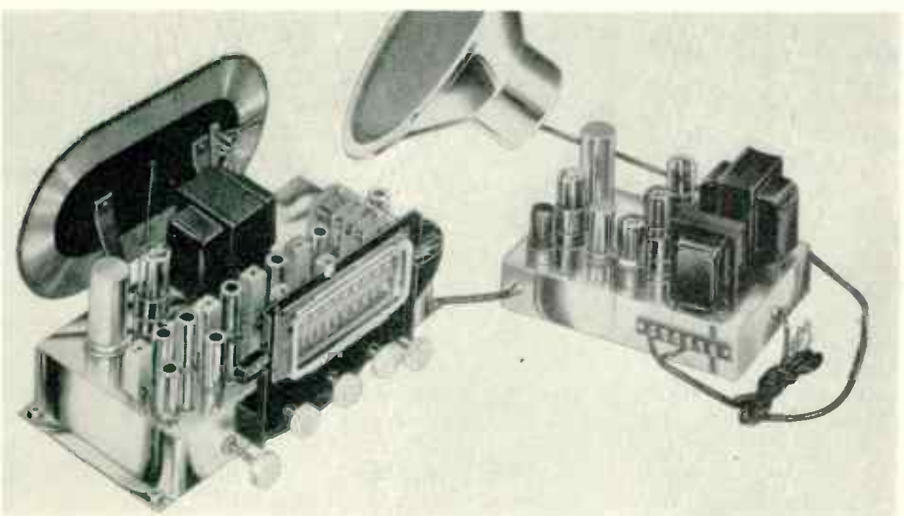
Conditions vary in different localities, but the trend is the same, differing only in degree.

The new business, whatever its volume in any given area, is divided into these classes: 1) standard FM and TV receivers, 2) custom-built chassis installations with various combinations of phonographs, noise-suppressors, wide-range amplifiers, and high-fidelity speakers, and 3) FM and TV installations and service work.

The importance of this changing aspect of sales and service, and the trend is well

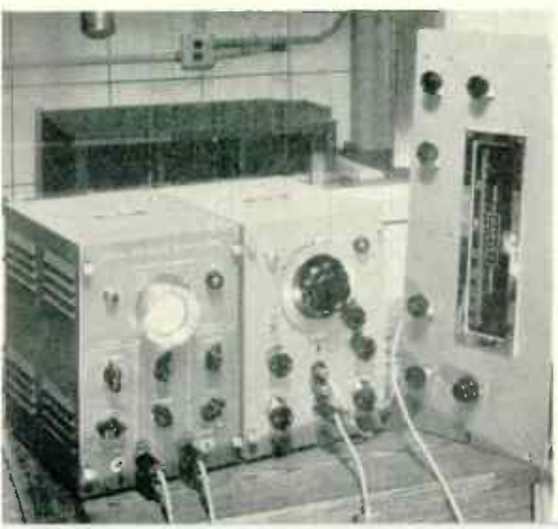


3. HARVEY RADIO FM TUNER AND ALTEC SPEAKER IN A CUSTOM CABINET INSTALLATION



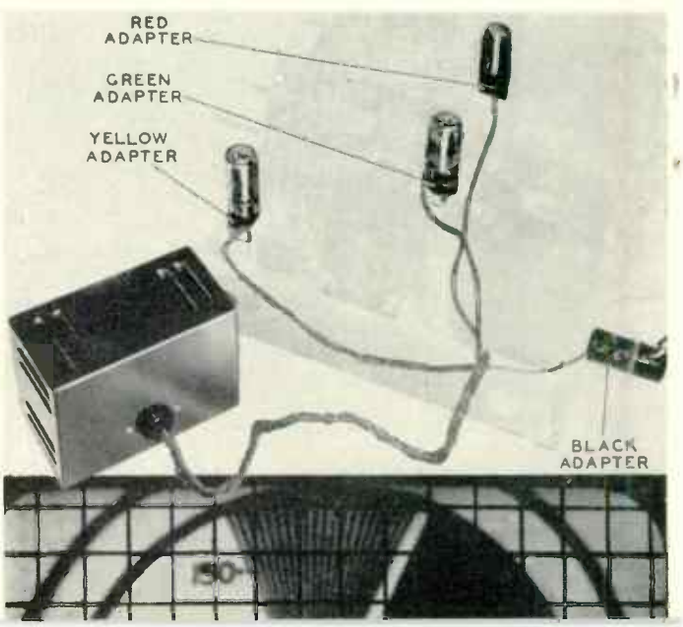
4. MEISSNER FM-AM CHASSIS AND AMPLIFIER FOR CUSTOM SET-BUILDERS

5. BENDIX FACTOMETER FOR PRE-CHECKING RECEPTION



6. LEFT: HARVEY RADIO'S FM SWEEP GENERATOR AND OSCILLOSCOPE FOR VISUAL ALIGNMENT OF FM RECEIVERS

7. RIGHT: PHILCO TEST UNIT FOR CHECKING TELEVISION SET PERFORMANCE WITHOUT THE NEED OF ACTUAL RECEPTION. IT SUPPLIES TEST GRID, SHOWN BELOW, ON PICTURE TUBE



AND SERVICEMEN

More FM and TV Stations Are High-Profit Equipment Sales and Service

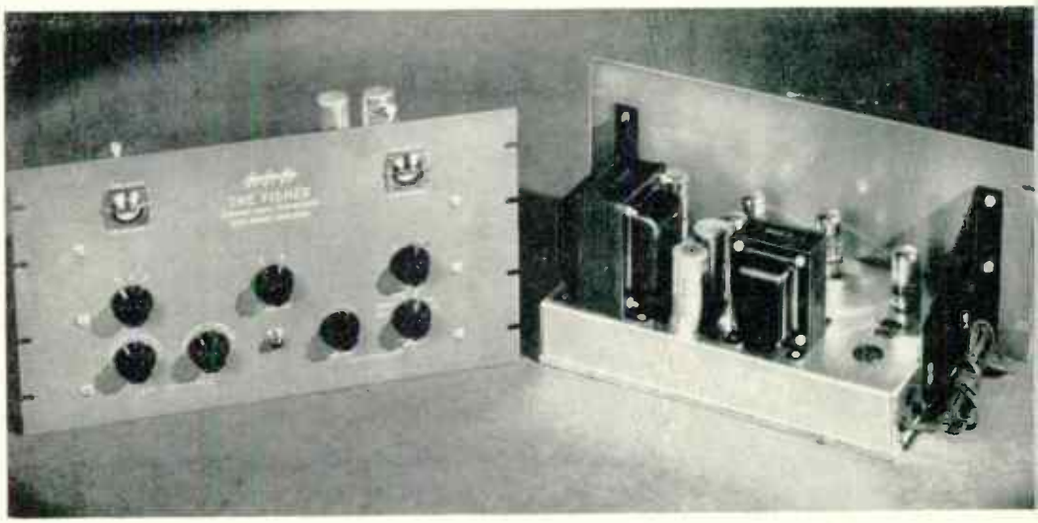
established, lies in 1) the increasingly technical nature of the new equipment, 2) the much higher margin of profits to be realized from the larger units of sale, and 3) the decreasing ratio of legitimate service charges to the original cost of the equipment repaired.

As an indication of this development, some of the new equipment and test instruments are illustrated on these pages. Each item was selected because it plays some part in the new business created by FM and television.

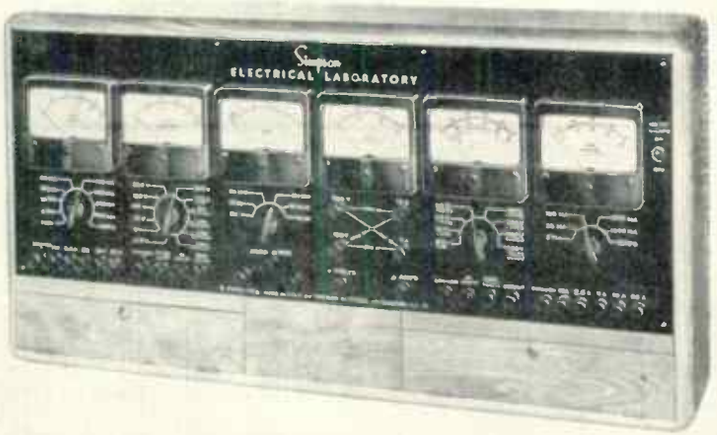
Space does not permit detailed descriptions. However, complete technical information can be obtained by addressing a postcard to the New Business Editor, *FM* AND TELEVISION Magazine. Give the numbers appearing under the illustrations of items in which you are interested.

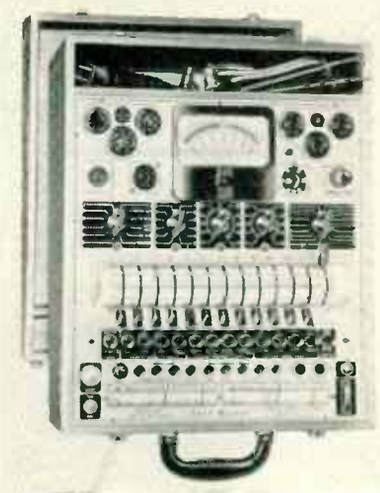
In addition, our New Business Editor will be glad to answer specific questions or to be of assistance in any way in connection with problems concerned with FM and TV sales, servicing, and custom set-building.

8. RCA SWEEP SIGNAL GENERATOR FOR SERVICING FM SETS. — 9. HICKOK OSCILLOSCOPE



10. FISHER DYNAMIC NOISE SUPPRESSOR AND POWER AMPLIFIER FOR CUSTOM SETS





11. ALTEC-LANSING AMPLIFIER. — 12. SIMPSON'S METER ASSEMBLY. — 13. PRECISION TESTER. — 14. BELOW: KAY FM-TV INSTRUMENTS

DISCUSSION OF FM PROPAGATION TESTS

Text of a Supplementary Brief Concerning Norton-Allen Testimony before the FCC—Conclusion

BY MAJOR EDWIN H. ARMSTRONG

What Mr. Allen did was to analyze the high-band signals on the hourly median basis for all 7 months of the Southampton tests, except the month of November, so that when he averaged his figures for 7 months the result reflected the signal drop-outs for only ¼th of the time (Fig. 1); and when he averaged the figures for 5 months, not including November (Fig. 4), the drop-outs were not reflected at all.

On the other hand, Mr. Allen applied the minute-by-minute method of analysis to the low band transmissions for all 7 months, except July and August, so that his averages reflected the drop-outs for 5 of the 7 months and 3 of the 5 months involved in Figs. 1 and 4, respectively.

A comparison of two sets of recordings on two different bases of analysis makes the resulting conclusions absolutely worthless.

Inadequacies of Test on High Band ★ A 725-watt transmitter does not give a strong enough signal at 70 miles to permit accurate tests of field intensities to be made. Such a signal is so near to the noise level that even slight drop-outs get into the noise area, and the depths of the drop-outs cannot be measured. Hence the recordings on such low power do not give the same picture as recordings on power sufficient to keep the normal signal well above the noise level.

The following quotation from a letter in the Commission's files, dated August 15, 1946, from Slowie (dictated by Allen) to Poppole of WOR, indicates that Allen appreciated the unreliability of the low power signals for testing purposes:

"There are times at Southampton and at Laurel when the signal levels provided by the 1-kw. transmitter are too low for recording purposes. The substitution of the high-gain antenna for the present doublet will greatly increase the value and reliability of the recordings, and anything which you can do to expedite the change will be greatly appreciated."

The high-gain antenna was not put into service until October 10, 1946, and the Southampton tests were discontinued on November 20, 1946, though the tests at the other three geographical points were continued through May, 1947.

Thus an additional defect in the Allen report and findings is that the recordings on the 2 bands were not comparable, the signals on the high band being too weak for even reasonably accurate measurement of the fluctuations in signal strength.

Nor was the apparatus used by the Commission in the Southampton recordings accurate enough to give good measurements, especially of the weak signals on the high band. In that apparatus the recorder armature was in the plate circuit of a vacuum tube amplifier, whose plate current was controlled by the AVC circuit. It is notorious that in such apparatus there is a "bug" known as a "floating zero," which makes it difficult or impossible to measure weak signals accurately. In the work at Westhampton Beach the same type of apparatus was used at the outset, though considerably improved by a crystal-controlled oscillator in the receiving set; but it was found, in spite of the transmitter power of 100 kw., that the floating zero still made the recordings of drop-outs inaccurate. The floating zero was finally eliminated by insertion of a crystal rectifier, by which, as already explained, the rectified intermediate-frequency currents of the receiver were made to drive the recorder armature directly.

Discrepancy Between Recordings and Charts ★ I analyzed the Commission's recordings of the high band transmission for the 5-month period from June to October, 1946, in an effort to measure the amount of time during which the signal was below the 5-microvolt level. Because the recording tapes were run at only 3 ins. per hour (as compared with 6-in. and 12-in. per hour speeds employed at Westhampton Beach), and because the analysis had to be made in a cramped part of the scale, the mechanical job of counting the time intervals was very difficult. I believe, however, that the result that I obtained is accurate to within 20%.

I found — by counting the intervals during which the signal strength was shown by the recordings to have been below the 5-microvolt level — that the total amount of time during the 5 months when that condition appeared to exist was about 8.6% of the total time covered by the recordings. Allowing for a 20% margin of error, the range would be from about 7% to about 10%.

These figures compare with Mr. Allen's figure of 3/10ths of 1% on his chart (Fig. 1). My findings, in other words, show that the aggregate duration of the drops below the 5-microvolt line for the high-band signal was 35 to 50 times as great as Mr. Allen showed on his Fig. 1.

By his Errata sheet [6] Mr. Allen has now corrected the .2% figure, changing it to 2.7% — increasing his original figure by a mere matter of 1250%.

I do not suggest to the Commission that my figure of 7% to 10% for time below the 5-microvolt level, as obtained by an examination of the high-band recordings made at Southampton, is a figure that can be relied on to show the extent of fading on the high band. I do not think that any figure derived from the Commission's recordings can be relied on, because I believe that the recordings themselves are unreliable, for the various reasons developed in this brief.

Errors on the Face of the Charts ★ It is not at all clear how Mr. Allen got from the recordings to his final charts, since the final charts purport to show the overall results over periods of 5 and 7 months and do not disclose any of the detailed plotting by which he got his hourly median and other figures and put them together into the composite picture which the charts present. Whatever errors may have been involved in the intervening work cannot be determined, since only the underlying data and the final charts have been available.

But if the charts themselves are fair specimens of the whole job of analysis, then they indicate that the analysis and the conclusions cannot be relied on, since the charts show errors on their face, and even mathematical absurdities.

For instance, Fig. 4 shows that the low-band recordings over a period of 5 months dropped below the 5-microvolt line for 10% of the time, *i.e.*, for intervals totaling up to ½ of one month of testing time. Fig. 1, on the other hand, shows that for 7 months the low-band signal dropped below the 5-microvolt line for 16% of the time — or for intervals totaling up to 1.12 months of testing time. Since the 5 months were included in the 7, this means that the addition of 2 months increased the time intervals below 5 microvolts from ½ of a month to 1.12 months, an increase of 6 3/100ths of a month.

This means that in the added 2 months the time during which the signals on the low band dropped below 5 microvolts was 31% of the total testing time. This figure is not only absurdly high, but it is quite

(CONTINUED ON PAGE 53)

[6] The Errata sheet was handed to me by Mr. Allen after I had pointed out to him some of the errors I had noted. It is dated November 26, 1947, consists of 3 pages, and is headed "Draft."

FIG. 1, ABOVE: JACK MCCULLOUGH, LEFT, AND BILL EITEL, WITH ONE OF THE NEW 3X12500A3 TRIODES. BELOW: 6-BAY TURNSTILE ON THE EIMAC PLANT AT SAN BRUNO, NOW SET UP FOR TEMPORARY USE

50 KW. OUTPUT ON 88 TO 108 MC.

An Indirect Approach to High-Power FM Transmitter Design Produces a Practical Solution

BY ARTHUR ARIGONI*

ON April 23, 1947, KSBR, of Radio Diablo, Inc., first went on the air with 50 kw. of power at 100.5 mc. The site is probably the worst conceivable FM location ever used, as San Bruno has an altitude of only 8 ft. above San Francisco Bay. The 6-bay turnstile antenna, as illustrated in Fig. 1, has an effective height of 80 ft. Hills 1,000 ft. high and only 3 miles away stand between the transmitter site and the metropolitan San Francisco area 12 miles north. Even so, a satisfactory signal is delivered to San Francisco and the Marin County suburbs north of there. Eastwards, 2,000- to 3,800-ft. hills separate the interior valley communities of Sacramento and Stockton from the transmitter site. In spite of these handicaps, good signals are delivered at airline distances of 60 to 80 miles.

Coverage with High Power ★ It is apparent that even with an antenna location as mediocre as could be found, high-power 100-mc. FM can supply good signals throughout a broad area. High power from a better antenna location is certain to outdo present AM coverage by a large margin. This will shortly be demonstrated when the KSBR transmitter is taken to its permanent site on the summit of Mount Diablo, a mountain which overlooks the entire central valley of California as well as the San Francisco bay area from a 3,800-ft. altitude. From this ideal point, fully adequate FM signals will be made available to more than three million people.

Mount Diablo is unique in its command of great areas of land. From its peak, 39 of California's 58 counties can be seen, as can Mount Lassen, Mount Whitney, and Half Dome in Yosemite. The mountain, which stands roughly at the focal point of a terrestrial parabola, played a vital part in the early development of northern California. Due to its visibility over large areas, it bears on its top the main point from which survey lines were determined for the entire northern part of the state. It will be in the spirit of the mountain to serve again as a pioneering landmark — this time for the dials of northern California's radio receivers.

Operations by a number of broadcasters in the old FM band demonstrated that 1) high-power is the way to assure listeners of sufficient signals at their receiver terminals, and 2) types of power tubes used at the 42 to 50 mc. were operating near their upper useful frequency limit. The design and development of KSBR's transmitter was undertaken by Eitel-McCullough, Inc., manufacturers of Eimac tubes, as a project directly related to development of new power tubes capable of operating throughout the new band at powers in the 50-kw. range.

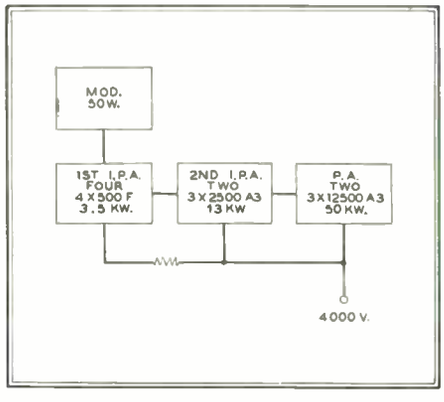


FIG. 2. 50 KW. FROM 3 STAGES

Transmitter ★ As shown in the block diagram of the KSBR transmitter, Fig. 2, a 50-watt REL modulator drives a 3-kw. intermediate power amplifier consisting of 4 Eimac 4X500F tetrodes. This drives a 13-kw. IPA with two grounded-grid Eimac 3X2500A3 triodes in push-pull which, in turn, drives the final power amplifier, employing two push-pull grounded-grid Eimac 3X12500A3 triodes. The IPA stages are illustrated in Figs. 3 and 4. Their experimental appearance comes from the fact that they were converted for the purpose from existing pieces of test equipment, but final installation atop Mount Diablo will see them rebuilt and, to a certain extent, condensed in size. Examination of the general view of the transmitter illustrated here, however, will give some indication of the remarkably small size of the complete unit, especially by comparison with a 50-kw. AM transmitter or even one of the few 50-kw. transmitters to reach operational status in the old 42–50 mc. FM band.

The gear which contains most of the engineering departures is the 50-kw. final amplifier, Fig. 10. One of the 3X12500A3 triodes is shown in Fig. 6. This is the new tube that came out of the KSBR development. While it was originally intended specifically for the task of producing 25 kw. with high efficiency at FM frequencies, it has proved its suitability for numerous other applications as well. It consists of 4 units of the 3X2500A3 type, assembled on a common mounting. Filament and grid terminals of the units are interconnected by low-inductance disks. Grid and filament contact fingers are integral with the tube, to permit a socket consisting of simple concentric rings against which appropriate clamps hold the

*Chief Engineer, Radio Diablo, Inc., San Bruno, Calif.

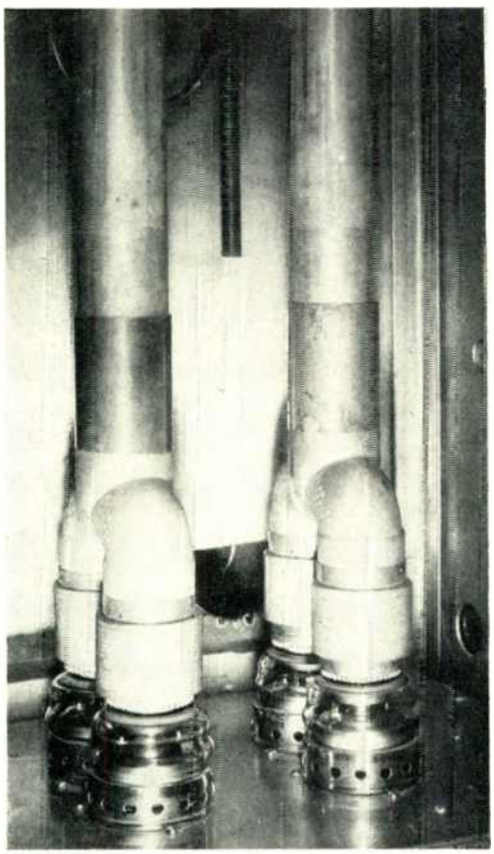
tube. The mounting is so designed that individual units can be taken out at the factory and replaced.

Tube Design Considerations ★ Multiple tubes, made from a number of small factory-assembled mass-produced units, have several advantages over single high-power tubes of power ratings equivalent to the total output of the assembly. A tube must be short compared with its operating wavelength if effective use of electrode areas is to be made. At high frequencies, this requires large electrode diameters in single-unit, high-power tubes.

Good over-all efficiency at high frequencies requires the use of low operating voltages, hence, small inter-electrode spacings. Small diameter grid wire and large effective filament area are also indicated. While it is not impossible to support a closely-spaced grid-filament structure answering these qualifications, it is certainly difficult and costly. Support rods, insulators, and construction of that kind are a liability not only in performance but also in production.

Great weight is another disadvantage of single-unit designs. Heavy-walled copper anodes and large cooling-fin assemblies are usually necessary, making a single-unit tube of 12.5-kw. plate dissipation capability weigh 100 to 200 lbs. By comparison, the 4-unit tube has a weight of 32 pounds. This light weight of the 3x12500A3, combined with the simple contact arrangement, speeds up tube changes tremendously and makes general handling very easy.

Multi-unit tubes gain their greatest advantage in the fact that they eliminate any compromise with performance in producing high power at high frequencies. In the case of KSBR, this makes possible performance in the 50-kw. stage equal to that of the preceding amplifier, the push-pull pair of 3x2500A3 triodes whose performance at 12.5 kw. was already known.



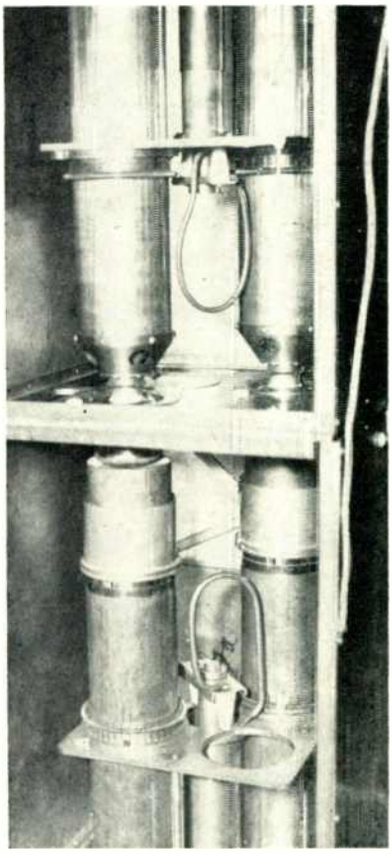


FIG. 3. FIRST IPA DELIVERS 3.5 KW. WITH FOUR 4x500F TETRODES IN PUSH-PULL PARALLEL, AT 72 PERCENT EFFICIENCY. FIG. 4. 2ND IPA DELIVERS 13 KW. FROM TWO 3x2500A3'S

TABLE 1 — OPERATING CONDITIONS

	First IPA (Four 4X500A)	Second IPA (Two 3X2500A3)	Power Amplifier (Two 3X12500A3)
D-C Plate Voltage	3507 volts	4000	4000
D-C Plate Current	1.3 amps.	3.5	13.5
D-C Grid Voltage	−200 volts	−500	−500
D-C Grid Current	.075 amps.	0.5	1.8
D-C Screen Voltage	500 volts	—	—
D-C Screen Current	.055 ma.	—	—
Driving Power (Approx.)	.050 kw.	3.2[1]	12.5[1]
Useful Power Output	3.5[1] kw.	13[1]	50

[1] Discrepancies between driving power and power output of preceding stage are due to losses in coupling circuits.

FIG. 5. THE COMPLETE 50-KW. TRANSMITTER BUILT FOR EXPERIMENTAL PURPOSES

Mechanical Design ★ Two 12-in. conductors on 14-in. centers, Fig. 7, comprise the cathode tank circuit of the 50-kw. amplifier. These conductors are entirely housed in an oval shield, Fig. 8, with ½-in. spacing from the conductor. The tank circuit is shown in Fig. 7 without the shield. Both the conductors and the shield are of sheet copper.

The cathode tank circuit is tuned by moving a shorting plate which contacts both the shield and the tank conductors. The shorting plate is illustrated in Fig. 9. It is moved by 4 leadscrews linked together by chain and driven from a panel control by means of a set of bevel gears. The cathode tank circuit is about ⅛ of a wavelength long at resonance.

The amplifier is divided into two separate sections by a 24- by 36-in. duralumin plate, ⅜ in. thick, which serves as an isolating shield between plate and

cathode circuits. The cathode-tank shield is firmly secured to the lower face of the dural shield. Bias leads into the amplifier

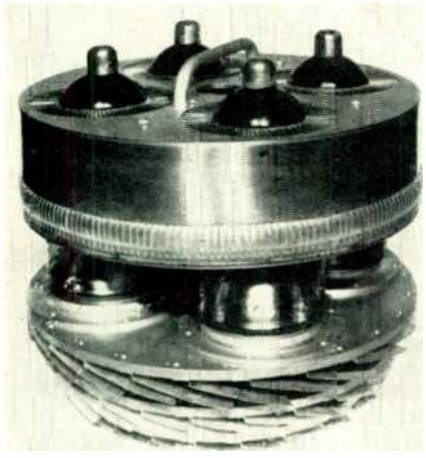


FIG. 6. THE EIMAC 3x12500A3 TRIODE

are small, flexible coaxial cables. These shielded leads prevent leakage of RF from the plate circuit into external parts of the amplifier.

The plate tank circuit and the cathode

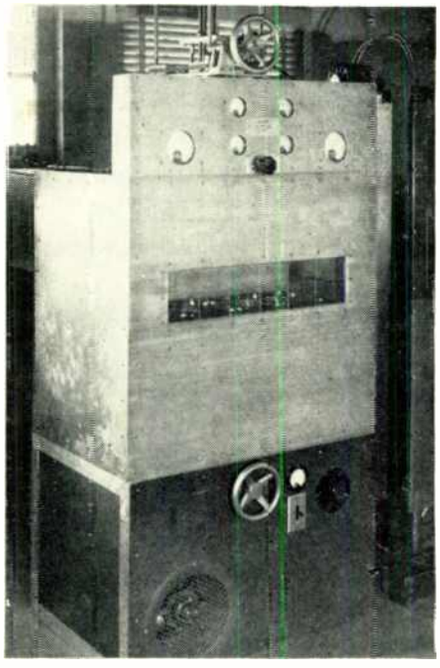


FIG. 10. THE FINAL AMPLIFIER UNIT

parallel at the top, the two loops feed a single open-wire transmission line to the antenna. The coupling loops are fastened

or down to adjust the amount of coupling with the plate circuit.

Located on the antenna transmission line near the point of its connection to the

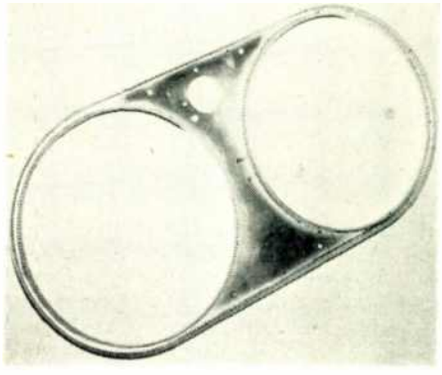
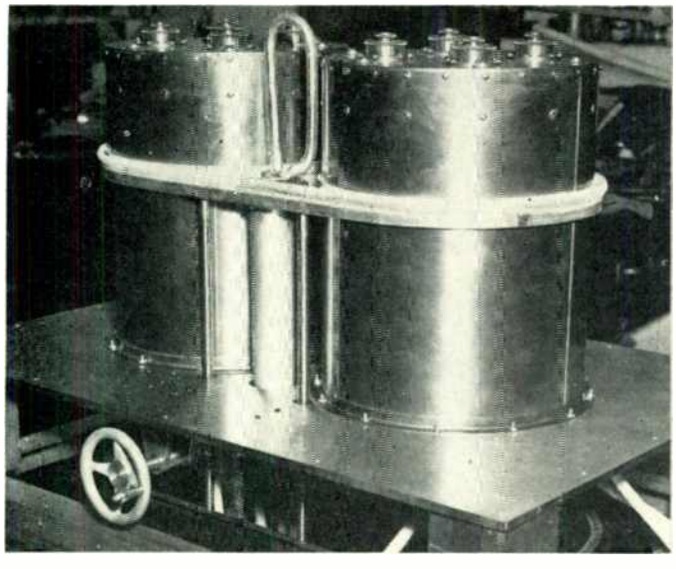


FIG. 9. SHORTING PLATE TUNES TANK

coupling loops is a single stub, adjustable as to length and placing. This tunes out the reactance of the loops.

Table 1 gives typical operating conditions for the 50-kw. stage. The amplifier delivers 50 kw. easily at 100.5 mc. and has produced a power output of 58 kw. without exceeding any tube ratings. Maximum output within the tube ratings has not been checked but it would probably exceed 60 kw.



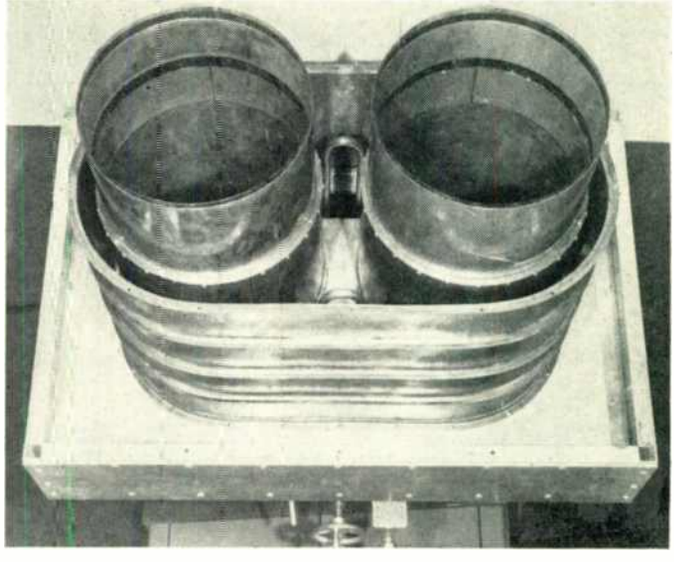


FIG. 7. CATHODE TANK CIRCUIT IN OUTER SHIELD, WITH SHORTING PLATE IN POSITION. FIG. 8. PLATE TANK CIRCUIT

tank circuit are quite similar. Spacing between conductors and the shield is 1 in. in the plate circuit, however, because the plate tank can have a higher surge impedence than the cathode circuit. The plate circuit is slightly more than ⅛ wavelength long at resonance when shunted with the output capacitance of the amplifier tubes. The plate-tank shorting plate is similar to the one in the cathode circuit except that it has a larger outer dimension to match the larger shield. Tuning is also achieved with leadscrews. Fig. 8 shows the plate tank circuit.

Two loops take power from the plate circuit. They enter the plate tank circuit from above and project through slots in the shorting plate into the field around the plate tank conductors. Connected in parallel at the top to a sheet of Teflon which has its own leadscrews, and can be driven up

SCHEDULE OF PAPERS AT IRE CONVENTION, N. Y.

Following is the schedule of papers to be presented during the I.R.E. Convention, New York City, March 22 to 25:

MONDAY AFTERNOON, MARCH 22
Frequency Modulation — Systems I — Navigation Aids — Antennas I

TUESDAY MORNING, MARCH 23
Systems II — Amplifiers — Passive Circuits — Tubes I — Antennas II

TUESDAY AFTERNOON, MARCH 23
Superregeneration — Transmission — Nuclear Studies — Tubes II — Components & Supersonics

TUESDAY EVENING, MARCH 23
Nuclear Studies

WEDNESDAY MORNING, MARCH 24
Tube Applications

WEDNESDAY AFTERNOON, MARCH 24
Television — Tubes III — Measurements

THURSDAY MORNING, MARCH 25
Computers I — Broadcasting & Recording — Propagation — Tubes IV — Measurements II

THURSDAY AFTERNOON, MARCH 25
Computers II — Microwaves — Receivers — Active Circuits

THE MICROWAVE HANDBOOK

Chapter 2: Why Microwave Equipment Departs So Radically from Conventional Radio Designs

BY SAMUEL FREEDMAN

2.1 Reactance at Microwave Frequencies ★ Every circuit, no matter how simple, contains inductance, capacitance, and resistance. It is physically impossible to construct pure inductance, capacitance, or resistance. An inductor must also possess some capacitance and resistance. Similarly, a capacitor must have inductance and resistance, and a resistor must have inductance and capacitance. These properties exist because of spacings, connections, and the composition of conducting materials.

While microwave circuits obey all the mathematical laws of low-frequency AC circuits, some amazing effects result from the extremely high values of microwave frequencies. For example:

A resistor offers opposition to both AC and DC currents. An inductor, however, has relatively small resistance to DC, but a high resistance to AC, increasing with the frequency. This is in accordance with the equation

$$X_L = 2\pi fL \qquad (1)$$

where X_L = *reactance in ohms*
f = *frequency in cycles*
and L = *inductance in henries*

From this it can be seen that, while the inductive reactance of a coil may be very small at low frequencies, on microwaves the value X_L increases to a point where the coil is virtually an AC insulator.

On the other hand, a capacitor offers maximum resistance to DC, but a low resistance to AC, decreasing with the frequency. This is in accordance with the equation

$$X_C = \frac{1}{2\pi fC} \qquad (2)$$

where X_C = *reactance in ohms*
f = *frequency in cycles*
and C = *capacity in farads*

Thus, while the reactance of a capacitor may be very high at low frequencies, on microwaves the value X_C drops to a point where the capacitor is virtually a short circuit.

The total reactance or opposition to the flow of AC is

$$X = X_L - X_C \qquad (3)$$

Note what happens to the value of X in a circuit comprising an inductance of 10 millihenries and a capacitance of .01 mfd. as the frequency is varied from 10 kc. to 10,000 mc.

Frequency	X_L (Ohms)	X_C (Ohms)
10 kc.	628	159.154
100 kc.	6,283	15.915
1 mc.	62,832	1.591
10 mc.	628,320	159.1
100 mc.	6,283,200	15.91
1,000 mc.	62,832,000	1.591
10,000 mc.	628,320,000	.1591

Thus, the value of X, predominantly capacitive at low frequencies, becomes predominantly inductive at the upper end of the frequency range. It is this effect which creates the need for completely new concepts of radio circuit design at microwave frequencies, and opens the way to new methods and applications.

This change comes about because 1) at the lower frequencies, inductance and capacitance are *lumped* or concentrated in individual components, while at microwaves they are *distributed*, and 2) the physical dimensions of low-frequency components are small compared to the wavelengths employed, in contrast to microwave circuit elements which approach or even exceed the operating wavelengths.

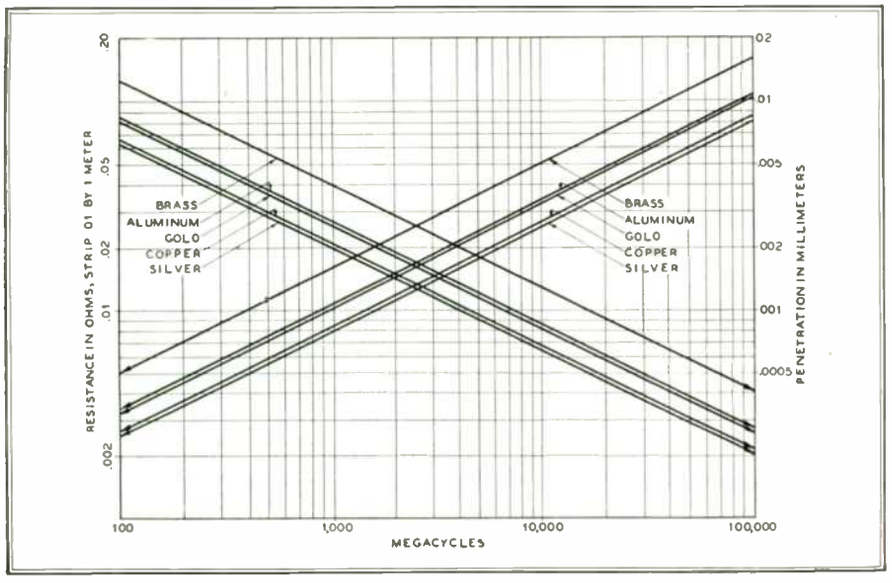


FIG. 5. RESISTANCE AND PENETRATION OF VARIOUS METALS AT MICROWAVE FREQUENCIES.

2.2 Skin Effect ★ Whereas DC flows in the entire cross-section of a conductor, the flow of AC tends to concentrate at the outer skin of the conductor until, at microwaves, a solid conductor can be replaced by a tube of the same outside diameter and a wall thickness of a few millionths of an inch.

This concentration of high-frequency current toward the surface of a conductor is called *skin effect*. As a result of this effect, a conductor of large cross-section and low DC resistance has a relatively high resistance to microwaves. However, the resistance to microwaves would be reduced considerably if the same volume of metal were rolled into a tube with a wall thickness of perhaps .00005 in.

Since it is desirable to reduce the AC resistance to the lowest figure possible per unit length, and since the skin effect precludes any benefit from the cross-section of a conductor, it is necessary to employ a conducting surface layer of the highest conductivity possible.

As far as electrical performance on microwaves is concerned, the composition of the core of a conductor makes little or no difference, as long as the surface is plated with a low resistance metal. Since the volume of the surface layer is small, it is common practice to use gold or silver plating on any metallic, plastic, or other core material. Typical gold plating is in the order of 50 milligrams per square inch.

Five different metals are used currently, either by themselves, or plated with silver or gold. These are:

Metal	Advantages	Disadvantages
Brass	Rigid, holds tolerance, inexpensive	Heavy, low conductivity
Aluminum	Light in weight	Special alloy required
Copper	Good conductivity	Mechanically weak
Silver	Excellent conductivity when bright	Corrodes readily, expensive
Gold	Good conductivity, does not corrode	Expensive

Fabricators are also investigating the possibilities of plated or sprayed glass, plastic, paper, and other materials. Fig. 5 is a calculated graph comparing 5 princi-

hear FM from ALL directions

Here's the antenna news for which dealers, and owners of FM receivers have been waiting. This new Ward-engineered non-directional dipole picks up FM signals efficiently from all directions, does not require orienting! Engineered for quick assembly and easy mounting, it comes complete for only $13.50 list!

Equal in signal strength to a high-gain folded dipole, the new "turnstile" is especially recommended for metropolitan areas where FM transmitters are in several directions from the receiver.

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FM LICENSE REQUIREMENTS

(CONTINUED FROM PAGE 46)

to emphasize that the FM engineering standards are not being changed, but only that additional time is being provided where necessary to meet these standards. This procedure will also permit more expeditious licensing of FM stations.

With respect to the field intensity measurements required of Class B FM stations by Section 3.216 (c) of the rules, the Commission has received inquiries concerning the time within which such measurements must be submitted. As indicated by a footnote to the rule, this material "shall be submitted within one year after the license has been issued or within such extension of time as the Commission may for good cause grant."

The Commission does not desire to impose an undue burden on FM licensees. However, the Commission wishes to obtain as much data as possible concerning FM service areas in order to provide for the best allocation and use of the FM band. While the Commission expects to follow a lenient policy concerning the requirement of field intensity measurements, it is hoped that FM licensees, particularly of the larger stations, will endeavor to supply this data as promptly as feasible.

HARRY SADENWATER REPORTS:

"I just had to phone you about the soap operas on FM. I've been listening to them all afternoon, and even they are wonderful on FM." That was Harry Sadenwater reporting. Maybe you remember him as a radio operator on the first transatlantic flight of the NC planes in 1919.

Or perhaps you know him because he has sold more radio broadcast station equipment than most anyone else. At any rate, Harry Sadenwater knows broadcast performance and programs from listening to them.

We were particularly impressed with his enthusiasm over the network programs on FM because he lives in the heart of New York City, and we have heard so many people say that reception is so good in metropolitan areas that FM couldn't be any better. Maybe a lot of other people should take a tip from Harry Sadenwater and spend an afternoon getting first hand information.

Of course, he did have some criticisms of AM studio techniques applied to FM. Specifically, "News reporters, speakers, and announcers would sound better on FM if they had a separate microphone, set back two or three feet. It's all right for them to cuddle up to the AM mike, but it just doesn't do on FM."

MICROWAVE HANDBOOK

(CONTINUED FROM PAGE 42)

in a dielectric. The magnetic field also varies in such event. This differs from a steady DC conduction current which gives rise to a non-varying magnetic field. The combination of varying electric field and varying magnetic field, called the *electromagnetic field*, has a tendency to propagate in the dielectric instead of remaining localized in the vicinity of the conductor. It is this tendency to propagate, increasing with increased frequency, that makes radio communication possible.

Thus, what at first seems like an impossible situation, because of the high reactance of a wire conductor, is very advantageously solved by use of the displacement rather than the conduction technique. This could only be possible with microwaves, since the equivalent condenser gap would have prohibitive reactance at lower radio frequencies.

2.4 Simulated Components ★ As explained in the foregoing sections, microwaves involve the use of AC frequencies much too high to permit lumped inductance or lumped capacitance. This becomes a problem even before the microwave frequencies are reached. However, on HF or VHF, the wavelength is still appreciable compared to physical dimensions involved, and conventional methods are still usable, even though the efficiency begins to fall off.

On microwaves, however, that problem is not only possible of solution, but the solution represents an important advance in the radio art. The phenomena existing along the length of a 2-wire line or a waveguide, between zero and one-quarter wavelength, make possible conditions that eliminate the need for coils, condensers, transformers, resistors or insulators. Many or all of these components can be eliminated by taking advantage of the inversion, capacitive, inductive and transformation effects existing along a quarter-wavelength of an overall half-wavelength in a 2-wire line or waveguide.

Figs. 6 and 7 show various effects or conditions existing along 2-wire shorted or open lines, or a waveguide of suitable dimensions. AC energy can be introduced at one point and observed as indicated at any other point. Typical effects or results which can be developed along a fractional wavelength of a transmission line are:

1. Capacitive effects without a condenser.
2. Inductive effects without coils or inductances.
3. A series-circuit effect without a condenser in series with an inductance.
4. A parallel-circuit effect without an inductance shunted by a condenser.
5. A step-up transformer effect obtained by introducing energy at a point of low

(CONCLUDED ON PAGE 51)

MICROWAVE HANDBOOK

(CONTINUED FROM PAGE 50)

impedance and removing it at a point of high impedance, with a resulting auto-transformer effect.

6. A step-down transformer effect obtained by suitable connection at a point of low impedance.

7. An AC insulator effect obtained by connecting to a point of high impedance even though it is a metallic connection.

8. Any value of impedance between virtually zero and infinity can be found somewhere along a quarter-wave section. It requires only a suitable connection or probe at the correct point within a quarter-wave length.

9. Any condition can be inverted by moving a quarter-wave away from an opposite condition.

10. Any condition can be repeated by double-inversion, or moving a distance of two quarter-waves from the point where the original condition exists.

Referring again to Figs. 6 and 7, the circuit equivalents shown exist in either a shorted or an open 2-wire line. The same reasoning applies also if a waveguide is substituted for the 2-wire line. Eight conditions are spotted in the illustration. It should be understood that the conditions do not change abruptly or exist only at those points. Between the points indicated there are intermediate effects. By changing the distances, the inductive, capacitive, or tuned-circuit effects vary.

Both the 2-wire lines shown are 1 wavelength long. This is 39.37 ins. at 300 mc., about 4 ins. at 3,000 mc., and only .4 in. at 30,000 mc. A full set of changes can occur in one-half that distance. There is no reason why the same techniques cannot be used on lower frequencies, except that the physical dimensions become impracticable. The line would have to be 1,000 ft. long for a typical broadcast-band frequency. The solid sine wave line in Figs. 6 and 7 is the voltage at various points, while the dotted line represents current. Wherever the voltage is shown as minimum or the current is shown as maximum, the impedance is minimum or virtually zero. Wherever the voltage is shown as maximum or the current is shown as minimum, then the impedance is maximum or virtually infinite. All the conditions are repeated every half-wave down the line.

These can be summarized as corresponding to the following circuit equivalents:

Condition	Shorted Line	Open Line
A Zero° Zero λ	Minimum impedance Minimum voltage Maximum current	Maximum impedance Maximum voltage Minimum current
B 45° ⅛th λ	Voltage & current nearly equal Impedance is an intermediate value	Voltage, current, & impedance same as for shorted line, but opposite in phase
C 90° ¼ λ	Circuit behaves like a pure inductance Maximum impedance Minimum voltage Minimum current Circuit behaves like a parallel-resonant circuit	Circuit behaves like pure capacitance Minimum impedance Maximum voltage Minimum current Circuit behaves like a series resonant circuit
D 135° ⅜th λ	Same as B for open line	Same as B for shorted line
E 180° ½ λ	Same as C for open line	Same as C for shorted line
F 225° ⅝th λ	Same as B for shorted line	Same as B for open line
G 270° ¾th λ	Same as C for shorted line	Same as C for open line
H 315° ⅞th λ	Same as D for shorted line	Same as D for open line
I 360° 1 λ	Same as E for shorted line	Same as E for open line

If the 2-wire line or waveguide is 1¼ wavelengths for example, conditions will be the same as at the ¼ wavelength position. The same would occur at 2¼, 3¼, etc.

The line can be used as a wavemeter or equivalent frequency meter by measuring the distance between any two adjacent identical conditions. For example, the distance between two maxima or two minima with respect to either current, voltage, or impedance corresponds to a half-wavelength.

To be continued next month

16-IN. PICTURE TUBE

Production of a 16-in. television tube is getting under way at RCA's Lancaster plant. It will provide an intermediate size between the 10- and 12-in. direct-viewing tubes, and projection receivers.

Unlike the smaller sizes, the new tube will have a metal cone, with a glass faceplate and neck. This type of construction has been made possible by the perfection of techniques for sealing large areas of metal to glass. A picture area of 125 square inches is obtainable on the 16-in. face. The new tube is now being demonstrated at Lancaster.

SERVICEMEN HAVE A NEW LOOK

(CONTINUED FROM PAGE 23)

fidelity FM network programs, such as those put on by Continental. The serviceman who takes upon himself the responsibility for supplying this information will aid the salesmen tremendously.

It all boils down to the fact that there aren't enough able servicemen to take care of the FM and TV sets that are being sold. As a result, a great many aren't working properly. No one knows the actual number, but it's suddenly coming to light that it is large enough to hurt sales in 1948 unless the situation is corrected quickly. There are more FM receivers in this category than TV sets, partly because many more FM receivers have been sold, and partly because the principal TV manufacturers have set up installation and maintenance organizations.

Whatever the total, it is so large as to create a demand for competent servicemen far beyond the supply, to the point where dealers will soon be hiring the good ones away from each other this year.

With all the network programs available from hundreds of FM stations, and more television broadcasting in more areas, it isn't going to be any problem to sell sets. However, the time when customers could be bluffed into accepting less than perfect performance is past. That's why the dealers who have competent servicemen are going to get the bulk of the business in 1948.

NEWS PICTURES

(CONTINUED FROM PAGE 27)

ware, is producing 12- and 14-in. reflectors of the same material for television projectors. Preformed blanks are ground down about .04 in., and polished. Then the concave surface is coated with aluminum by the high-vacuum evaporation process. The reflectors are produced by the McKee Glass Company, Jeanette, Pa.

6. Physicists at Bell Laboratories are working with a new tube in which amplification up to 500 times has been obtained shooting a stream of electrons at a diamond chip. Such tubes may be of great aid in the study of the fundamental structure of solid matter, and its behavior under the impact of electrons.

FM-AM DUPLICATION PACT

FM-AM duplication was specified by the networks-AFM agreement in these terms: "Recognizing the desirability of broadening the public opportunity to hear more music on FM broadcasts and in the expectation that FM broadcasts will provide additional employment opportunities for musicians, the parties are happy to announce that, in the meantime, (while final contract terms are being worked out) FM duplication of AM programs will begin on February 1, 1948."

UNIVERSAL FM RECEIVER

(CONTINUED FROM PAGE 22)

lator, or an FM station near the top of the band.

1. Connect the signal source to the two antenna terminals. Disconnect the ground link. If a signal generator is used, make the connection through a 300-ohm dummy load.
2. Plug in the line cord.
3. Turn on the monitor switch.
4. Set the volume control at 5.
5. Set the tone control at 10.
6. Set the dial pointer at the exact frequency of the test signal.
7. Adjust C5 to receive the test signal.
8. Adjust C1 and C9 for maximum gain as indicated by the tuning indicator.
9. Recheck step 7, and repeat steps 7 and 8 to obtain maximum reading on the tuning indicator. This completes the alignment steps.

FM PROPAGATION TESTS

(CONTINUED FROM PAGE 36)

inconsistent with the other figures shown in the charts for the low band signals.

The discrepancy between Fig. 4 and Fig. 1 with respect to the high band is even greater, and it also involves a mathematical absurdity. There the comparative figures for signal drops below 5 microvolts is 4½% of the time for 5 months and .2% of the time for 7 months.

4½% of the time in 5 months is 22.5% of 1 month of testing time. If 2 additional months be added — even if no drops below 5 microvolts had occurred in those 2 months — the total amount of such drops during the whole period would still be be 22.5% of a month. Mr. Allen, however, adds the 2 months and comes out with a figure of two-tenths of 1% for the drop-outs during the whole 7 months, *i.e.*, 1.4% of a month. The report gives no clue as to how this mathematical miracle was performed, but the effect was to lose 21.1% of a month of poor signals.

After I completed my analysis, I pointed out this error to Mr. Allen, who recognized it at once but was unable to explain it. After conferring with his associates, who apparently had plotted the curves, he furnished me with the

(CONCLUDED ON PAGE 54)

FM PROPAGATION TESTS

(CONTINUED FROM PAGE 53)

Errata sheet mentioned above. One of the corrections therein was a change of the .2% figure to 2.7%.

That 1250% correction, however, did not remove the mathematical absurdity, since 4½% of 5 months is still 22.5% of a month, and 2.7% of 7 months is only 18.9% of a month. Mr. Allen has still lost 3.6% of a month even assuming that there were no drop-outs — in the additional 2 months — an assumption which a glance at the recordings will show to be unjustified.

There are other errors in the charts, but it seems hardly necessary to go further to show the unreliability of Allen's methods and conclusions. The apparatus at Westhampton Beach is available for inspection and use by the members of the Commission or any of its staff at any time, and for whatever period of time may be considered necessary.[7] Similar apparatus, which has been used to make similar tests at Mt. Holly, N. J., 77 miles from the Alpine transmitter, can also be made available for the inspection and use of the Commission or its staff, either at Mt. Holly or at Southampton, Pa., or at any other place where the Commission may desire to witness tests.[8]

The Westhampton Beach recordings are a conclusive demonstration of the effects of fading on the upper band and the relative absence of that phenomenon on the lower band. No attempt was made at the hearing to dispute the Westhampton recordings or to deny what they showed. Allen expressly admitted on the stand that those recordings showed exactly what I said they showed (Tr. 756).

Norton's Testimony ★ As I have pointed out before, the Commission has had bad engineering advice from its staff on the relative efficiency of the low and the high FM bands since the presentation of the Norton testimony at the 1944 hearing: At that time Mr. Norton made a basic error which not only misled the Commission but which was also kept out of the public record for over 3 years. That error has now been admitted by Norton at the present hearing (Tr. 782–84).

Mr. Norton has now attempted to shift to the Commission the responsibility for overlooking what tropospheric fading would do to the service range on the high band, by contending that he informed the Commission about such fading in an earlier hearing (Tr. 776). But what he fails to point out is that all that testimony was given 7 months after the final decision to put FM "upstairs," and only after the Zenith tests at Deerfield had made it impossible to ignore the fading phenomenon. Norton also refers to two exhibits which he introduced at the October, 1944, hearing, but only one of them is pertinent (Ex. 433), and that contains merely a one-sentence statement, on page 4, that: "Fading may be expected to be somewhat more severe as the radio frequency is increased through the range from 50 to 300 mc. and at the shorter distances for the higher frequencies."

No reference was made to that vague pronouncement at any time during Norton's testimony. On the contrary, at the same hearing Norton made the flat statement that:

"Fortunately, from the propagation standpoint, this [the shift to the upper band] does not involve a compromise. For the same power input into the transmitting antenna I would expect slightly larger FM service areas on frequencies between 130 and 200 mc. than on 45 mc. even if all of the listeners use receiving antennas which are built into their receivers."

My statement to the Commission at the hearing in the present proceeding, concerning the way Mr. Norton had presented his ground wave calculations to the Commission, will be found to be fully borne out by reference to the Norton testimony at those hearings (Docket No. 6651, Tr. 3772; Docket No. 8487, Tr. 776).

The transfer of FM broadcasting from the lower to the higher frequency range was set in motion by the dramatic appearance of Mr. Norton at the 1944 hearings with the prediction, based upon alleged secret data in possession of the Armed Forces, that ionospheric disturbances caused by sun spots would seriously impair service on frequencies up to 80 mc., and possibly even to 120 mc.

On this subject Mr. Norton was asked by me on cross-examination (Tr. 784):

"But you were wrong?"

and he replied (id):

"Oh, certainly; I think that can happen frequently to people who make predictions on the basis of partial information. It happens every day."

No one will dispute that statement.

Conclusion ★ In my original brief in this proceeding I urged the Commission to make a correct ascertainment of the scientific facts before rendering its decision. If, now, there be any doubt in the minds of the Commission as to the conclusiveness of the Westhampton Beach recordings as proof of the effects of the fading phenomenon in the 50-mc. and 100-mc. areas, then it is urged that the hearings be reopened so that the unreliability of the Allen tests and charts may be more fully explained to the Commission.

Respectfully submitted,
EDWIN H. ARMSTRONG

[7] The Westhampton Beach recordings were reproduced for only 2 months, because of the expense of reproduction, but the recordings for the period since September 6 are available for the Commission's inspection, if desired.

[8] Tests were made at Mt. Holly during the hearings and showed results similar to those arrived at in the Westhampton tests.

ADVERTISERS INDEX

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Forerunner of the Eimac tetrode line, the 4-125A is probably the most universally accepted power tetrode yet designed. Its Pyrovac plate and processed grids impart a high degree of operational stability, resistance to overloads and exceptionally long life. Rated at 125 watts plate dissipation, one 4-125A will handle 500 watts input with less than three watts of grid drive.

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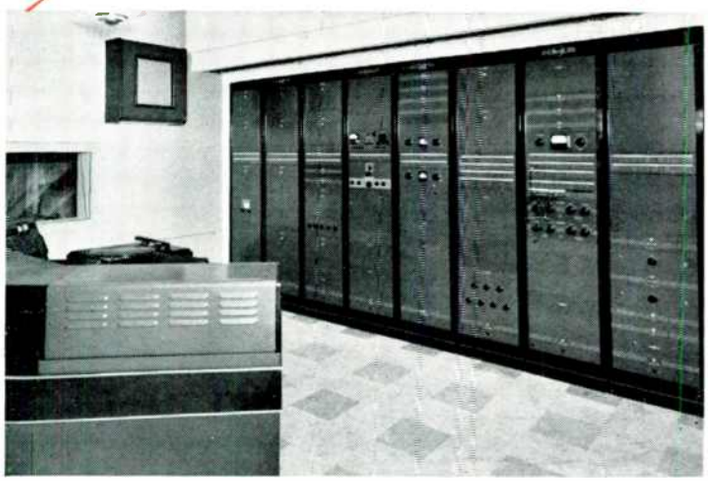

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