Price 35 Cents

Oct. '51

FM-TV RADIO COMMUNICATION

★★ Published by ★★
Milton B. Sleeper

11th Year of Service to Management and Engineering

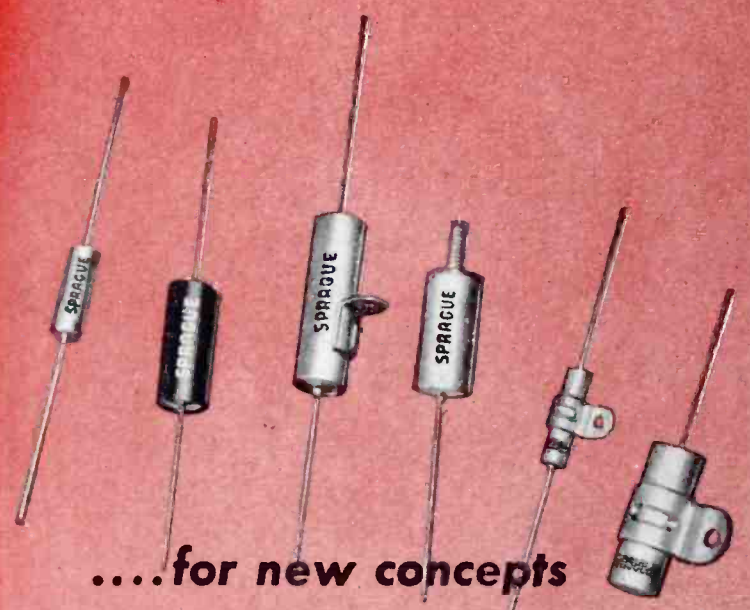
Ahead of and beyond JAN...

Sprague has developed many new ways to reduce size and weight and to improve the high-temperature performance of components

Joint Army and Navy component specifications were never meant to limit engineering progress—and, with Sprague, they most certainly haven't!

The extent of what has been achieved is no better indicated than by the fact that much of Sprague's vast military-use production is based on capacitors, wire-wound resistors and high-temperature wire insulation for which no standard JAN specifications yet exist! These are, in effect, super-JAN—fully approved via waivers to the equipment manufacturers. Such components are being produced and used in ever increasing quantities.

If your problem is one that can be solved by smaller, lighter components or by better elevated temperature performance, chances are excellent that a Sprague application engineer can help you.



....for new concepts of equipment design

Typical of Sprague engineering progress ahead of and beyond JAN limits are these famous subminiature, hermetically-sealed, metal-encased paper capacitors. Far smaller than equivalent JAN styles and available in types for 85°C. and 125°C. operation, these capacitors have helped make possible a long list of military electronic equipment, which never could have met size and weight limitations prior to the development of these capacitors. Sprague Bulletin 213-B gives full technical data.

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASSACHUSETTS

Radio TOWERS

★ BROADCASTING ANTENNAS
★ 2-WAY COMMUNICATION
★ TV-FM SUPPORT TOWERS
★ MICROWAVE RELAY TOWERS

DIRECTIONAL ANTENNAS

BY WINCHARGER

SPECIFY Genuine WINCHARGER TOWERS for POSITIVE RESULTS

Ahead of them All!

WINCHARGER

ENGINEERING SERVICE

AM-FM-TV-Short Wave or 2-Way Communication problems are all within the expert scope of Wincharger engineers. You'll get experience - seasoned advice on every phase of design, requirements, installation and maintenance. Write for free new booklet describing all types of Wincharger Towers in detail.

WRITE
WIRE
PHONE

You have to be GOOD to be the LEADER

Well over 1,000 successful antenna tower installations from coast to coast testify to Wincharger's "know how" in radio tower design and construction. Many of the first directional antennas were pioneered on Wincharger drafting boards. The slender uniform cross section permits highly efficient radiation combined with surprisingly low initial and maintenance costs. A sleeker, streamlined tower with adequate high safety factor. Directional arrays of Wincharger Towers are efficiently serving many stations where strict adherence to a critical and complicated broadcasting pattern is most essential.

BE PREPARED the Minute New TV Channels are Available

write NOW!

WINCHARGER Corporation

TELEPHONE 2-1844 Dept. 2
SIOUX CITY 2, IOWA, U.S.A.

FM-TV RADIO COMMUNICATION

Formerly *FM* MAGAZINE, and *FM* RADIO-ELECTRONICS

VOL. 11 OCTOBER, 1951 NO. 10

INDUSTRY NEWS

FM BROADCASTING

TELEVISION

APPARATUS DESIGN

COMMUNICATION

AUDIO SECTION

SPECIAL DEPARTMENTS

ROY F. ALLISON, *Editor*

MILTON B. SLEEPER, *Publisher*

FRED C. MICHALOVE, *Eastern Manager* — WILLIAM G. DOWNIE, *Western Manager* — ALAN C. MACY, *Business Manager*

SOPHIE FORTY, *Production Manager* — LILLIAN BENDROSS, *Circulation Manager* — EDWARD M. HANDBERG, *Art Director*

Publication Office: 264 Main St., Gt. Barrington, Mass. Tel. Gt. Barrington 500

New York Office: 6 East 39th Street, Room 1209, Tel. Murray Hill 5-6332

Chicago Office: 3035 Lake Avenue, Wilmette, Ill. Tel. Wilmette 5654

RADIO COMMUNICATION Magazine is mailed on the 15th of each month.

Subscriptions: Should be addressed to 264 Main St., Great Barrington, Mass.

Single copies 35c—Subscription rates: $6.00 for 3 years, $3.00 for 1 year. Add 50c per year in Canada; foreign, add $1.00 per year.

Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will *FM-TV* Magazine be responsible for their safe handling in its office or in transit.

Entered as second-class matter August 22, 1946, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at Post Office, Boston, Mass. Printed in the U. S. A.

CPA AUDIT

CIRCULATION AUDITED BY
HENRY R. SYKES
CERTIFIED PUBLIC ACCOUNTANT
SYKES, GIDDINGS & JOHNSON
PITTSFIELD, MASSACHUSETTS

RTMA statistics show that TV sets dropped in August to the lowest level for that month since 1948, while AM hit a new postwar low. Only FM went up over July, but the figure set a new low for that month.

Why? If anyone knows that answer, he's keeping quiet about it. Looking back to '47, August has always gone up in anticipation of fall trade buying, at least until this year. This isn't explained by the shortage of materials or manpower.

The public simply isn't buying. As for television, from what we hear, the lookers aren't looking, at least as much as they did. Of the funny people, folks are asking: How many different things can an actor do with one face? The puppets are even more limited in that respect. And Berle, that idol of the darkened living room, is being rated as offensive by an increasing number of people.

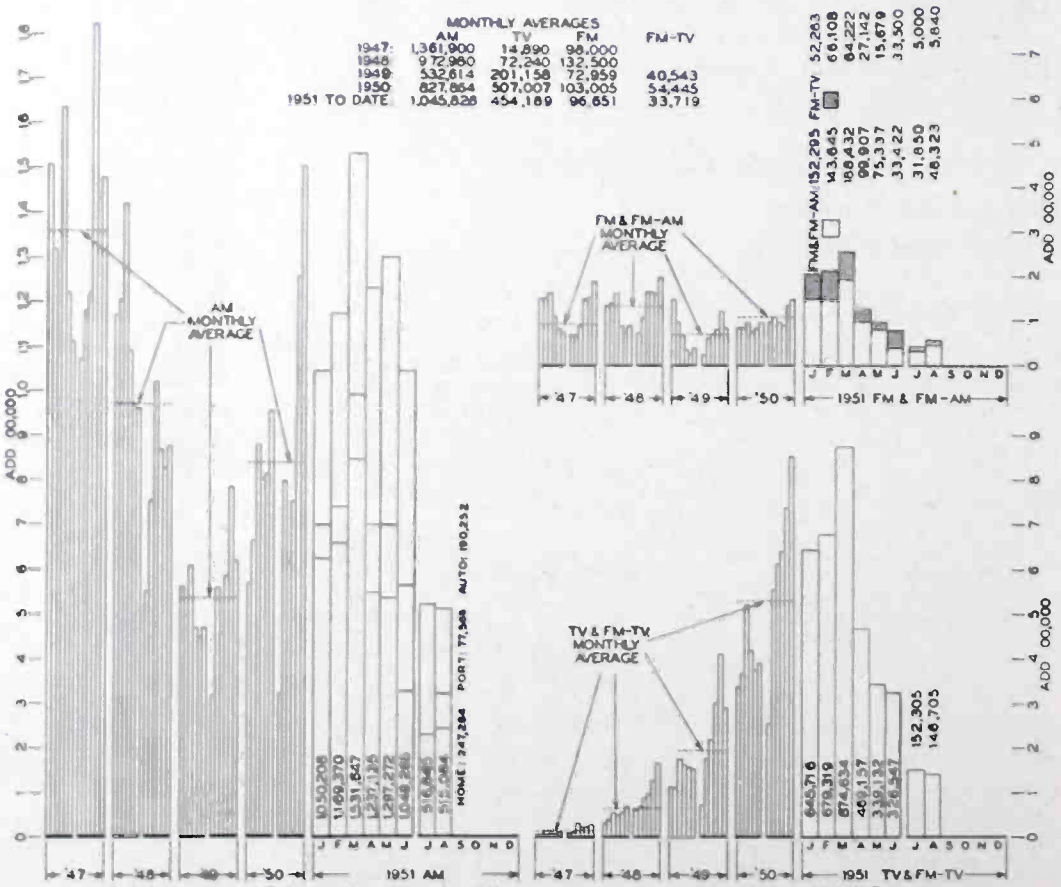
Since MacArthur's address to Congress, the only program features that seem to have stirred up great enthusiasm were the Kefauvre hearings and the cross-country networking when the Japanese Peace Treaty was signed.

The really enthusiastic comments about television are coming from the high-fidelity enthusiasts. Using good audio systems, they are having a grand time listening to the magnificent quality of sound effects, intended and otherwise, and of voices and music on the live-talent shows. And they add the comment: We could have the same quality on FM broadcasting if the stations wanted to put it out.

Lack of demand for AM sets is probably not related to audio programs, but it's apparent that many people, dissatisfied with the paucity of good music and the surfeit of whodunits, are turning to records. This is reflected in the growing trend to custom FM-phonograph installations.

July receiver tube sales dropped sharply to 13,185,567, of which 7,117,435 were for new equipment, 4,625,314 for replacements, 1,222,735 for export, and 220,083 for Government agencies. In August, they rose to 23,761,253, with 12,917,526 for new equipment, 7,230,419 for replacements, 2,767,794 for export, and 845,514 for Government agencies.

Cathode-ray tubes in July totaled 89,-144, of which 99% were rectangular and 16 ins. or larger in size. August production rose to 210,043 tubes, of which 93% were rectangular, and 98% were 16 ins. or larger in size.



TV, FM, and AM set Production Barometer, prepared from RTMA figures

A SIGNAL SOURCE FOR ALL TV COLOR SYSTEMS

the Du Mont UNIVERSAL COLOR SCANNER

Operating on the principle of the flying spot scanner, the Du Mont Universal Color Scanner provides for the Broadcaster, Receiver Manufacturer, Development Laboratory – tri-color signals from any 35 mm. 2 x 2" color transparency. Available as outputs are an FCC approved field sequential video color signal and three simultaneous video color signals which may be fed to any external sampling equipment for experimental work with line or dot sequential systems. Horizontal line frequencies may be set at 15.75 or 29.16 kc and vertical field rates at 60 or 144 fields per second (intermediate values may be specified as desired). This assures a flexible equipment embracing both present black and white standards as well as FCC approved color standards and adaptable for use with any of the other presently proposed color systems.

SEND FOR DETAILED TECHNICAL LITERATURE

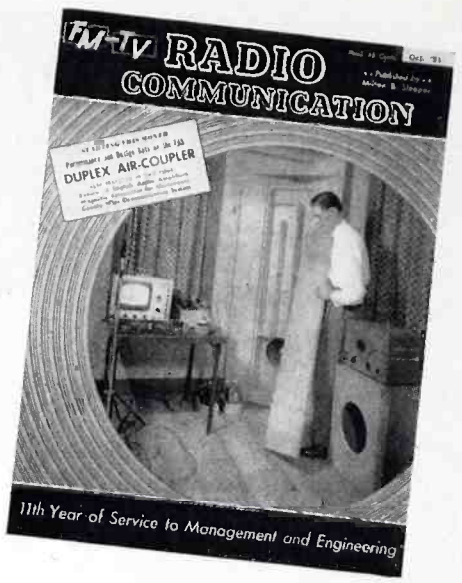
DUMONT

First with the Finest in Television

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

THIS MONTH'S COVER

In response to many reader requests, a very complete set of measurements was made on the characteristics of the original Air-Coupler, first described in our issue of October, '50. In the course of this work, a modification of the original design was found to offer substantial improvement. Specifically, a cleaner, deeper bass was achieved, an audible result that was confirmed by actual measurements. Your editor appears in the cover picture of the new Duplex Air-Coupler design.



SPOT NEWS NOTES

ITEMS AND COMMENTS, PERSONAL AND OTHERWISE, ABOUT PEOPLE AND COMPANIES CONCERNED WITH RADIO COMMUNICATIONS

Very Interesting Reading:

If you aren't a member of the Radio Club of America, you may have missed one of the most interesting stories ever published. It's the detailed account of the first amateur radio transmission across the Atlantic, told in 78 pages, with many heretofore unpublished photographs, by the men who manned the 1BCG transmitter at Greenwich, Conn., and the receiver at Ardrossan, Scotland, back in 1921.

Text and pictures furnish a fascinating account of the status of radio 30 years ago. You can still get a copy by sending $1 to the Radio Club of America, 11 W. 42nd Street, New York City.

Some Kind of a Record:

At a time when we are pouring millions of dollars and engineering man-hours into weapons of war, it is startling to discover that our military people are still not able to equal the record of careless civilian automobile drivers in the matter of killing people. Since January 1, 1900, there have been 988,000 Americans killed in automobile traffic accidents. But the 1-millionth American soldier did not die until 176 years and 17 weeks after the battle of Concord and Lexington.

Acoustical Terminology:

Adopted by the American Standards Association, under sponsorship of the Acoustical Society of America in cooperation with the IRE, is set forth in a 50-page publication which carries the approval date of July 31, 1951. This is a highly important and useful reference source for everyone concerned with the use and application of audio equipment. Obtainable at $1.50 per copy from the ASA, 70 E. 45th Street, New York 17.

TV at Home and Abroad:

RCA board chairman David Sarnoff: "Television broadcasting in Europe is in the hands of governments too preoccupied with their political, economic, and financial problems to give any serious thought to video. With the exception of England, where about 1,000,000 sets have been installed in homes, television service in the rest of Europe is almost non-existent. But even in England the service is inadequate, and progress is slow. The advances made by TV in America under our free, competitive, private enterprise system are so much greater than anything I've seen in Europe that comparisons are impractical."

H. H. Davids:

In our September issue, his name was given correctly in the Contents as author of "Predicting Mobile Equipment Performance," but by one of those slips which make editors' hair turn grey, his name did not appear on the title of the article itself. Our sincere apologies to Mr. Davids for this error.

Railroad Communication in 1851:

FCC Chairman Coy, speaking at Harriman, N. Y., on September 21 at the 100th anniversary of the first train order dispatched by telegraph for the New York & Erie Railroad: "Supt. Charles Minot is riding an express train westward, and is scheduled to meet an eastbound express here at Harriman . . . he telegraphs up to the next stop at Goshen,

(Continued on page 7)

SPOT NEWS NOTES

(Continued from page 6)

14 miles away, to ascertain if the train has arrived there. Discovering that it has not, he wires Goshen to hold up the eastbound express for further orders. This is the first telegraphic train dispatching in history. He then instructs the conductor and the engineer of his train to proceed to Goshen . . . Minot's engineer has visions of a disastrous collision . . . His reply is: 'Do you take me for a damned fool? I won't run by that thing!' Whereupon Minot takes the throttle himself, and speeds ahead to Goshen. No collision. No catastrophe! The first train order by telegraph is a success." At the peak use of telegraphy, about 1910, 80,000 operators were employed. Today, that number has dropped by 50%, and 70% of all train orders are dispatched by telephone.

FM Set Promotion:

RTMA and the National Association of Radio and Television Broadcasters are planning a cooperation campaign to promote the sale of FM sets. Drive is scheduled to start early in 1952. Information can be obtained from David Grigsby of Zenith Radio, chairman of the RTMA advertising committee, or from John H. Smith, Jr., director of the NARTB FM department, 1771 N Street, N. W., Washington, D. C.

$296 Million Expansion:

Planned by Westinghouse for completion about 1953. This will provide an increase in production capacity of approximately 50%. Added facilities will be used for the manufacture of electronic equipment, small motors, aircraft armament, jet engine parts, vacuum tubes, lamps, plastics, home appliances, and audio and TV broadcast receivers.

Palmer M. Craig:

Appointed vice president in charge of engineering for Philco's television and radio division. He first joined the company as a senior engineer in 1933.

Magnetic Recording Rubber:

The development of recording bands made from neoprene base has been announced by Brush Development Company, Cleveland 14, Ohio. Magnetic oxide is pigmented into the neoprene with an unusually high degree of uniformity. A permanent lubricant is included in the base material which virtually eliminates wear of the material and the recording head. The bands are intended to be stretched over a supporting drum. This project was initiated by and carried out with the cooperation of Bell Telephone Laboratories.

(Continued on page 8)

Professional Directory

Jansky & Bailey
Consulting Radio Engineers
EXECUTIVE OFFICES:
970 National Press Bldg.,
Washington 4, D. C. ME 5411
OFFICES AND LABORATORIES:
1339 Wisconsin Ave., N.W.
Washington 7, D. C. AD 2414
Member AFCCE

GARO W. RAY
CONSULTING RADIO ENGINEERS
Standard, FM and Television Services
HILLTOP DRIVE
STRATFORD, CONN. Tel. 7-2465

ANDREW ALFORD
Consulting Engineers
ANTENNAS & RF CIRCUITS
Laboratory and Plant:
299 Atlantic Ave., Boston 10, Mass.
Phone: HAncock 6-2339

GEORGE C. DAVIS
Consulting Radio & Television Engineers
501-514 Munsey Bldg.—Sterling 0111
Washington 4, D. C.

WELDON & CARR
Consulting Radio Engineers
WASHINGTON, D. C.
1605 CONNECTICUT AVE.
DALLAS, TEXAS 4212 S. BUCKNER
SEATTLE, WASH. 4742 W. RUFFNER

McNARY & WRATHALL
CONSULTING RADIO ENGINEERS
906 National Press Bldg. DI. 1205
Washington, D. C.
1407 Pacific Ave. Phone 5040
Santa Cruz, California

SPOT NEWS NOTES
(Continued from page 7)

More TV in England:

BBC station at Holme Moss, 17 miles east of Manchester, started operation on October 12, adding 11 million potential viewers. Video transmitter, on 51.75 mc., has a peak power output of 45 kw., three times that of the station at Alexandra Palace.

Southwestern IRE Conference:

Meeting and radio show will be held at Rice Hotel, Houston, May 16 and 17. Conference manager is Gerald L. K. Miller, 1622 W. Alabama Street, Houston.

Railroad Radio:

About one-half of the US railroads are now using FM radio communication. In the past year, FCC authorization increased 60%, to a present total of 400 fixed stations and 5,200 mobile units.

Dr. Newbern Smith:

Will receive the 1952 Harry Diamond Memorial Award, presented each year by the IRE to the person in Government service who has made outstanding contributions to the radio art. Dr. Smith is engaged in wave-propagation studios at the National Bureau of Standards.

Tuners and Amplifiers:

Circuits and service data on 22 FM-AM tuners and 50 audio amplifiers are presented in the 352 pages of "Audio Amplifiers and Associated Equipment, Volume 3," recently published by Howard W. Sams and Company, Inc., 2201 North East 46th Street, Indianapolis 5, Ind. This book, in a sturdy binding, 8½ by 11 ins., is priced at $3.95.

15,000-Cycle FM Programs:

Quite a stir is being created in the New York City area by the two programs sponsored by our sister publication, HIGH-FIDELITY, on WABF. They are broadcast on Thursday evenings from 10:00 to 10:30, and Sunday evenings from 8:30 to 9:00, at 99.5 mc. Music is furnished from original 15,000-cycle tapes from which Mercury master records are made. If you have a chance to hear these programs, we'd like to know what you think of the quality as compared to music from records.

Microwave Communication:

Look for a very large expansion in the use of microwave equipment during 1952, for many point-to-point business communication purposes, and for industrial applications of remote control and telemetering.

(Concluded on page 9)

Professional Directory

KEAR & KENNEDY
Consulting Radio Engineers
1302 18th St., N. W. HUdson 9000
Washington, D. C.

GEORGE P. ADAIR
Consulting Engineers
Radio, Communications, Electronics
1833 M St., N.W., Washington 6, D. C.
EXecutive 1230

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

Winfield Scott McCachren
Radio Engineering Consultant
UHF-TELEVISION SPECIALISTS
2404 Columbia Pike Arlington, Va.
GLebe 9096

RATES FOR
PROFESSIONAL CARDS
IN THIS DIRECTORY
$12 Per Month for This Standard Space. Orders Are Accepted for 12 Insertions Only.

THE WORKSHOP ASSOCIATES
INCORPORATED
Specialists in High-Frequency Antennas
135 Crescent Road
Needham Heights 94, Mass.
NEedham 3-0005

Special Services Directory

SPOT NEWS NOTES

(Continued from page 8)

Next Month:

As usual, the November issue of RADIO COMMUNICATION will be concerned particularly with articles of interest to engineers and supervisors of radio systems in the transportation group. A special feature will be the first detailed account of the performance of the 450-mc. equipment now in use by the Chicago Yellow and Checker Cab Companies, written by Norman Wunderlich. Also, in November, the revised Registry of Transportation Systems will be released. This Registry lists all taxicab, railroad, intercity bus, transit utility, auto emergency, and highway truck systems. Names and addresses of operating companies are given, together with the number of mobile units, operating frequencies, call letters, and make of equipment used. Price of this Registry is $1.00.

TV Programs:

Jack Gould, in *The New York Times:* "Something definitely has gone wrong . . . The novelty of TV is wearing off for broadcaster and viewer alike . . . Television, in other words, has not solved any of the basic problems of repetition and duplication . . . Only so much entertainment can be absorbed, and the individual does have a saturation point . . . TV is following a suicidal course if it worships only at the shrine of vaudeville, and ignores the wealth of program materials in the arts, in the sciences, in education, in the limitless other interests of mankind."

Citizens Radio:

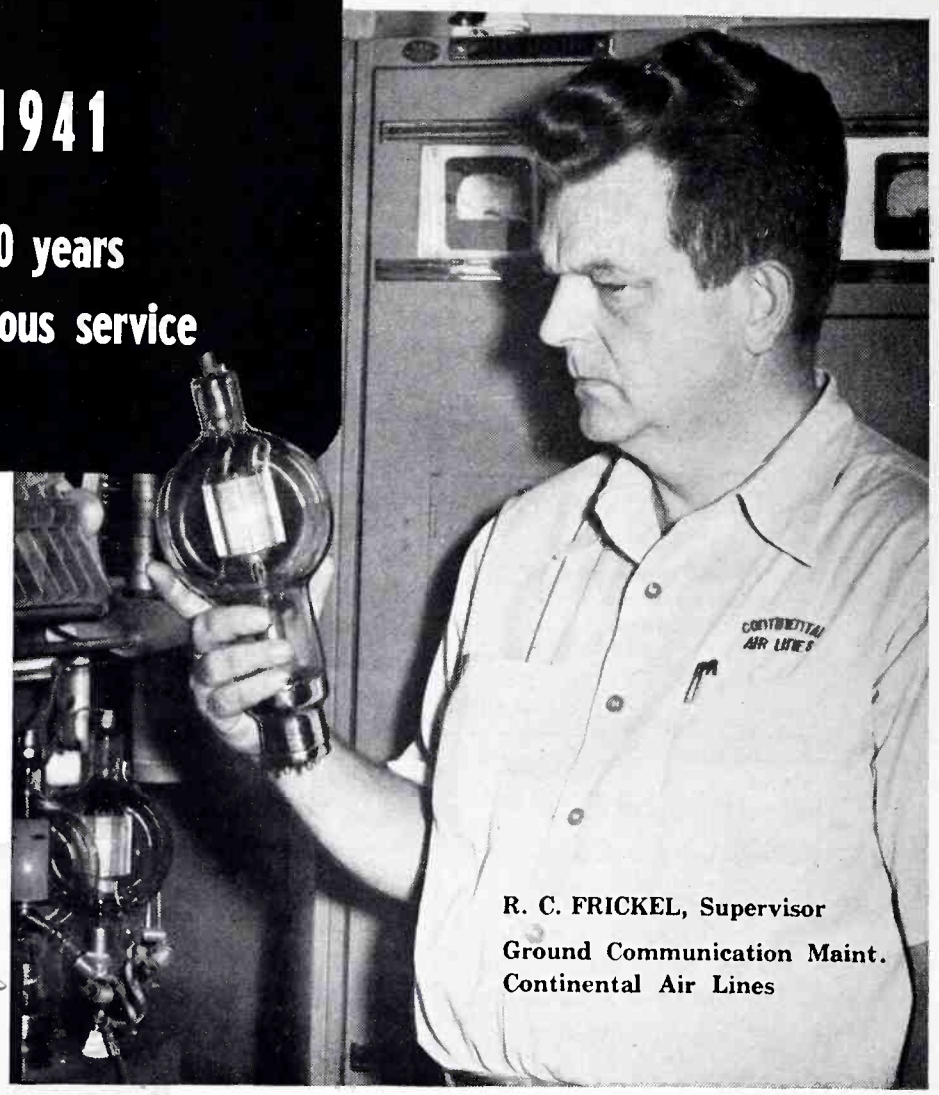
As predicted in these pages, the likelihood is developing that the citizens radio band, 460 to 470 mc., will be reassigned to mobile communication. Deserving contenders for this space are the pickup and delivery companies, and others engaged in urban service who, at present, are denied the use of mobile equipment. That band is as wide as the total assigned to all 5 classes of communication systems at 450 to 460 mc., and it shouldn't be wasted.

Lowell Institute Station:

An important contribution to improved programming and to the expansion of FM service is the new Boston station WGBH, on 89.5. Top feature from this source is the music of the Boston Symphony, setting a new standard of program quality in that area. A complete account of this project and the FM installation will appear in a forthcoming issue of RADIO COMMUNICATION Magazine.

INSTALLED . . . 1941

Old P-167 gave 10 years of almost continuous service



R. C. FRICKEL, Supervisor
Ground Communication Maint.
Continental Air Lines

CONTINENTAL AIR LINES, Inc.
PASSENGERS FREIGHT EXPRESS MAIL PARCEL POST

STAPLETON AIRFIELD
DENVER 7, COLORADO

August 9, 1951

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

We finally had to replace old "P-167." This tube had been in continuous use at Continental Air Lines so long that it almost seemed like the passing of an old friend.

We here at Continental are very proud of our 17 year safety record and we know that dependable plane-to-ground radio communications have played an important part in the maintaining of this perfect record of safety.

Old P-167 was installed on June 17, 1941, and was removed July 28, 1951. During these 10 years the tube has seen almost continuous use at Continental's Denver transmitter, which is the communications control center of the airline's plane-to-ground radio contact.

The dependable performance of your tubes, as demonstrated by old P-167, is all the evidence we need as to where to buy our tubes. We will continue to use Eimac Tubes, as in the past.

Cordially,

R. C. Frickel, Supervisor
Ground Communications Maintenance

RCF:wrs
Attch.

P.S. Tubes P-117 and P-118, which were installed at the same time as P-167 in the same transmitter are still going strong.

The feelings expressed in Continental's letter are not unlike the feelings of thousands of other users of Eimac tubes. Top performance and a low cost to life ratio always make for customer satisfaction.

The new Eimac 450T that replaced "Old P-167" in Continental's transmitter should, because of improved vacuum tube materials and techniques, give even more satisfactory service.

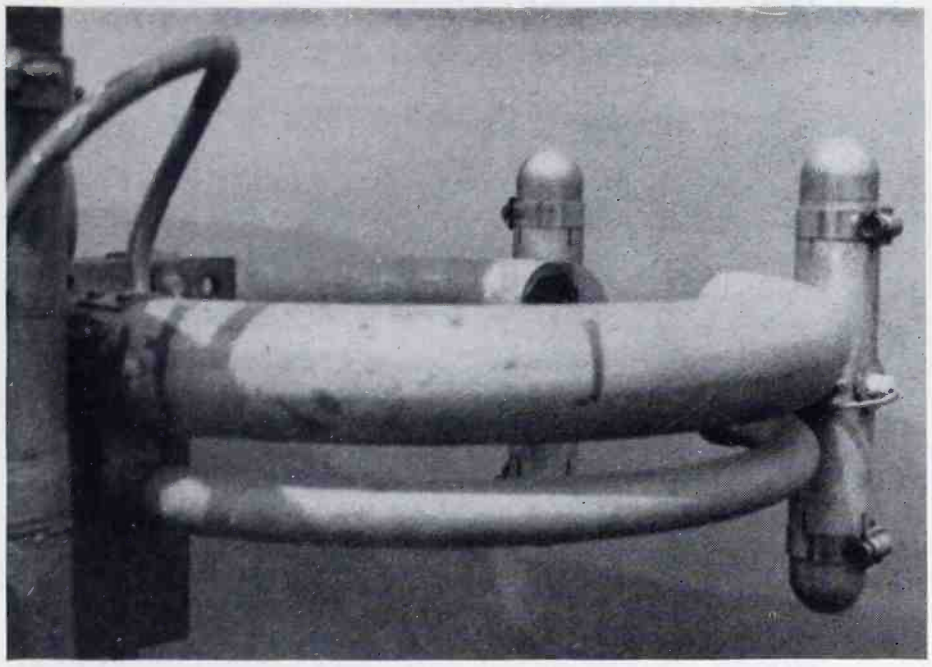
Eimac tubes invariably do a job better . . . and at lower cost. Take advantage of their almost two decades of proved performance.

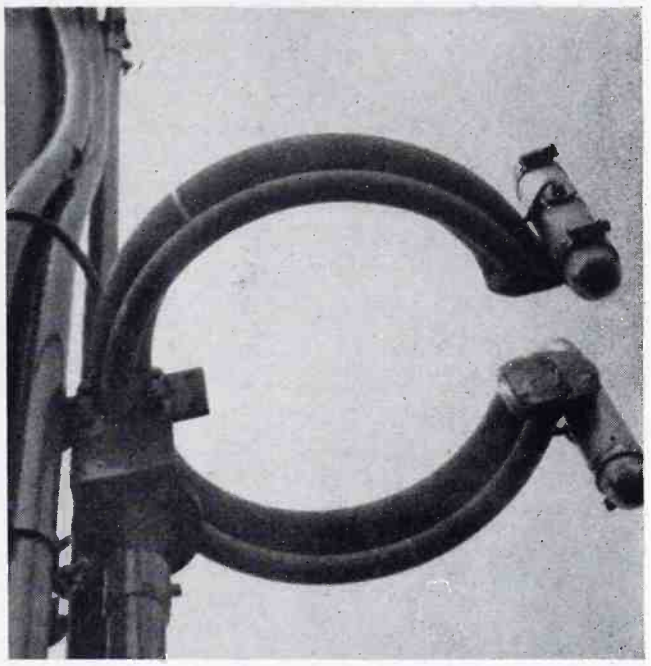
A new "Quick Reference" catalog on Eimac's Wide Variety of Tube Types is yours for the asking.

EITEL-McCULLOUGH, INC.
San Bruno, California

Follow the Leaders to Eimac TUBES The Power for R-F

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California





FIGS. 1 AND 2. CLOSEUP OF A DOUGHNUT WITH TUNING PLATES REMOVED, AND STUBS ADDED. NOTE HEATER CONNECTIONS AT THE EXTREME LEFT

HIGH-POWER FM ANTENNA DESIGN

MODIFIED G. E. DOUGHNUT-TYPE ANTENNA AT WMIT, IN WHICH ADJUSTABLE STUBS WERE SUBSTITUTED FOR TUNING PLATES — *By* MILTON B. SLEEPER

EXPERIENCE has disclosed that the most difficult design problem encountered in the operation of high-power FM broadcast stations is not related to the transmitter, but to the antenna. This comes about during periods of rain or sleet, resulting in a change of impedance which sets up standing waves on the transmission line. The higher the gain of the antenna, and the more critical its electrical design, the greater the effect of rain or sleet on its characteristics.

In this connection, it is interesting to note that the FM antenna used for many years for the station on Mt. Washington, N. H.,[1] was relatively unaffected when rime built up on the dipoles and transmission line to a depth of a foot or more. However, that was a very simple type of low-gain antenna, relatively less affected by weather conditions. Also, the very dry nature of the rime seemed to cause less detuning than the sleet encountered at lower altitudes.

8-Bay Antenna at WMIT:

Early this year, a new tower and an 8-bay G. E. doughnut-type antenna were erected at WMIT, on Clingman's Peak, N. C.[2] This altitude is a few hundred feet above Mt. Washington, but the weather conditions are much less severe. Nevertheless, the WMIT antenna, with a gain of about 6.5, proved sensitive to the occasional sleet formations and the heavy fog which prevail for such long periods that the mountains in that area are called The Smokies. While the new 50-kw. output stage was still operating at low power, trouble developed to the point where it was found advisable to alter the design of the antenna, and to provide heating elements to prevent the formation of sleet.

Originally, the doughnut elements which comprise the antenna were tuned by adjusting the space between plates fastened to flat surfaces visible at the right in Fig. 2. Those plates were later removed, and replaced by the stubs shown in Figs. 1 and 2. They are of telescopic construction, providing an adjustment of inductance and capacitance. The wider spacing, as compared to that between the flat plates used originally, is sufficient to eliminate detuning under conditions of rain or fog. The width of the gap can be seen more exactly in Fig. 6.

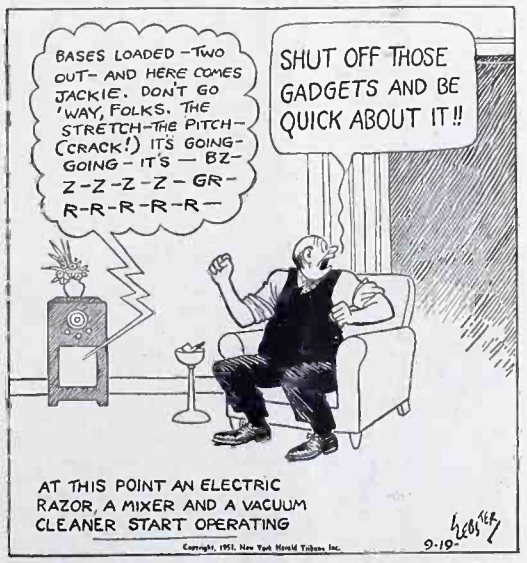
Addition of the heaters proved to be a fairly simple job. It was necessary to take down the doughnuts in order to mount the stubs. While that work was being done, metal-clad heating elements were inserted in the doughnuts and the stubs as well. Figs. 1, 2, and 4 show how the connections were made. The total current required is low, for each bay heater draws only 3 amperes.

Construction Details:

The 6⅛-in. coaxial line running from the transmitter to the tower can be seen in Fig. 5. It is supported just above the bend by a spring suspension which allows for the expansion and contraction of the horizontal run, as well as the vertical section.

At the foot of the mast which carries the doughnuts, the line is connected to a matching section through a 3⅛-in. reducer. This detail is shown in Fig. 3. A shorting stub is used in that section for impedance-matching purposes. In addition, there are trombones, Figs. 3 and 8, to provide the proper phase rela-

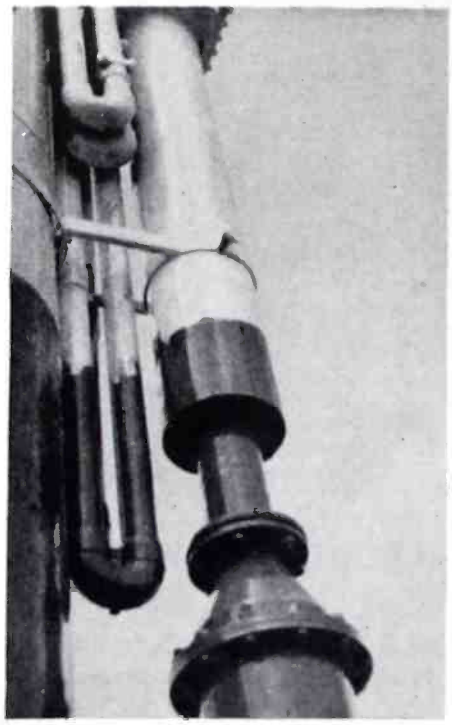
The Unseen Audience : : : : : : : : By WEBSTER

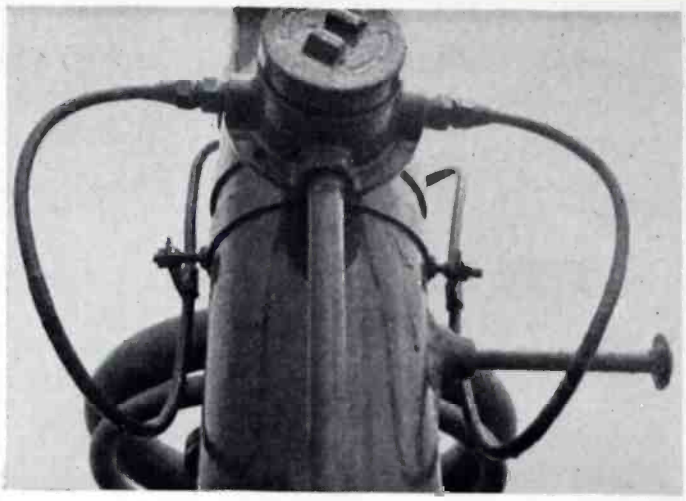


APPARENTLY THE ARTIST WHO DREW THIS CARTOON FOR THE "NEW YORK HERALD TRIBUNE" KNEW FROM EXPERIENCE THE FALLACY OF THE ARGUMENT THAT PEOPLE WHO LIVE IN LARGE CITIES DON'T NEED FM RECEIVERS

[1] This antenna, with the rime coating built up on the windward size, was shown on the front cover of FM MAGAZINE, April, 1941.

[2] For a complete description of the new installation, see "FM Station WMIT Is Back Again" by Milton Sleeper, RADIO COMMUNICATION, August, 1951.





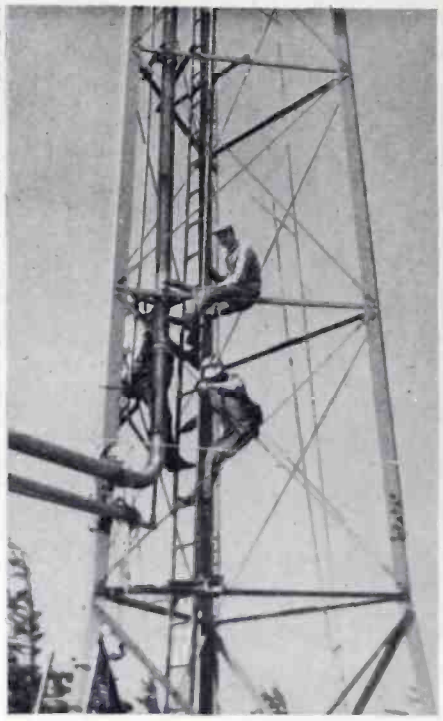


FIG. 3. A REDUCER IS USED BETWEEN THE 6-IN. LINE AND THE MATCHING SECTION AT THE BASE OF THE ANTENNA. FIG. 4. CONNECTIONS FROM A JUNCTION BOX TO THE HEATER ELEMENTS. FIG. 5. A SPRING SUSPENSION ABOVE THE BEND PROVIDES FOR EXPANSION AND CONTRACTION OF THE LINE

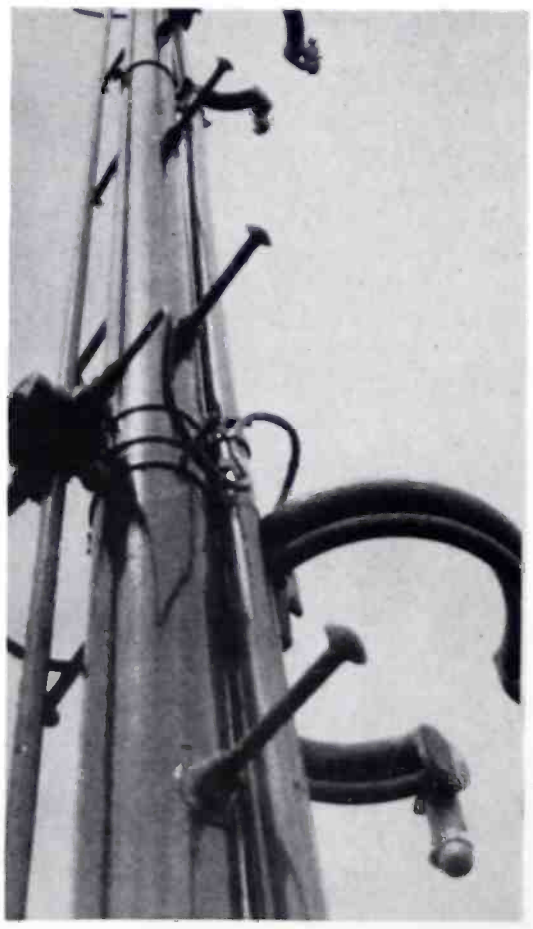
tionship between the bays. The latter are fed in pairs from 4 lines running up the mast.

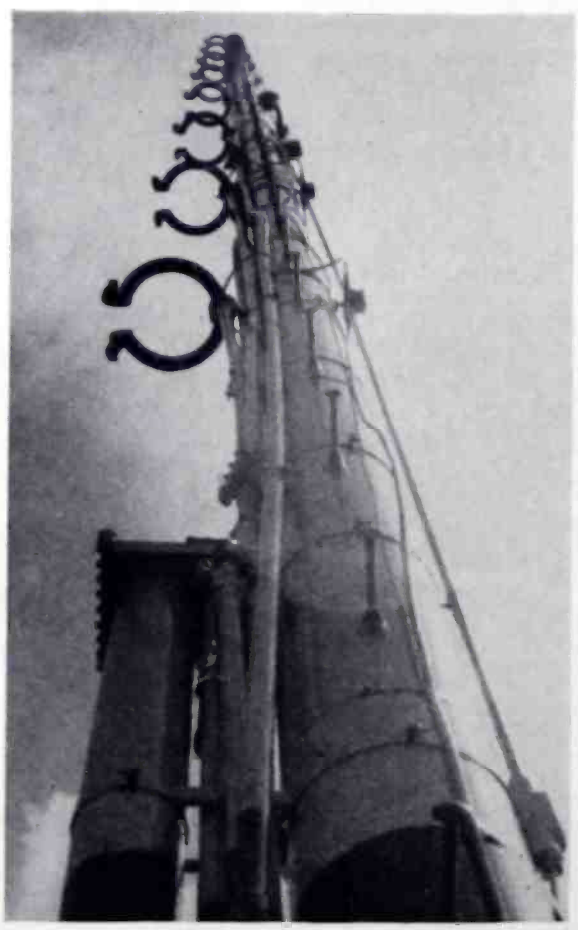
Last July, when these photographs were taken, the work of revising this was just being completed by S. Sabeff, G. E. field engineer and antenna specialist. At the same time, WMIT's chief engineer, Joseph McFarland, was making final tests on the new 50 kw. output stage of the transmitter, but it had not been brought up to full power. Now, however, the transmitter is operating at its rated output, and the report from WMIT is that the performance of the antenna is satisfactory in every respect. The only trouble experienced was at a time when the transmitter was operating on reduced power. Apparently a burr had been left at a joint in one of the feed lines, with the result that the line failed at that point.

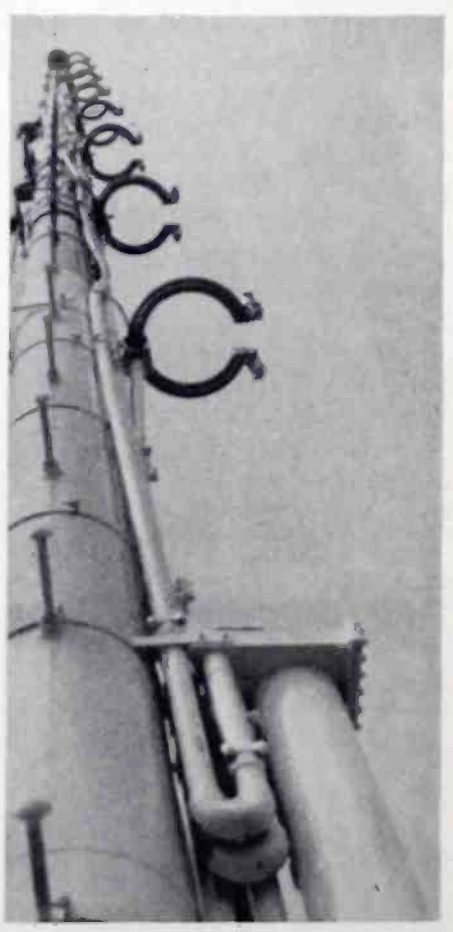
Reports from listeners, and tape recordings sent in from distances up to 350 miles show that service is extending far beyond the calculated contour. Six stations are now rebroadcasting WMIT programs, including AM station WMRA, at Myrtle Beach, S. C. This is a distance of approximately 450 miles.

About the Photographs:

We are indebted to Mr. Sabeff for the accompanying illustrations. Most antenna engineers are not tower climbers, and most tower climbers are not photographers. However, Mr. Sabeff developed his skill with a Leica while scaling some of the most perilous peaks in Europe. So he very obligingly climbed the 180-ft. tower and photographed the most interesting parts of the structure. The illustrations here are evidence of his cooperation and his skill in all the essential departments.

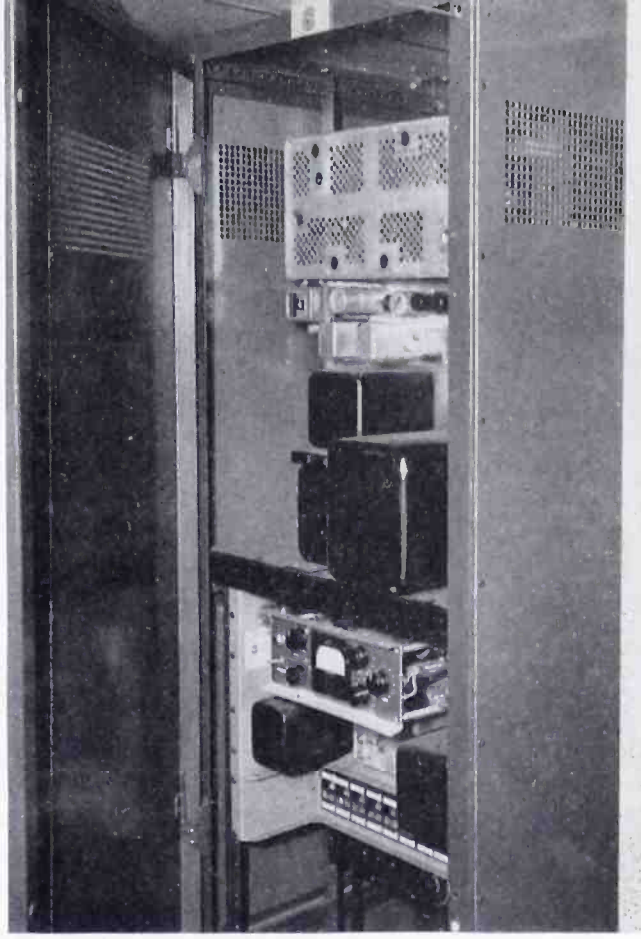






FIGS. 6, 7, & 8. VIEWS SHOWING CONNECTIONS TO THE HEATERS, AND CONSTRUCTION DETAILS OF THE MAST, MATCHING SECTIONS, AND THE TROMBONES

FIG. 1. TRANSMITTING UNIT OF THE CARAVAN. ROOF IS REINFORCED TO SUPPORT WEIGHT OF ANTENNAS, CAMERAS, AND OPERATORS, SO THAT IT CAN BE EMPLOYED AS A CAMERA PLATFORM



TV FOR ARMY USE

SIGNAL CORPS' TELEVISION CARAVAN CAN PICK UP, TRANSMIT, RECEIVE, DISPLAY TRAINING PROGRAMS

ON this and the following page is a pictorial report on the mobile television system built by RCA for the Signal Corps. The equipment, demonstrated for the first time on September 25, was built to specifications prepared by the Signal Corps Engineering Laboratories. Its primary purpose is to determine the potentialities of television as a military training aid, by experimenting with the presentation of training films and live field action on multiple direct-view and projection television screens. Also, it will provide pertinent incidental information on the value of TV for civilian educational or training purposes.

The equipment is installed in four custom-built bus-type coaches, each 31 ft. long and with a capacity of 10 tons. Unit 1 is the camera pickup and transmitting vehicle, while unit 2 contains the associated power supplies, tools, spare parts. and test equipment. The receiving and display equipment is installed in unit 3. Unit 4 is the companion vehicle for unit 3, containing power supplies and maintenance equipment. More detailed descriptions are given below.

Pickup & Transmitting Unit:

Included in this vehicle are the following:

A triple camera chain is provided, with the usual control, monitoring, and switching facilities. Sufficient cable is carried on reels so that all three cameras can be operated up to 250 ft. from the vehicle, or one camera can be employed at a maximum distance of 750 ft.

For video, there is a 7,150-mc., 100-milliwatt microwave transmitter, and a parabolic antenna with a gain of 5,000. The antenna can be located up to 500 ft. from the coach.

An FM transmitter, with an output of 45 watts at 150 mc., is used for the sound channel. This is an RCA base-station communication transmitter modified to provide high-fidelity audio. A whip antenna system on the roof of the vehicle can be made unidirectional, bidirectional, or nondirectional as desired.

Two order-wire transmitter-receivers are used as engineering and producer's private lines. One order-wire link can be used as an emergency sound program transmitter.

Tape and disc recorders and reproducers are furnished to meet such needs as may arise.

Complete audio facilities include 4 microphones, one a parabolic type; a microphone boom and various microphone stands; a public address system; and a switching system for program integration.

Two hand-carried, 2-way portable radio sets are provided for directing pro-

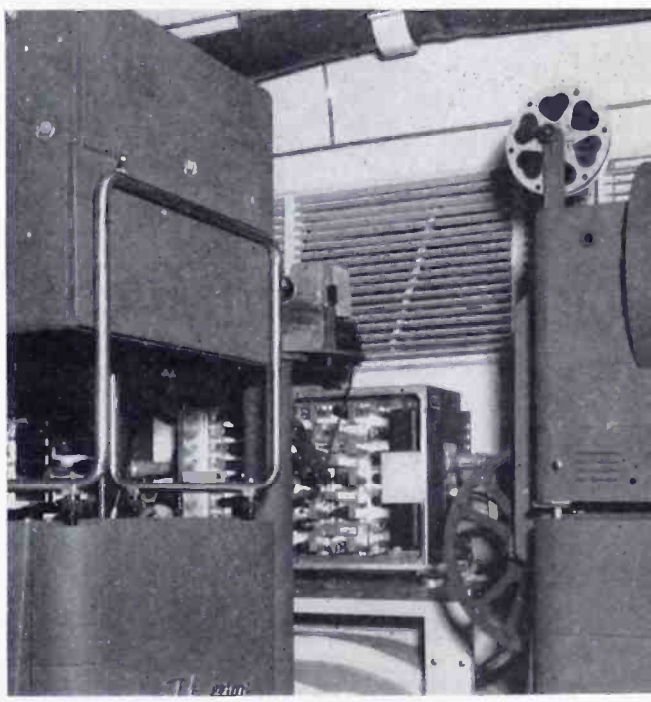


FIG. 2, TOP RIGHT: 45-WATT FM TRANSMITTER FOR TV SOUND IS A COMMUNICATION UNIT MODIFIED TO PROVIDE HIGH-FIDELITY AUDIO

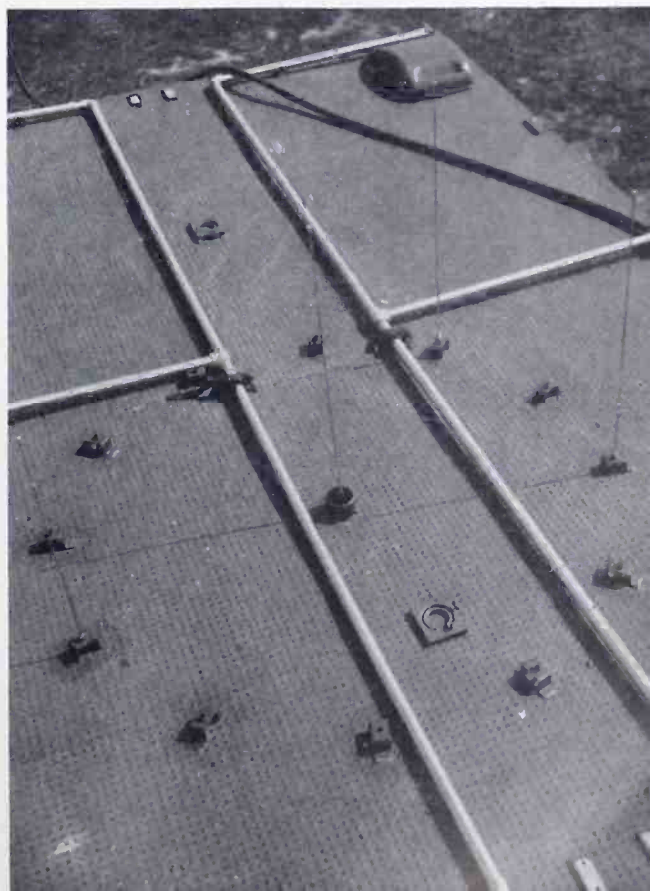


FIG. 3, RIGHT CENTER: TV FILM PROJECTION AND SCANNING EQUIPMENT IN RECEIVING UNIT

FIG. 4, RIGHT: REINFORCED ROOF OF TRANSMITTING VEHICLE. PARASITIC DIRECTOR WHIPS PROVIDE DIRECTIONAL FM SOUND RADIATION

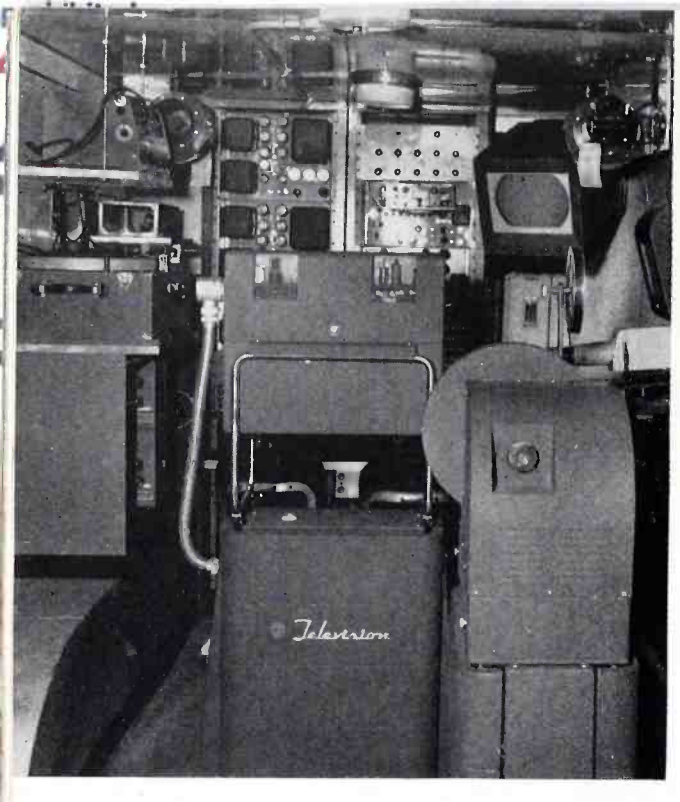


FIG. 8. RECEIVING POWER UNIT. THIS VEHICLE CONTAINS A 15-KVA. ENGINE-DRIVEN GENERATOR, TEST EQUIPMENT, SPARE PARTS, AND REELS FOR AUDIO, VIDEO, AND POWER CABLES

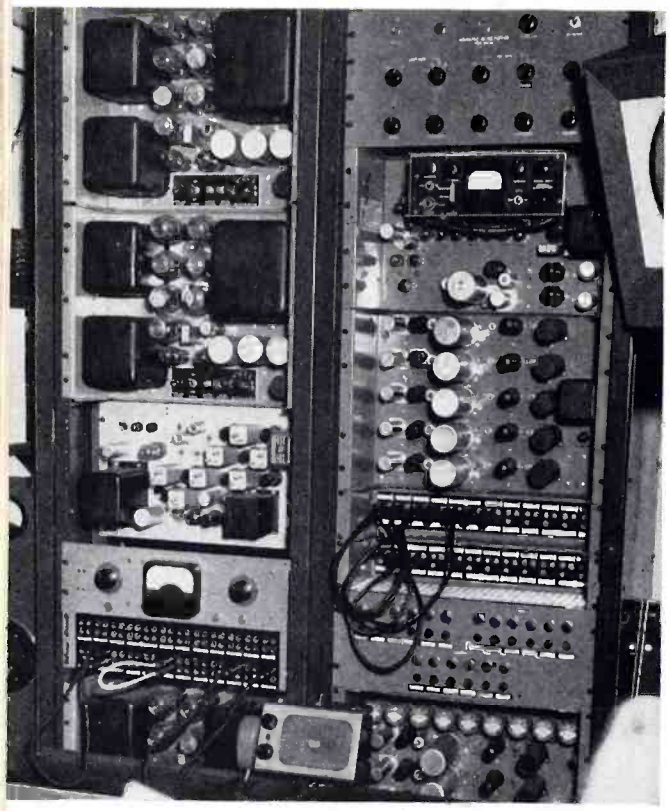


FIG. 5, TOP LEFT: VIEW OF THE INTERIOR OF THE RECEIVING VEHICLE. FILM PROJECTOR AND SCANNING EQUIPMENT ARE IN FOREGROUND

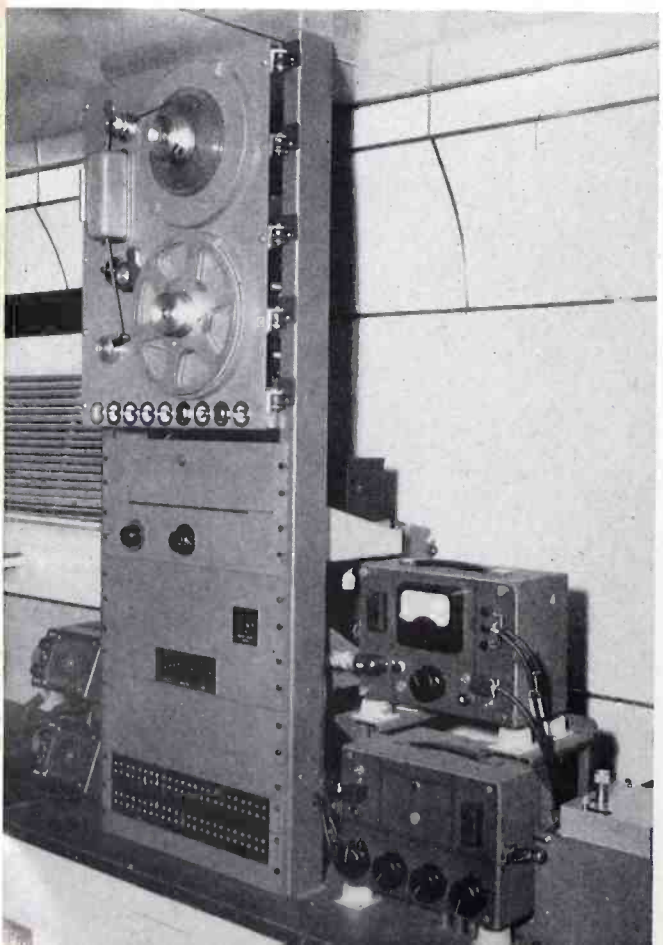


FIG. 6, LEFT: CONTROL, MONITORING, AND DISTRIBUTION POSITION IN RECEIVING UNIT

FIG. 7, LOWER LEFT: THIS HIGH-FIDELITY TAPE RECORDER IS PART OF COMPLETE AUDIO FACILITIES PROVIDED IN TRANSMITTING UNIT

ductions that may be spread out over large areas.

Transmitter Power Supply:

Two gasoline-driven generators in unit 2 have a capacity of 15 kva each. Outputs are 120 and 208 volts, connected in a 3-phase, 4-wire system. One generator provides power for unit 1. The other is for standby use or for the complete scene-lighting equipment, which can be operated up to 750 ft. away from the power-supply vehicle.

An order-wire transmitter-receiver is included in this unit also. A switching arrangement is provided in all vehicles so that these 2-way mobile radios can be powered by the trucks' batteries while traveling on the road. Thus, intercommunication between all units of the system is possible at any time.

The power-supply vehicle contains parts, tools, and laboratory test equipment for maintenance of units 1 and 2.

Receiving & Display Unit:

The following equipments are included in unit 3:

The video receiver and antenna for this system are so designed that they can be located atop the coach or anywhere up to 500 ft. away. In addition, a separate FM sound-channel receiver and an antenna are furnished.

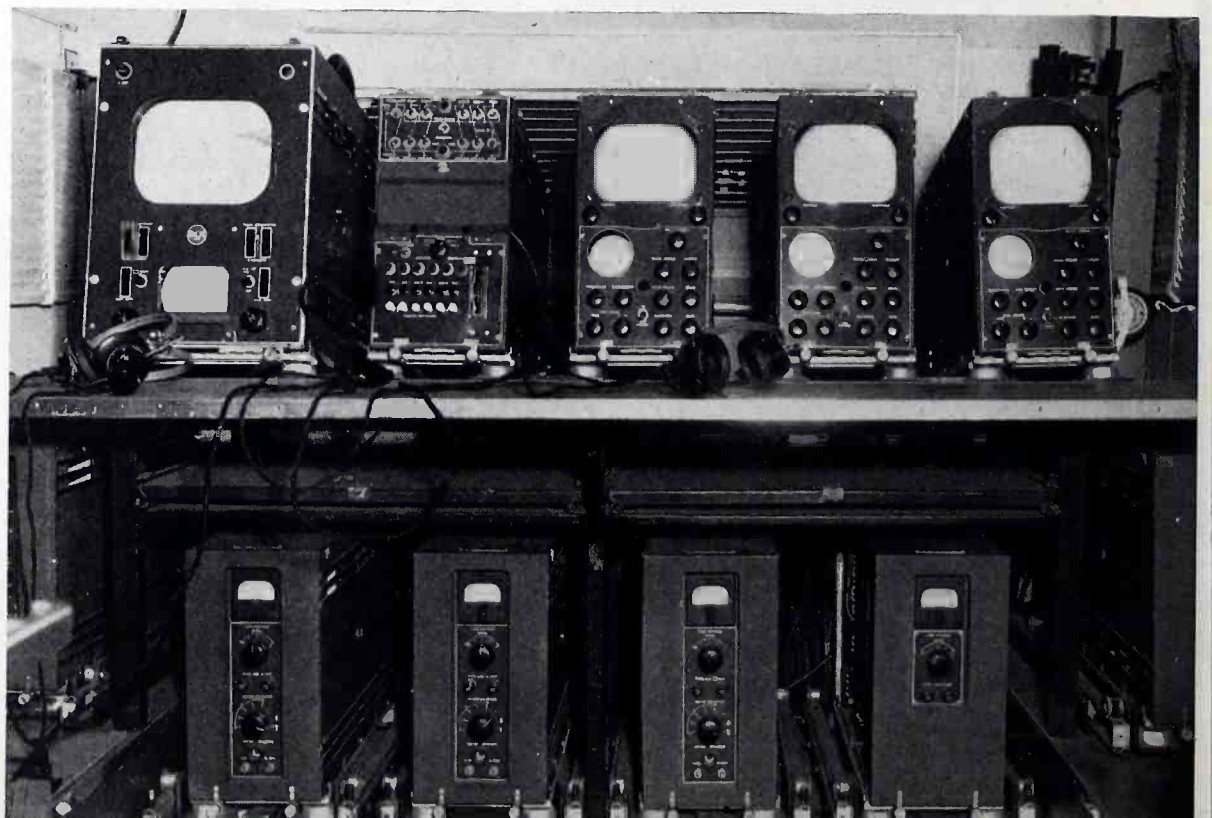
Two order-wire transmitter-receivers are arranged so that one can be used as an emergency sound-channel receiver.

Films and slides can be used in conjunction with TV programs. For this purpose, a scanner is provided, by means of which films and slides can be presented on the TV picture tubes and the projector screen.

Ten 16-in. direct-view TV receivers and one projection model are furnished.

(Concluded on page 23)

FIG. 9. CONTROL AND MONITORING POSITION IN THE TRANSMITTING VEHICLE. MONITORING AND SWITCHING EQUIPMENT IS SHOCK-MOUNTED, CAN BE ROLLED FORWARD FOR MAINTENANCE



LEFT: First mobile TV studio to be shipped to South America is this DuMont Telecruiser, bound for the new station nearing completion at San Paulo, Brazil. It is equipped with two field cameras, picture control, monitoring, and audio facilities, and microwave relay equipment. The interior arrangement provides accommodations for audio and video directors, a technical director, and a program director.

RIGHT: As a part of new $25,000 antenna test facilities, RCA has built this 100-ft. concrete apron at Medford, N. J. Vertical directivity pattern of a broadcast antenna can be checked by mounting it horizontally on the wooden dollies, and swinging it on the apron. Cables connect an antenna under test to instruments in an adjacent building. At a distant point is a recorder with a selsyn drive to rotate the antenna.

LEFT: The first two-way mobile FM radio equipment to pass final test positions at General Electric's newly-established Kent St. plant at Utica, N. Y. The new factory will be devoted exclusively to an expanded schedule of communication equipment production. This activity is being transferred gradually from Electronics Park, Syracuse, in order to maintain a continued flow of deliveries to new mobile radio systems.

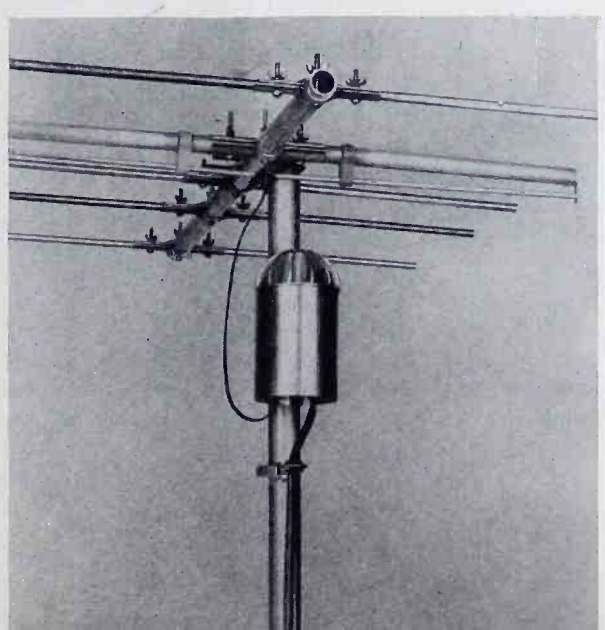
BELOW: Lt. Ralph McNail, who heads the Police Communication Bureau at St. Louis, Mo., designed this $5,000 mobile radio center. The 15-ft. trailer, built with body panels of 15-gauge steel, contains communication equipment, 3.5-kva. generator, and 3 antennas.

RIGHT: In this photograph, taken during the APCO convention, are FCC Commissioner Edward Webster, Miami's Superintendent of Communication Ben Demby, and Motorola vice-president Daniel Noble. Ben Demby, who pioneered 118 mc. in 1945, has the first police equipment operating on 450 mc.

BELOW: At the Timken Roller Bearing plant, Canton, Ohio, Motorola mobile radio units are used to dispatch 24 material-handling vehicles, including 9 straddle-trucks which move steel billets from the mill to storage yards up to ½ mile distant, and back for processing or shipping.

BELOW, RIGHT: This single-channel, mast-mounted TV booster is a product of La-Point-Plascamold Corporation, Windsor Locks, Conn. Designed for fringe-area use, it operates from a power supply turned on and off at the TV set. Amplification is provided before noise pick-up on the lead.

BELOW: Brigadier General James D. O'Connell, of the Special Assignment Group of the Office of the Chief Signal Officer, will be the principal speaker at the Thursday luncheon during the IRE conference on vehicular radio, at Hotel Sheraton, Chicago, October 25 and 26.



Design Details of a Linear Magnetic

UHF OSCILLATOR ATTENUATOR

A SIMPLE AND INEXPENSIVE METHOD FOR MODULATING OR ATTENUATING ACCURATELY THE OUTPUT OF A UHF RF GENERATOR — *By* FRANK REGGIA*

FAMILIAR methods of RF generation and measurement are not suitable at microwave frequencies. New techniques are necessary in order to obtain requisite accuracy in test and developmental work. A substantial contribution to UHF measurement techniques is an inexpensive microwave attenuator for coaxial transmission lines, recently developed at the National Bureau of Standards, which utilizes a magnetic field to obtain instantaneous changes in attenuation.

The new device, an outgrowth of NBS research in power-measuring techniques at microwave frequencies, is known as a magnetic attenuator. Its operation depends on the interaction between the normal electromagnetic field within a transmission line into which a microwave energy-dissipating material is inserted, and an external magnetic field applied perpendicularly to the axis of the line. The loss characteristics of the dissipative material are altered substantially by this interaction. The magnetic attenuator requires no movable components, mechanical controls, or slotted coaxial transmission line sections, and can be operated manually or automatically from a local or remote position. Fig. 1 shows the unit in use.

A waveguide attenuator employing similar principles has been described by Theodore Miller.[1]

Attenuators for the microwave frequencies are used to adjust power levels, to isolate monitoring equipment, or to pad an oscillator for load variations. Generally, however, their use has been complicated by inaccuracies of control, and mechanical inflexibility.

Attenuator Construction:

In conventional microwave attenuators, the energy is dissipated in an element composed of resistive film on glass or bakelite. Powdered carbon or polyiron materials used for that purpose have characteristics which vary with length, composition, and the operating frequency. Often, the dissipative element must be machined carefully to close tolerances, and is usually very fragile. Additional difficulties arise when variable attenuation is required in a transmission-line circuit. The complex mechanisms necessary to provide a high degree of control precision result in bulky, expensive, hard-to-handle instruments.

The new attenuator, in contrast, is simple in construction. It is composed of a slug of highly-permeable resistive ferromagnetic material, inserted in a coaxial line section which is then put within the field of an electromagnet. The significant feature of this device is the change in the loss properties of the dissipative material when it is subjected to a magnetic field. Because the magnetic field is produced by an electromagnet, its magnitude can be controlled simply and precisely by varying the current in the field coils. Consequently, the permeability and loss characteristics of the dissipative material can be adjusted continuously, and variable attenuation is obtained. The control characteristics are linear over a substantial range.

The electromagnet requires a DC power source of 0 to 250 volts at 30 milliamperes to produce a maximum magnetic field of 1,500 gauss in the air gap. Small changes in the magnetic field are obtained by controlling the field current with a multi-turn Helipot potentiometer.

*Central Radio Propagation Laboratory, National Bureau of Standards, U. S. Department of Commerce, Washington 25, D. C.

[1] "Magnetically Controlled Waveguide Attenuator," *Journal of Applied Physics, 20,* 878, September 1949.

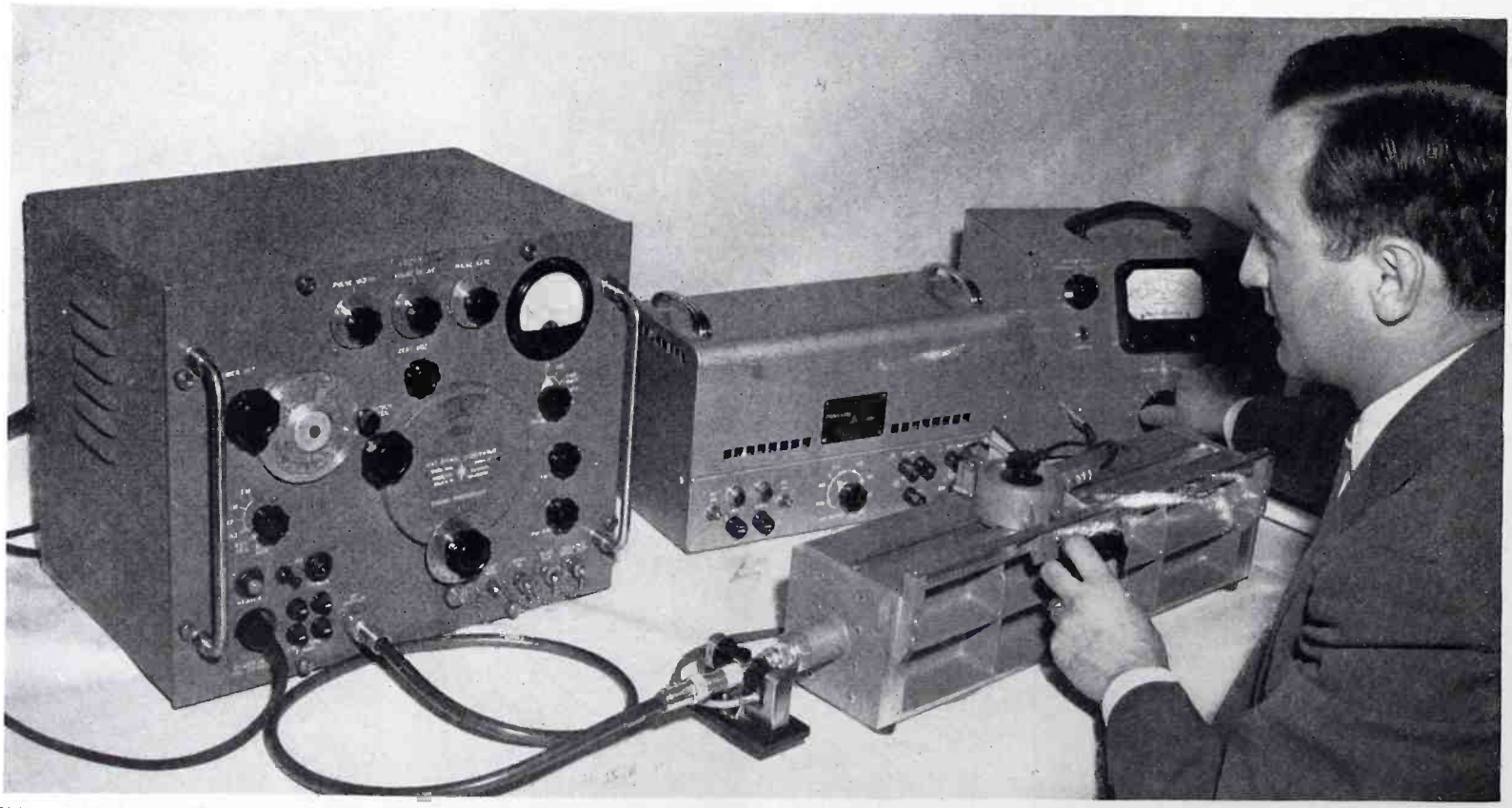
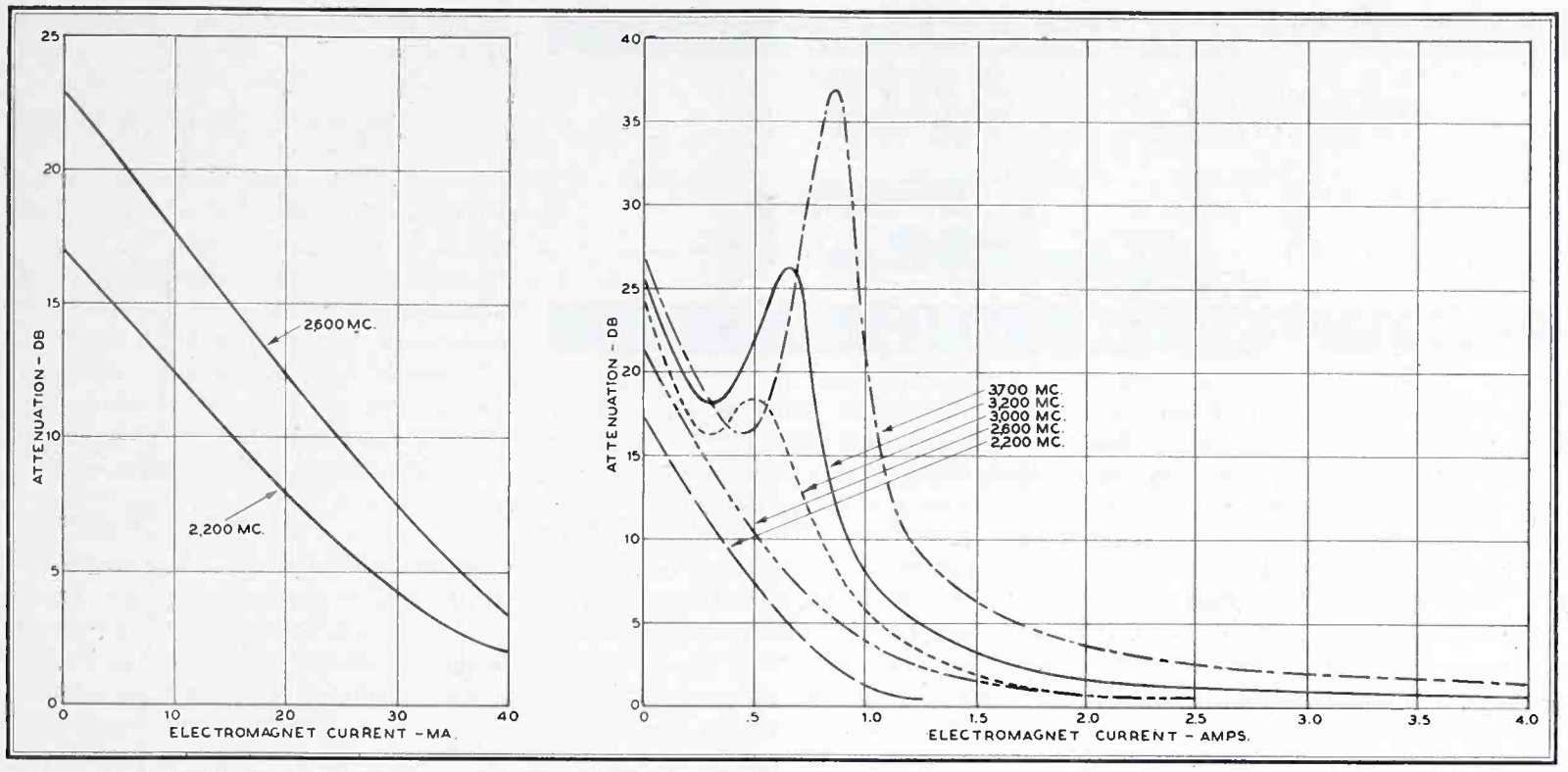


FIG. 1. MAGNETIC ATTENUATOR USED BETWEEN UHF OSCILLATOR AND STANDING WAVE MACHINE. ATTENUATION IS CHANGED BY FIELD CURRENT



FIGS. 3 AND 4. ATTENUATION VS. FIELD CURRENT FOR VARIOUS OPERATING FREQUENCIES. LARGER ELECTROMAGNETS PROVIDE GREATER ATTENUATION

The size of a magnetic attenuator for ⅜-in. coaxial transmission lines, Fig. 2, is only 4 by 4 by 2 ins. The dissipative material, a cylinder of polyiron, is about ½ in. long and ⅜ in. in diameter. A recessed hole for the center conductor is drilled into the cylinder. Ceramic insulators are placed at the extremities, the assembly is encased in a metal sheath, and connector pins are then fastened to the ends of the center conductor. Standard coaxial connectors complete the assembly.

The attenuator is separated into its individual components in Fig. 2. At the left is the complete housing with connectors. The metal sleeve enclosing the elements and the connector pins are shown at the center. At the right is an exploded view of the inner components, showing the slug or cylinder of energy-dissipating material, the ceramic spacers, and the connector pins.

Performance:

An investigation of materials such as polyiron and ferrites, with resistivities from 10^2 to 10^7 ohms per centimeter, showed that the loss characteristics depend not only upon the composition and length of the material but also on the operating frequency.

An experimental model of the attenuator, employing polyiron as the dissipative element, was operated at frequencies from 1,000 to 3,000 mc. Variations were produced in the losses of the polyiron which were large enough to change the power by a ratio greater than 60 to 1. This was achieved with a voltage SWR consistently less than 1.5.

Recently, a study was made of an attenuator employing a slug of Ferramic B as the dissipative medium. This slug was also ½ in. long and ⅜ in. in diameter. The relation between loss and operating frequency was demonstrated by this experiment. At 2,200 mc., the attenuation was varied from 17 db to less than ½ db, as indicated in Fig. 3. Less than 45 milliamperes were required for the magnetic field. At a frequency of 2,600 mc., changes in attenuation of more than 20 db were obtained with the same electromagnet currents. So that saturation would be avoided in the iron core of the small, low-current electromagnet, a larger unit was used to obtain greater ranges. Attenuation changes in excess of 95% have been obtained without difficulty at several frequencies.

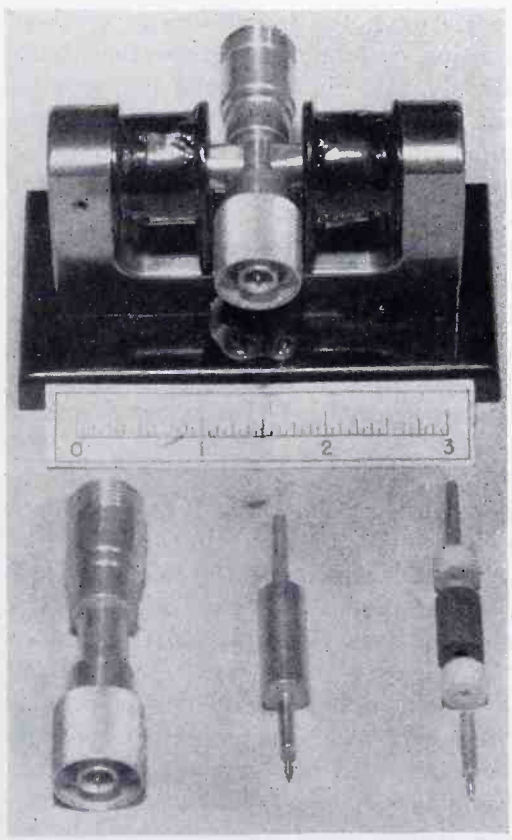


FIG. 2. ASSEMBLY OF ATTENUATOR COMPONENTS

A unique resonance phenomenon was exhibited at 3,200 mc. As the electromagnet current was increased, the attenuation decreased from its zero-current value of 24 db to about 18 db, and then peaked at about 25 db. Finally, it decreased to approximately 1 db. This is shown in Fig. 4. The peak occurred at a current level of approximately .6 ampere. When operating at 3,700 mc., a similar phenomenon occurred. The attenuation decreased from 26 db to about 16 db, then peaked sharply at 37 db. It dropped to about 1 db as the current increased further. The resonance effect appeared when the electromagnetic current was .8 ampere.

When the magnetic field is rotated about the axis of some magnetic attenuators, a point is encountered where the field has maximum effect. For instance, when a magnetic field of constant intensity was rotated about the axis of the Ferramic B attenuator, changes in attenuation of 17 db were obtained at 3,700 mc. However, this rotational variation does not exist for all materials used in the attenuators.

Applications:

Various applications for this magnetic attenuator are evident immediately. An audio source can be employed to vary the electromagnetic current, which would produce a changing field in the attenuator and, consequently, amplitude-modulate an RF signal. The resultant modulation envelope would include second and higher-harmonic frequencies of the AF

(Concluded on page 23)

JEREMIAH COURTNEY'S

MOBILE RADIO

NEWS AND FORECASTS

MANUFACTURERS can start right now to tool up for multiple-channel equipment in the marine VHF band if the Commissioners' questioning of the opponents of that proposal at the recent oral argument affords any clue to their final decision on this important point.

For at the October argument the single-channel proponents had heavy weather with no haven in sight offered by any of the five Commissioners hearing the argument on this particular proposal.

The proposed Rules would require all ship stations in the 152 to 162-mc. band to use, in addition to the working frequency desired, the intership frequency of 156.3 mc., the calling and safety frequency of 156.8 mc., plus a coastal station frequency for ship to shore public correspondence. The proposal would be effective January 1, 1952 except for ship station equipment licensed prior to January 1, 1951 for which the effective date of compliance would be given as January 1, 1953.

Quite naturally, the communications common carriers such as Lorain County endorsed the mandatory multiple-channel equipment proposal. Every ship afloat will have the opportunity of using common carrier facilities and their potential market for business would be greatly enlarged in consequence.

Tug Boats Opposed:

The tug boat operators, like Moran Towing of New York, were flatly against the proposal. They brought out that their operations were entirely of a localized nature, within a particular harbor. If something goes wrong with one of their tugs, or another boat in the harbor, they don't want their men to call four places. They want them to call just one place, always: the home office. That office will do the rest, summoning such assistance as the emergency requires. The single-channel system has worked in actual emergencies; whether the multiple channel system would work as well is to be doubted. Underlying concern of the tugboat operators seemed to be that the present system has worked so well in almost perfect fulfillment of a long-needed requirement for operational harbor communications that any change would only have the effect of impairing the present high efficiency.

History vs. Theory:

There is, of course, much to be said for the ounce of history over the pound of projected theory in these matters. Then, too, the economic factor is not to be overlooked. Estimates on the cost of multiple-channel equipment ran all the way from 140% to 400% of the cost of single channel equipment. Maintenance of the multiple channel equipment can be expected to run correspondingly higher, too.

Conspicuous by their absence from the proceeding were the leading mobile equipment manufacturers. (At one point when the cost factor came up, one of the Commissioners remarked about their absence.) Our own guess is that the manufacturers were among the missing either because they haven't made up their mind on the merits of the Commission proposal or, having done so, have not found it politic to express their views. To favor the multiple-channel proposal would be definitely to restrict their immediate sales market and quite possibly to tread on the toes of many of their existing customers to whom they have already sold single-channel equipments. On the other hand, to take aim at the proposal might well limit their total long-run sales in the field, placing them meanwhile in the light of an unwelcome volunteer insofar at least as the Commissioners who favored the proposal might be concerned.

Whatever the reasons, the leading manufacturers had nothing to say for or against the multiple-channel requirement.

Safety Aspects:

Some of the individual Commissioners did, however, asking the objectors to address themselves to the safety aspects of their proposal. Commissioner Webster, for example, explained that, under the proposal, every vessel equipped for VHF would be a member of a mutual life-saving pact, as it were. Chairman Coy suggested that some of these localized marine operations might not stay put within their harbors and might be found at sea without benefit of distress or intership communications facilities in that range.

As one of the objectors summed it up, you get nothing in this world without payment. Are the theoretical and unproven benefits of the mutual life-saving VHF pact, in which United States ships would be pioneering, worth the price to be paid in increased capital investment. increased operating and maintenance costs and, quite possibly, decreased operational communications efficiency through the required use of more complicated equipment? All of which seemed to return the ball to the Commission.

Probable Outcome:

Our own guess is that the high-seas ships using VHF (and certainly the Great Lakes ships) are going to become pioneer members, whether they want to or not, in the Commission's VHF mutual life-saving pact. Whether ships engaging in localized marine operations within a mile or so of home base will be required to subscribe for membership looks like a toss-up that could go either way.

Mobile Interest Is High:

Perhaps the most important, and encouraging, aspect of the entire marine argument proceedings was the obvious interest and awareness that was demonstrated by all the individual Commissioners in the mobile communications problems involved. It was quite clear that the Commission as a whole is fast becoming as well-informed in the mobile field as it has always been in the broadcast field — which is another indirect tribute to the growth that has occurred in the mobile area.

For all who feel that the mobile field is large enough to encompass both direct-user and common-carrier assignments, however, it must have been on the discouraging side to find Commissioner Jones again devoting his able talents to the development, through his questioning, of the superficially simple solution to all allocations or rule-making proceedings, which is to give the common carriers all the frequencies, to the end that maximum frequency conservation would be attained by providing service to everyone on the same terms.

This solution in the radio field quite overlooks all precedents in the allied fields of communication — postal, telephone, and telegraph — where the large users are free to establish, and often do establish, their own systems for handling inter-company communications by messenger, telephone, or telegraph. Everywhere in the communication world the large user has the option of building his own facilities or buying the service from a common carrier on a per unit

(Continued on page 23)

*908 20th Street, N. W., Washington 6, D. C.

RURAL FIRE-STATION NETWORK

FM TWO-WAY RADIO EQUIPMENT PROVIDES FAST COMMUNICATION BETWEEN FIRE-FIGHTING UNITS OF 46 TOWNS IN ONEIDA COUNTY — *By* WARD BOHNER*

VARIOUS discussions of 2-way radio systems and of their operation have appeared in the pages of this Magazine. Such systems provide faster, more efficient coordination of police or fire departments within a municipality, and effectively increase their capabilities.

However, the very real benefits of integration obtained with 2-way communication need not be limited to urban areas. In rural areas, where local traffic is light, a single dispatcher at one base station can control a system extending over an entire county, for example. Only one operational fixed frequency is required, in addition to the normal pair of mobile and base station frequencies. As the number of members in such a network increases, the effectiveness of the system increases and the cost per member decreases. This article describes the conception, planning, and operation of the Oneida County mutual aid fire radio system, as an example of what can be done by a group of formerly-isolated community fire departments through the use of 2-way radio.

Planning a Network:

The original suggestion that Oneida County, New York, set up a 2-way radio network was presented at a summer quarterly meeting of Oneida County fire chiefs held in July, 1949. The author, then Fire Chief of Waterville, made the suggestion that all fire stations in the county be tied together by a radio network, and that each fire department should install at least one transmitter and receiver. With such equipment, all stations could be informed immediately of emergencies of any kind occurring anywhere in the county, and whatever aid was needed could be requested and obtained.

A committee was appointed by the Mutual Aid Association to contact radio manufacturers for information and recommendations about such a system. This committee reported its findings to the group in October. Its optimistic report led to the formation of a new committee of county fire officials to make further investigations. The new committee approached the county board of supervisors, discussed the plan with its members, and were able to obtain from them an appropriation of $35,000. This sum was to provide one 30-watt FM 2-way mobile radio for each town or village member of the Mutual Aid Association, besides all necessary base and repeater stations and test and repair equipment.

Fire Chief Leo R. Barry of Utica was appointed by the board of supervisors as the first coordinator of the new radio system. Through the cooperation of the City of Utica and of Chief Barry, permission was granted to install the dispatching center of the system in the Utica fire alarm headquarters.

System Design:

Because of the rugged terrain of this unusually large county, the requirement for complete border-to-border coverage, and the desire for truck-to-truck radio operation throughout the county, complex technical problems were involved in designing and setting up the system.

Engineers made detailed studies of the hilly area, and concluded that it could be best covered by installing the Utica base-station antenna on the fire station roof, and erecting three repeater stations at strategic points.

Fig. 1 presents the plan in detail. One repeater was installed at Paris Hill near the southern end of the county, the second near Glenmore in the northwestern corner, and the third on Starr Hill in the northeastern part of the county. The locations of the base station and repeaters, and the frequencies employed are shown in Fig. 1.

In choosing equipment for the system, provision was made for the following operating requirements:

1. All operators in the network located near the Utica base station would be able to communicate directly with the Utica dispatcher, without the signals being relayed by one of the repeater stations.

2. Any 2-way mobile units beyond direct range of the Utica station could

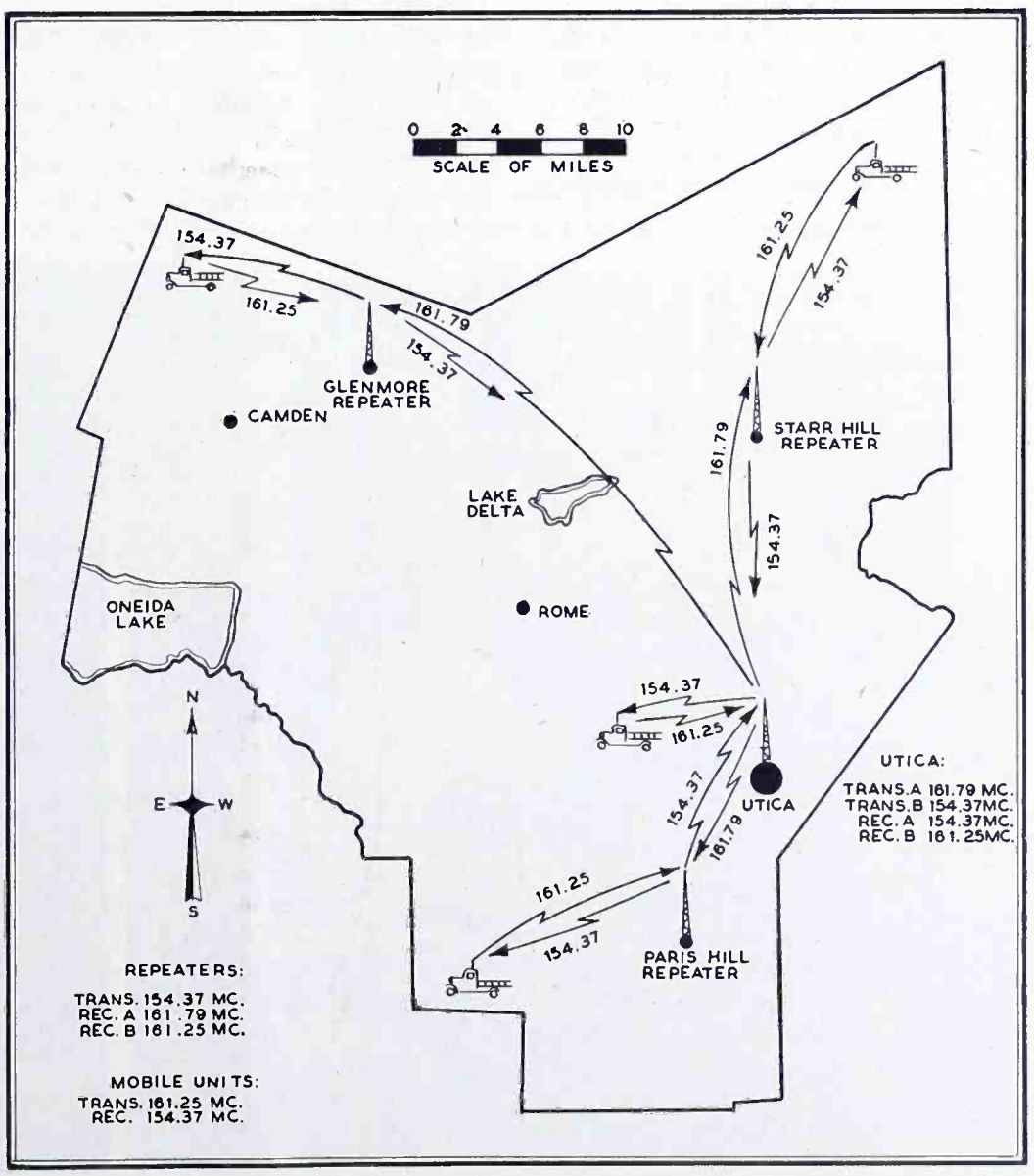


FIG. 1. MAP OF THE NETWORK, SHOWING BASE STATION, REPEATER, AND MOBILE FREQUENCIES

*County Fire Coordinator, Oneida County, New York.

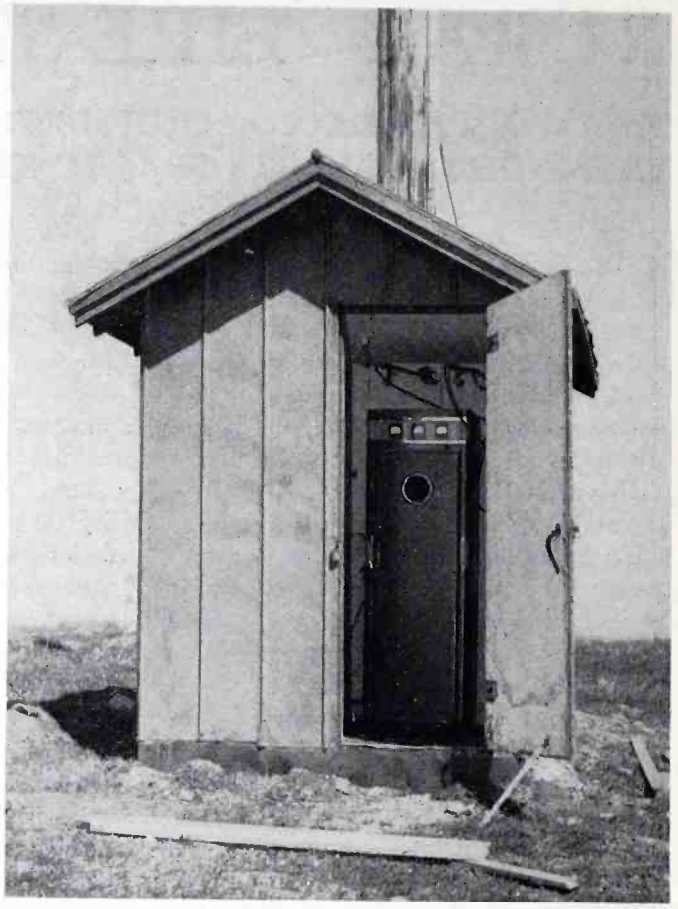


FIG. 2. PARIS HILL REPEATER STATION. NOTE ANTENNA SEPARATION. FIG. 3. HOUSE FOR REPEATER RADIO EQUIPMENT AND STANDBY GENERATOR

talk to the Utica dispatcher via the nearest repeater station.

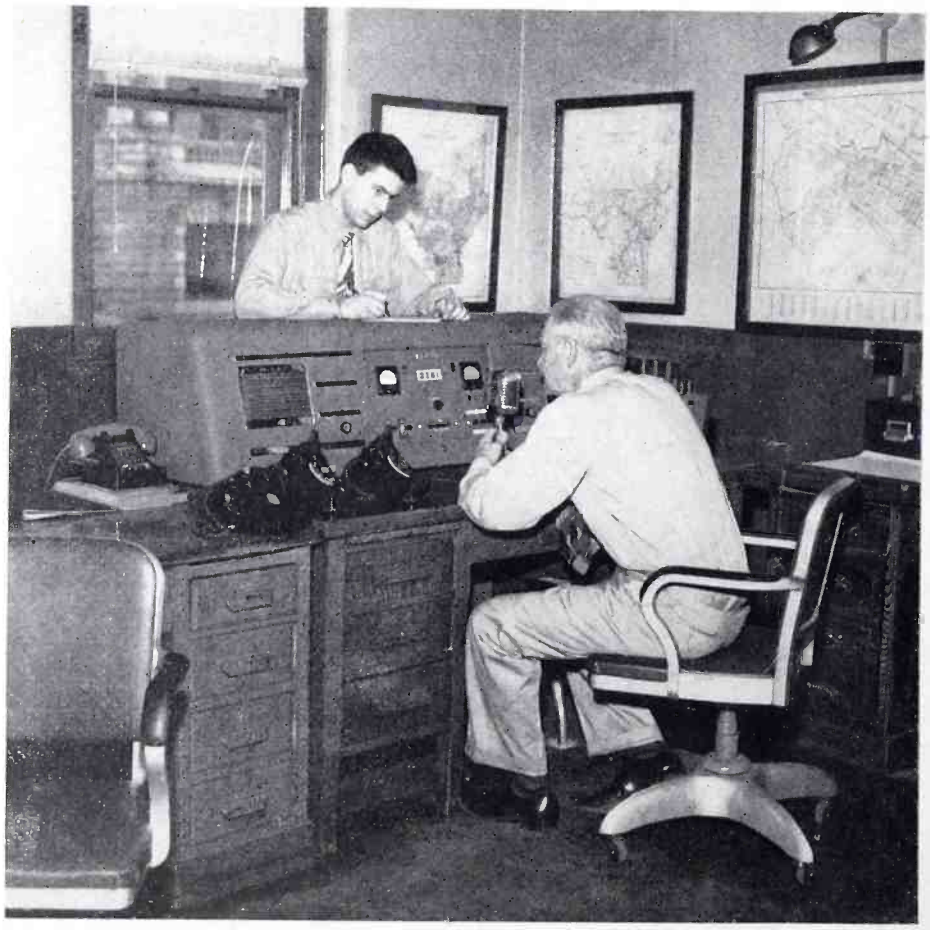
3. Any operator of a mobile unit could talk to any other operator in the county by relay through one or more of the repeater stations.

Base Station and Repeaters:

The site for each repeater station was chosen after considering its height, accessibility in bad weather, the availability of land, and proximity to an outside power source. Use of the Starr Hill plot of ground was permitted by New York State, and the two other sites were donated by private owners. Figs. 2 and 3 are views of the Paris Hill installation.

The repeater stations, including radio equipment, antenna supports, and houses, were installed according to the Motorola package system. Each repeater station is housed in a small, cement-floored building with a gasoline-driven standby power supply, as shown in Fig. 3.

When the power line to a repeater station fails, the emergency power supply is activated by an automatic change-



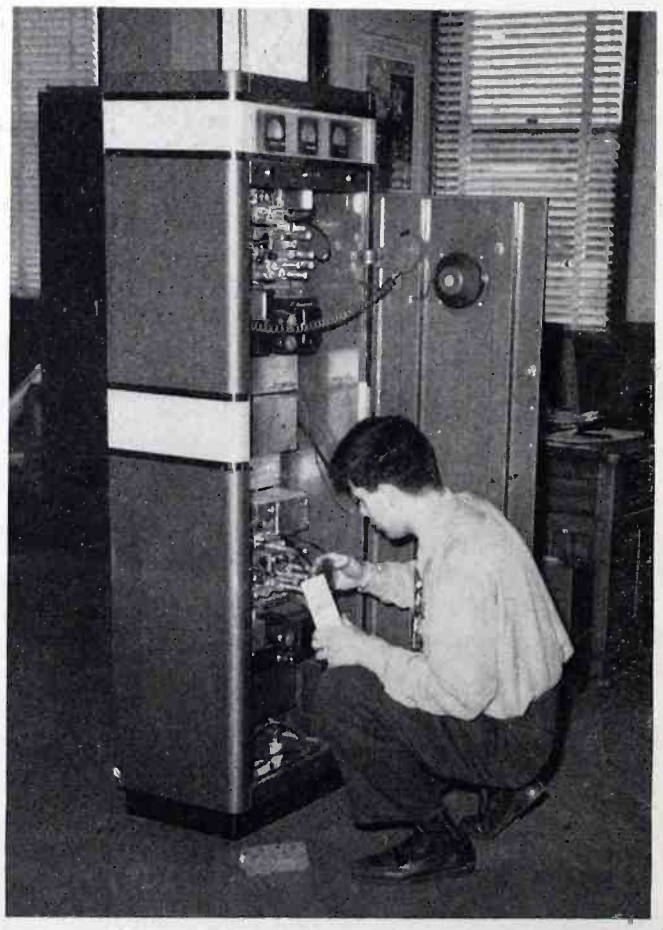
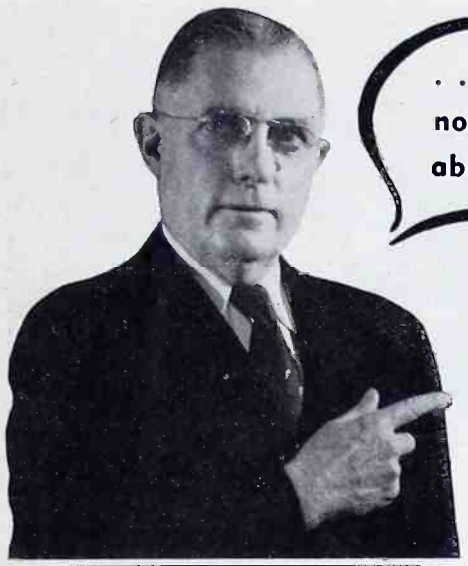


FIG. 4. CHIEF DISPATCHER EDWARD ROTHENBURG AT UTICA BASE-STATION CONSOLE FIG. 5. ROBERT MOTE, FULL-TIME MAINTENANCE ENGINEER



. . . Sorry — there just are no experienced men available with Licenses . . .

PLACEMENT

Don't Get Caught Short . . . Without A LICENSED RADIO OPERATOR

TRAIN A REPLACEMENT -- NOW YOU CAN COUNT ON HIM -- LATER

SELECT A MAN NOW WITH YOU - WHO WILL STAY WITH YOU - WHO WANTS TO GET AHEAD

ENROLL HIM in this Guaranteed FCC License Training UNDER ONE OF THESE THREE PLANS

1. You Pay All, $89.50 Cash
2. He Pays All (Terms Available)
3. You & He Split Cost

Send for Information on These Plans

Cost is Minor Compared to the Security

WE GUARANTEE

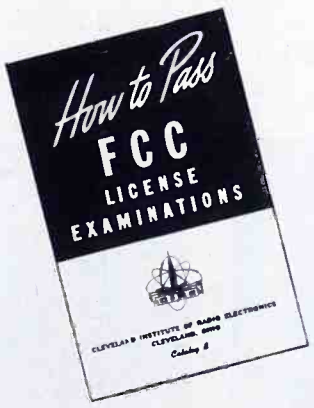
TO TRAIN AND COACH HIM AT HOME IN SPARE TIME UNTIL HE GETS

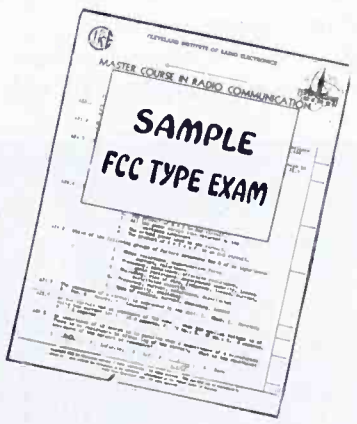
HIS FCC LICENSE

If he has had any practical experience — Amateur, Army, Navy, radio repair or experimenting.

Send for this FREE Material

It tells how easily a man of your choice can be trained at home in his spare time to get his FCC license.





Look How FEW HOURS OF STUDY MAY BE REQUIRED TO GET FCC LICENSE WITH OUR COACHING AT HOME IN SPARE TIME

Name and Address	License	Lessons
Lee Worthy, 2210½ Wilshire St., Bakersfield, Calif.	2nd Phone	16
Clifford E. Vogt, Box 1016, Dania, Fla.	1st Phone	20
Francis X. Foerch, 38 Beucler Pl., Bergenfield, N. J.	1st Phone	38
S/Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Calif.	2nd Phone	23

Cleveland Institute of Radio Electronics
Special Attention: Desk 14
4900 Euclid Avenue
Cleveland 3, Ohio

I want to know how a man of my choice can get his FCC ticket in a minimum of time. Send FREE booklet, "How to Pass FCC License Examinations" (does not cover exams for Amateur License), as well as a sample FCC-type exam, and information as to payment plans available.

☐ Be sure to check here if you are an employer,

NAME.....

ADDRESS.....

CITY.....ZONE.....STATE.....

Paste on penny postcard or send air mail.

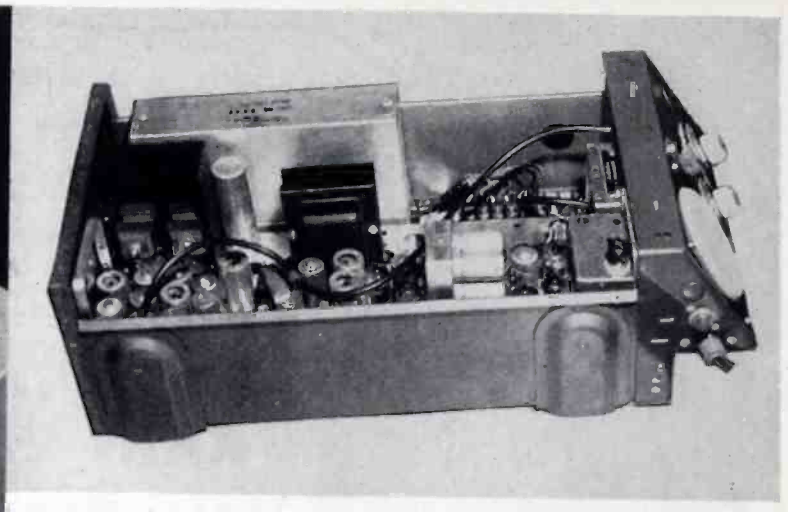


FIG. 6, LEFT: VIEW OF THE SELECTIVE CALLING FACILITIES AT THE UTICA STATION

FIG. 7, ABOVE: A RECEIVER WHICH IS USED TO TRIP FIRE-ALARM SIREN RELAY

over unit. The primary power for each repeater is supplied from a separate source. Since it is unlikely that two or more of these power sources would fail simultaneously, at least two repeater stations would normally be operating on primary power at all times.

Three-skirted coaxial antennas are mounted high on 85-ft. poles at each repeater station, Fig. 2. The receiving antenna is mounted at the top of the pole, and the transmitting antenna is mounted on the side with such spacing that no signal interaction results.

Figs. 4 and 5 show the base station transmitter-receiver, located only a few feet from the dispatcher's desk and remote control console. A gasoline-driven standby power supply has been provided.

System Frequencies:

Two receivers and a 60-watt transmitter are employed at repeater stations. Receiver A operates on 161.79 mc. to receive the Utica control station signal. Receiver B operates on 161.25 mc. to receive the signals from mobile units. The repeater transmitter operates on 154.37 mc. for transmitting to the Utica station and to all mobile units.

Each mobile transmitter operates on 161.25 mc. and is picked up by repeater receiver B for retransmission on 154.37 mc. The mobile receiver operates on 154.37 mc. to receive signals from the repeater transmitter or directly from Utica.

Utica base station receiver A operates on 154.37 mc. to pick up repeater broadcasts, while receiver B operates on 161.25 mc. for direct communication with mobile units. Control station transmitter A operates on 161.79 mc., which is received on receiver A at each repeater, for rebroadcasting on 154.37 mc. Control station transmitter B operates on 154.27 mc. for direct communication with nearby mobile units.

While three repeater stations are used simultaneously under some conditions, two repeaters can be deactivated by the dispatcher, leaving one remaining repeater to operate alone. For instance, if a Camden fire truck is nearest the Glenmore repeater station and has a radio message, the Utica dispatcher can deactivate the Paris Hill and Starr Hill repeaters by using the Motorola Quik-Call

(Continued on page 24)

FIG. 8. FIRE CHIEF ANDREW JONES USING 2-WAY MOBILE RADIO EQUIPMENT WHICH IS MOUNTED ON RUNNING BOARD UNDER LADDER, FIG. 9

MOBILE RADIO NEWS

(Continued from page 18)

basis. Resolution of the choice is founded in the economics of the individual situations, and American communications are unquestionably cheaper and better for the existence of the choice.

The same option for recognized classes of radio users now firmly and soundly characterizes the operational radio communication world beyond re-making, howsoever desirable the common carrier approach might appear as a question of original impress. And this is fortunate indeed for the volume users of radio, like the large taxicab fleets, for example, who couldn't begin to afford the common carrier solution to their radio needs, and whose frequency utilization matches or exceeds that of any common carrier.

Revised Application Forms:

The long-awaited revision of application forms in the public safety, industrial, and land transportation radio services has been put forward for comment by the Commission in a notice of proposed Rule Making with respect to which comments are due by November 3. The new forms, 400 and 400-A, when finalized, will eliminate a host of older and more complicated forms: 401, 401-B, 403, 405, 701, 702, and 726. The upper half of

(Concluded on page 34)

UHF ATTENUATOR

(Continued from page 17)

field. However, these harmonics could be eliminated readily by providing a DC bias about which the AC field would oscillate. The use of the NBS magnetic attenuator in this manner would permit amplitude modulation of UHF oscillators without the concomitant frequency modulation which occurs when the oscillator is modulated directly.

The magnetic attenuator is adaptable also as an output stabilizer for microwave oscillators. In this connection, the unit could be used with a degenerative feedback circuit in which the magnitude of the field produced by the electromagnet would be controlled by a small amount of RF power taken from the transmission line. Another magnetic unit could also be utilized in such a feedback network. The rectified control voltage coupled from the transmission line could be applied to a magnetic amplifier, which would control the electromagnet field directly.

Investigations are being directed now toward finding better and more efficient dissipative materials. Among the latest materials under study are magnetic ferrites, which yield greater attenuation changes for a given electromagnetic current than does polyiron. These ferrites should, therefore, make it possible to produce the same changes in attenuation with smaller currents.

TV FOR ARMY USE

(Continued from page 14)

These have video and sweep circuits only, and are fed video from a master distribution box. They can be used as far away from the vehicle as 500 ft.

Six hand-carried 2-way radio units are available for directing the engineers when they are setting up the equipment.

Audio and video amplifying and switching facilities for program integration and distribution are planned to meet virtually any requirements of field operation.

Receiver Power Supply:

Unit 4 is identical to unit 2 except that it contains only one gasoline-driven generator. Cables for the display screens are carried in this vehicle.

At present, the mobile TV system is at Fort Monmouth, New Jersey, where operating crews are being trained. After the training period, the system will be under the supervision of the Army Pictorial Service and will be based at the Signal Corps Photographic Center in Astoria, Long Island.

FIRE NETWORK

(Continued from page 22)

selective equipment provided for this purpose.

This provision for deactivating two repeaters is necessary because of the interference caused at some points by the simultaneous operation of three transmitters on the same frequency. Even though they carry the same intelligence, there are differences in phase which occasionally cause severe distortion. The difficulty is eliminated, of course, by using only one repeater at a time.

Other benefits are obtained with the repeater selective calling equipment. Since it is possible to operate only one repeater station at a time, they can be checked individually at Utica for normal operation. By sending to a local mobile unit and receiving transmissions from it through a repeater, the operation of the repeater transmitter and both repeater receivers can be checked. If a receiver is out, the trouble can be further isolated to either the audio or RF-IF sections by noting the presence or absence of the repeater carrier.

Selective Calling:

Two selective calling systems are used in the radio network, one for the repeater control and another for blowing sirens at specific stations which have receivers for this purpose.

Three 2-position non-holding switches on the panel of the remote control console in the Utica central office, upper left in Fig. 6, permit selective control of the repeater stations. Each switch corresponds to one repeater. When the dispatcher pushes one of the switches up, an electrical pulse containing two tones is superimposed on the transmitter carrier.

Although all three repeaters receive the pulse, only two are deactivated by the combination of tones being transmitted. The third repeater transmitter is unaffected, and continues operating.

By pushing the same control panel key down, thereby transmitting two different tones, the deactivated repeaters are returned to operation.

Beside the control console is a push-button box, at the right in Fig. 6, which controls the second selective calling system. By pressing four buttons on this box, two pulses, one of approximately .75 second and one of about .5 second, each containing two tones, are impressed on the transmitter carrier. Each fire station receiver provided with suitable equipment responds to only one specific combination of tones. When this tone combination is received, a relay is thrown to activate the station siren. One such

(Concluded on page 25)

FIRE NETWORK

(Continued from page 24)

receiver is shown in Fig. 7. By utilizing two pulses, each carrying two tones, false responses are eliminated.

System Operation:

Many fire departments in the system are volunteer units. When the siren is set off, all members of the department report immediately to man the fire apparatus. The first to arrive, Fig. 8, radios to Utica that his department is ready for service. The Utica dispatcher then broadcasts whatever information is available about the fire.

If a fire occurs in a community served by the Utica telephone exchange, the person reporting the fire is connected directly to the dispatching center. The dispatcher then activates the community fire alarm. Should the fire occur outside the Utica telephone exchange area, if the town has a remotely-operated siren, the local telephone operator dials a key number to the exchange in Utica to have the siren set off. If the town does not have a remotely-operated siren, the operator calls the local fire chief in the usual manner.

When the volunteer company reaches the fire, it reports to Utica by radio if assistance is required. Referring to a chart, the dispatcher sounds the sirens in towns near the scene of the fire.

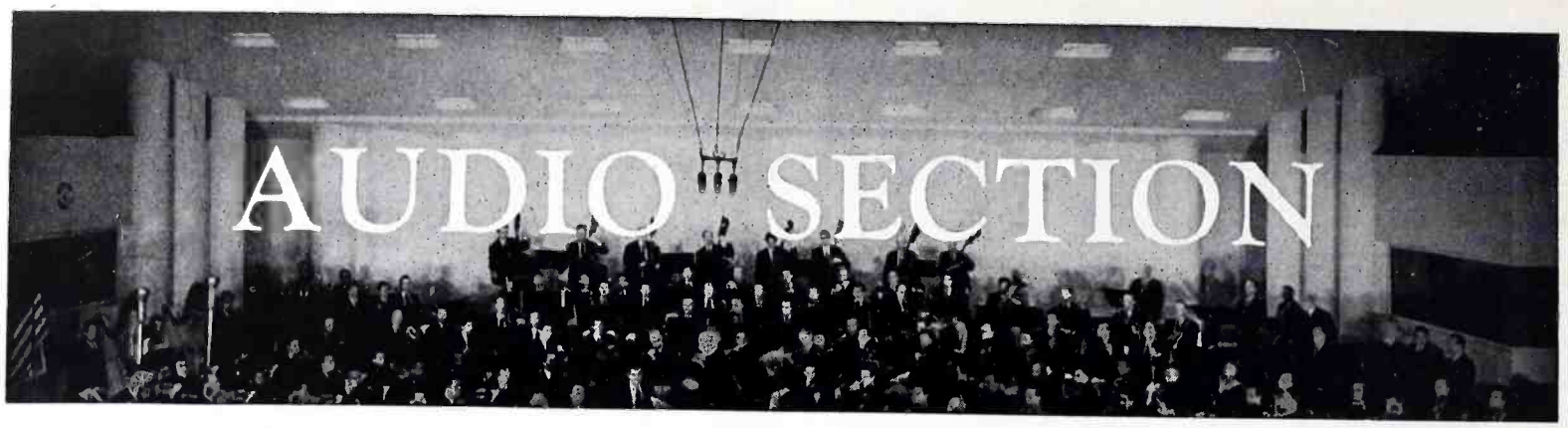
In the event that a mobile unit is transmitting when the Utica dispatcher requires the circuit for an emergency message, a precedence circuit permits the Utica station to take control of the repeaters. This is accomplished by a relay at the output of repeater receiver A, which disconnects receiver B from the transmitter when a signal is received from the Utica control station.

In the Oneida County Mutual Aid plan at present are 46 cooperating town and village fire departments, each of which has at least one 2-way radio installed on a piece of mobile fire-fighting equipment. Also included are three radio-equipped vehicles from other county departments, and five which belong to Aid Association members. A fire truck installation is shown in Fig. 9.

These 46 communities range in population from 500 to 5,000 persons. Average population for each fire district is about 2,000.

Conclusion:

The Oneida County radio system provides substantial benefits to each community served by it. It is the type of system that will be duplicated extensively for, already, it has justified its cost many times over in lives and property saved.



IMPROVING THE AIR-COUPLER

PART 1: PERFORMANCE TESTS ON ORIGINAL AIR-COUPLER — CONSTRUCTION AND RESPONSE CURVES OF THE DUPLEX AIR-COUPLER — *By* ROY F. ALLISON

NO actual performance specifications were presented when details of the original Air-Coupler System were published in RADIO COMMUNICATION Magazine last year.[1] The reason for this omission was not that the value of performance curves was not appreciated, but simply that neither the necessary measuring equipment nor sufficient time was then available to take speaker output measurements. However, the performance of the system was so impressive to the ear, and so obviously superior to anything else at comparable cost, that confirmation in the form of curves was not considered necessary. The rich, non-resonant bass from the Air-Coupler, which produced true *sound* and not merely speaker flutter down well below 30 cycles, encouraged us to give our readers the full details of the system immediately, without benefit of proof in the form of sound-pressure curves.

Hundreds of Air-Couplers have been built since that information was published. Almost without exception, their owners have been highly enthusiastic about the results they have obtained. The only letters we have received which expressed disappointment in the performance of the Air-Coupler have been from those who did not follow the directions given for its construction. Thus, it would appear that our assumption was justified.

On the other hand, there have been many requests for performance curves. In order to satisfy the curiosity of our own Fowler-Allison-Sleeper group, as well as to provide others with the information they wanted, we undertook to find out if the Air-Coupler would perform as well on graph paper as it does in a living room. In this project and in subsequent development work we were assisted ably

[1]October, November, and December 1950. Copies of the December issues are still available at 25 cents each. Reprints of October and November Air-Coupler articles are 10 cents each.

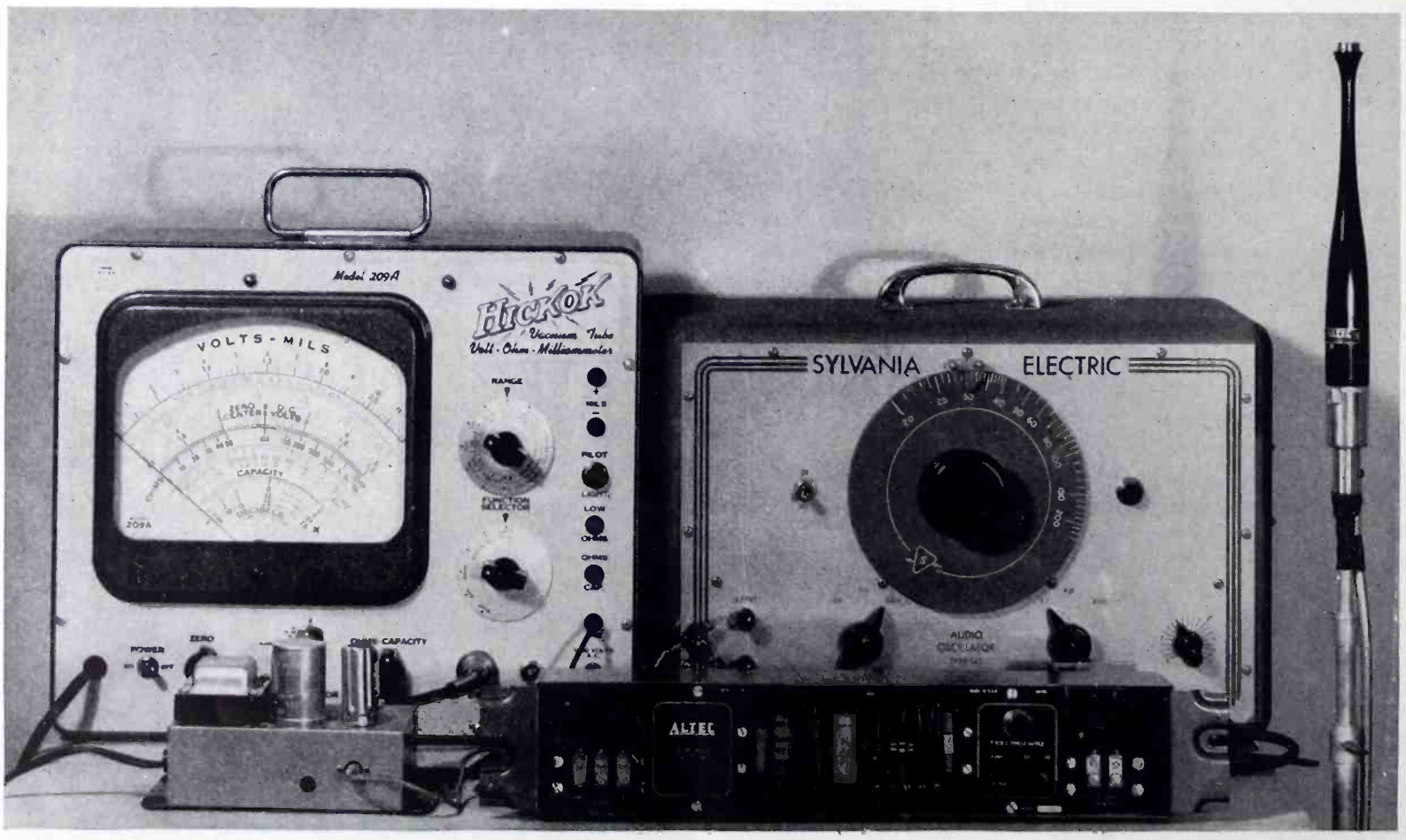


FIG. 1. TEST EQUIPMENT USED FOR TAKING MEASUREMENTS OF AIR-COUPLER RESPONSE. THE METER WAS READ IN VOLTS FOR GREATER ACCURACY

by Alan Macy, business manager of RADIO COMMUNICATION and HIGH-FIDELITY Magazines.

Test Equipment:

It is obvious that equipment for testing the Air-Coupler must be reasonably flat down to 20 cycles. After careful consideration of all factors involved — cost, frequency response, and dependability — the units shown in Fig. 1 were chosen. Of course, there are other instruments which would have been capable of doing the job.

A Sylvania AF oscillator was used to drive a Williamson amplifier, which was connected to the Air-Coupler speaker. The sound output was picked up by an Altec 21B microphone, which fed a Pickering preamplifier modified to give flat response and somewhat less gain. A McIntosh 50W-2 amplifier was coupled to the preamplifier. We put a resistive load across the amplifier output, and took readings across this load with a Hickok VTVM ohmmeter-milliameter.

Before beginning the actual tests, we checked the response of all the equipment with the exception of the microphone. This was done simply by feeding the stepped-down output of the Williamson amplifier directly into the preamplifier, thus bypassing the speaker and microphone. Readings taken on a frequency run provided correction factors which were applied later to speaker measurements. The microphone is rated as flat down to 7 cycles when used without impedance-matching transformers, and these were not required.

It is realized that results in a living room will not be identical to those obtained from the same speaker enclosure in a free field. It has been argued that since an enclosure will be actually used in a living room, not in a free field, tests should be made under normal operating conditions. The obvious flaw in this reasoning is that rooms are not all of the same dimensions. An enclosure adjusted for optimum results in a free field would be likely to sound better in any given room than it would if it were adjusted for best results in another room of different size.

Tests were made out of doors, except where noted, in order to approximate a free field as nearly as possible. Unfortunately, these were far from ideal conditions. Noise from a road nearby caused interference, since we were obliged to interrupt the tests for every passing automobile. The noise of a large truck would send the meter needle off scale. On days that were even slightly windy, we had to work in a garage, leaving the large doors open when possible in order to minimize standing waves.

Under conditions such as those described, results cannot be the same as would be obtained in a true free-field room. In addition to errors caused by ambient noise, tests in the garage were complicated by cancellation effects. Some dips and peaks in the response curves were obviously false; on occasion, the sound level at the observer continued undiminished while the meter readings dipped sharply.

The frequencies at which these false readings were obtained shifted when the microphone was relocated, as did the relative amplitudes of the errors. Prejudiced readings would be quite possible under these conditions. We recognized

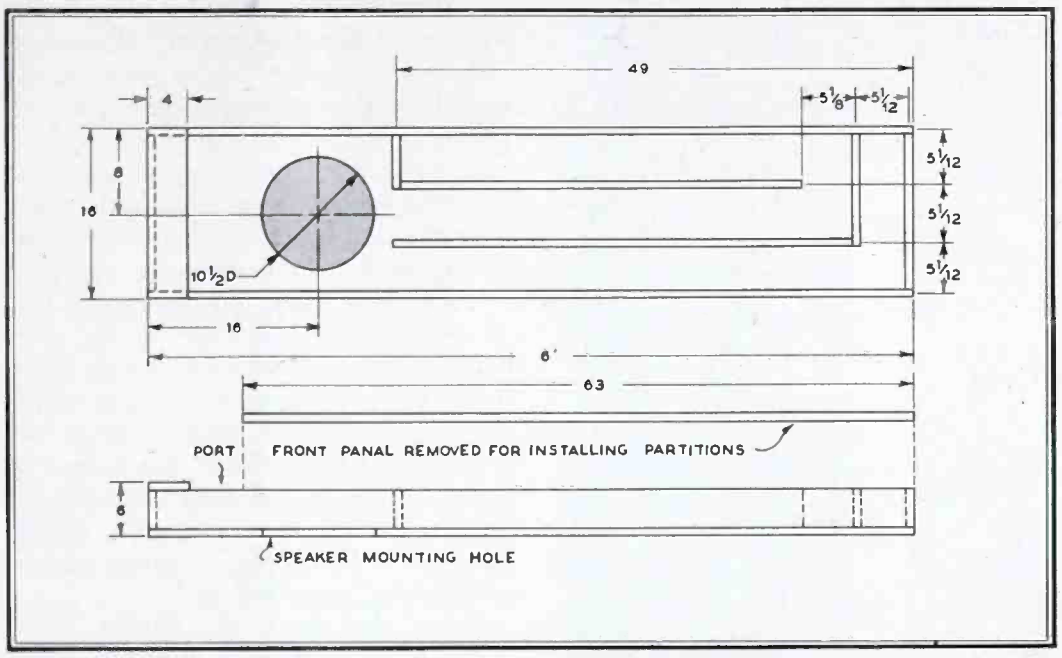


FIG. 4. HERE ARE ALL THE DIMENSIONS REQUIRED FOR CONSTRUCTION OF THE NEW AIR-COUPLER

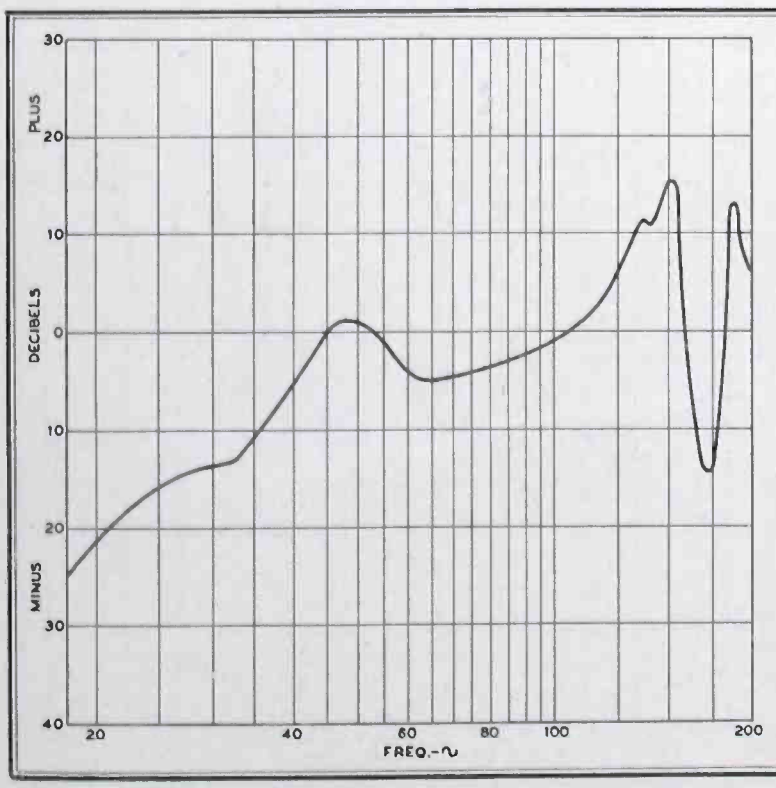


FIG. 2. MEASURED RESPONSE CURVE OF THE ORIGINAL AIR-COUPLER

FIG. 3. PERFORMANCE OF THE SPEAKER WHEN MOUNTED IN A PLAIN BAFFLE

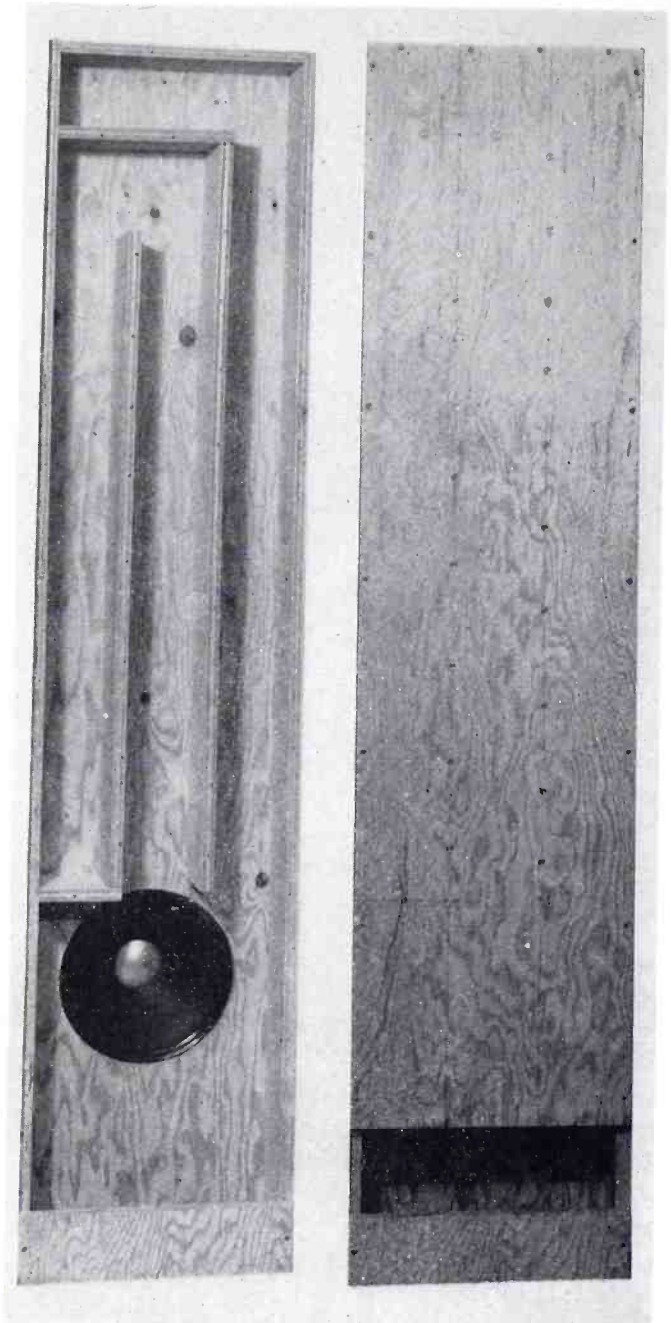


FIG. 6. DUPLEX AIR-COUPLER CONSTRUCTION

this pitfall, and made every effort to avoid it. Thus, while it was patently impossible to make tests of laboratory quality, the curves presented here are believed to be reasonably representative of the true performances of the speaker enclosures tested.

Test Results:

Fig. 2 shows the response of the original Air-Coupler from 18 to 200 cycles. Fig. 3 is a curve for the same 12-in. speaker mounted in a plain baffle for comparison. The dip in the Air-Coupler response at 170 cycles appeared to be genuine, although in most positions of the microphone it was not so pronounced.

The rise at 48 cycles may explain why conventional bass boost circuits, designed for maximum boost in the vicinity of 50 cycles, produce no apparent improvement in Air-Coupler performance. The output is boosted acoustically by resonance of the 6-ft. enclosure. Any additional electrical boost makes the sound output turn muddy, and increases the unbalance in the 50-cycle region. Specifically, the usual bass-boost circuit produces a droop over the whole range from 60 to 120 cycles — a full octave, and a most important one.

Below that peak, the output drops about 14 db and levels off at 33 cycles. It decreases slowly from that point down. This flatter part of the response curve has no apparent cause in theory. Yet it is, without doubt, the key to the relatively superlative performance of the Air-Coupler. Admittedly, the response is down considerably from 20 to 30 cycles, but it is usable response. In contrast, the output of an ordinary bass enclosure drops sharply below a certain cut-off frequency.

Improving the Coupler:

There are frequent exceptions to the rule that speakers with good response curves must sound good. On the other hand, it is almost always true that, with a given speaker, the enclosure which provides the best response curve sounds the best. Criteria for the excellence of such curves include freedom from large peaks and dips, as well as extended frequency range. It seemed logical, therefore, to assume that if the 48-cycle peak and the 170-cycle dip in the Air-Coupler response curve could be eliminated or damped considerably, it would sound even better.

Accordingly, we undertook to build reflex cabinets of various shapes and dimensions around the Coupler. While we were able to increase the total efficiency, the curve was not much improved. It was finally decided that any marked improvements could be obtained only from changes in the Air-Coupler itself.

Also, we concluded that the use of two or more Air-Couplers of various lengths would result in a smoother overall curve. This idea was rejected, however, for reasons of the complication, size, and expense of multiple units. That led us to the more practical concept of two air columns of different lengths driven by the same speaker. Such a duplex design turned out to be quite practical indeed, as is shown in Fig. 4, since it could be accomplished by a simple modification on the original Air-Coupler. Thus, the old model can be converted easily.

To make a Duplex Air-Coupler, we removed the front panel, Fig. 4. Then, we installed partitions in the main body of the coupler to make two folded columns. Column A is slightly less than 7 ft. long, while Column B is just over 9 ft. in total length.

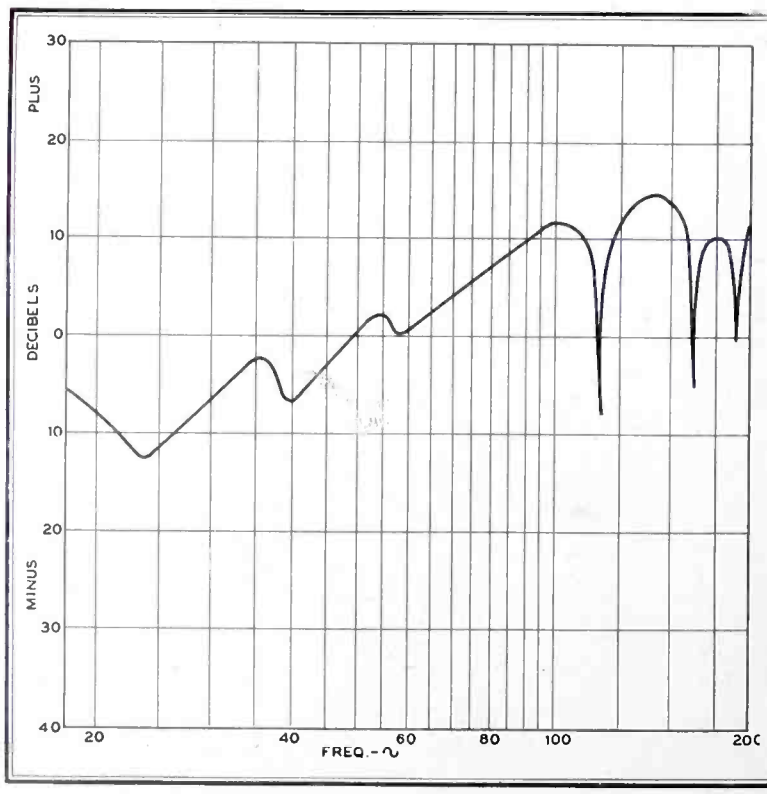


FIG. 5. FREE-FIELD RESPONSE OF THE DUPLEX AIR-COUPLER

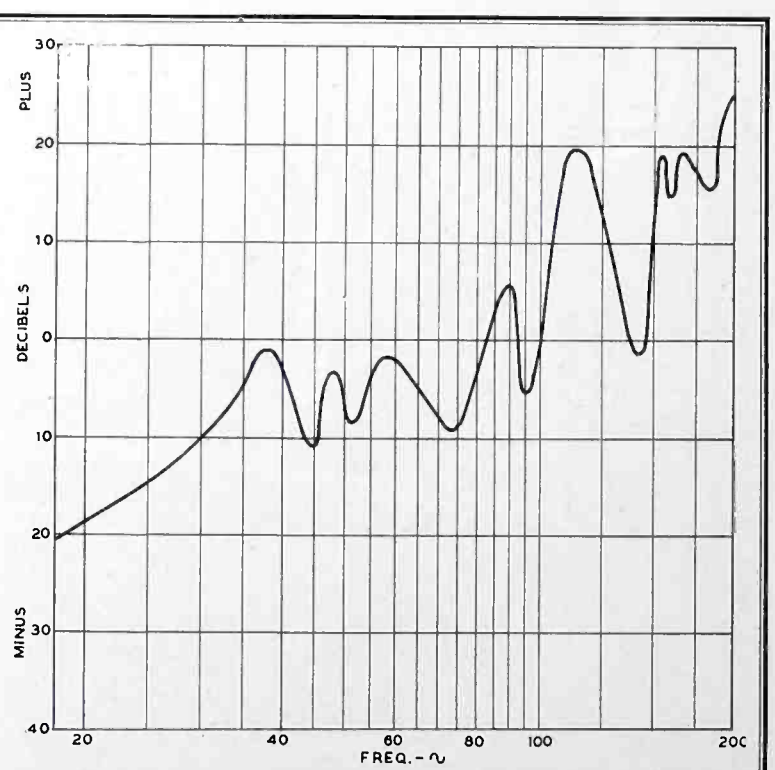


FIG. 7. CURVE OBTAINED WITH COUPLER IN FRONT OF PLAIN CORNER REFLECTOR

Duplex Performance:

Fig. 5 is the response curve of the Duplex Air-Coupler. The improvement over the original coupler is obvious, since the peaks and dips were eliminated, and the relative level below 50 cycles was raised. The sharp dips in the curve at 120, 163, and 190 cycles were false. Their frequencies and amplitudes depended on microphone placement. With a curve such as this, a relatively simple correction network can be employed in the amplifier to provide almost perfectly flat response down to 16 cycles! Flatness to 16 cycles, from such a small enclosure and a 12-in. speaker, is hardly credible — but we not only heard it but checked it with our test equipment.

The dip in the curve at 23 cycles was a subject of considerable discussion. It was argued on the one hand that Column B should be shortened in an attempt to increase the output at 23 cycles, since at present there are almost no program sources to provide anything at 20 cycles or below. However, the limit of human hearing extends to 16 cycles, and there are everyday sounds as well as musical notes which have fundamental frequencies that low. As loudspeaker systems improve, program sources of wider range will become more generally available, also. Therefore, it was decided to retain the longer column, so that the owner of a Duplex Air-Coupler would be certain that his loudspeaker system could reproduce any signal of audible frequency that will be available in the future.

Construction:

As has been stated, the outside dimensions of the Duplex Air-Coupler are the same as those of the original model. Therefore, those who have built Air-Couplers already can make the changes very simply. Complete dimensions are given in Fig. 4, so that those who have not yet made Air-Couplers will have all the information required to do so.

The model we experimented with was constructed of ¾-in. plywood. Others may have used different wood thicknesses; therefore, partition dimensions are given center-to-center. The width of the partition boards must be exactly that of the Air-Coupler side pieces, so that a complete front-to-back seal is made when the Coupler is assembled. That is, the partitions must be screwed firmly to both front and back pieces.

We found a fairly simple way to install the partitions. Possibly it was not the easiest method, but it resulted in perfect screw alignment so that the partition boards were not split by screws inserted too close to the edges. First, we laid out center lines for the boards on the inside of the back panel. Then, placing the outside of the front panel against the outside of the back panel in the correct relative position, we drilled screw holes all the way through both panels at intervals along the center lines. The boards were cut to proper lengths, and right-angle butt joints were made. With the two right-angle assemblies held on the center lines, they were screwed to the back panel. This stage of construction is shown in Fig. 6. Finally, the front panel was screwed on, with the screw holes matching the partition-board edges perfectly. The Duplex Air-Coupler was then outwardly identical to the previous model, as indicated in Fig. 6 at the right.

In order to obtain some idea of the performance of the new Air-Coupler under typical listening conditions, we set it up in front of a simple corner reflector and measured the resultant response. The data is plotted in Fig. 7. It can be seen that front-to-back cancellations produced quite serious detriment to the overall response. On the basis of this

(Continued on page 38)

DESIGN DATA for AF AMPLIFIERS — No. 14 Inverse Feedback

PART 2 — TYPICAL CIRCUITS — HOW TO CALCULATE GAIN REQUIREMENTS AND COMPONENT VALUES FOR DESIRED AMOUNTS OF FEEDBACK

DESIGN Data Sheet No. 13 discussed the operation of inverse feedback in reducing distortion and improving speaker damping. It is proposed in this Sheet to describe typical circuits and design criteria.

The circuit given in Fig. 1 is by far the one most often employed and is satisfactory in all usual cases. The feedback is taken from the secondary of the output transformer and is applied to the cathode of the main amplifier input stage.

In some instances, the feedback is taken from the output transformer primary and is applied around the output stage only. The latter method is easier to design, but has two disadvantages. First and most important, the output transformer is not included in the loop. Since even the best transformers generate appreciable distortion, the total distortion of the amplifier cannot be reduced below this level. Second, two feedback circuits are required for a push-pull stage. These must be matched perfectly or distortion will be increased more than it is reduced. Thus, the circuit of Fig. 1 gives better results, is non-critical as to components, and is quite simple.

It was shown that negative feedback reduces gain. The amount of gain reduction is given by the following equation:

$$A' = \frac{A}{1+AB} \quad \text{(FORMULA 1)}$$

where A' is gain with feedback, A is original gain, and B is the percentage of the output voltage fed back. The sign of B is negative for negative feedback.

Distortion is reduced in the same way, as follows:

$$D' = \frac{D}{1+AB} \quad \text{(FORMULA 2)}$$

where D' and D are distortion respectively with and without negative feedback.

As the gain of the amplifier increases, the percentage of output voltage fed back for a given gain reduction decreases. The method of calculating feedback circuit constants and gain requirements for a given amount of feedback is as follows:

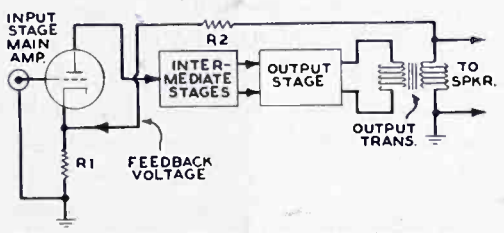


FIG. 1. APPROVED CIRCUIT FOR FEEDBACK

First, decide on the amount of feedback. Suppose that a pair of 6L6's is to be used in the output stage. The total distortion for push-pull 6L6's is given as 2%. If it is desired to reduce this to .2%, then 20 db of feedback or a voltage gain reduction of 10 times is required. This is ample for speaker damping purposes, since it has been demonstrated that feedback in excess of about 10 db gives little extra damping effect. Also, .2% distortion can be considered negligible. The average listener cannot detect .5%.

Second, calculate the voltage gain required. Normally, an amplifier should be driven to full power output by a 1-volt input. This must hold after feedback is applied. Therefore, since the voltage gain will be reduced with feedback by a factor of 10, the amplifier without feedback must be designed for full output with an input of .1 volt.

Operated Class A, push-pull 6L6's are rated at 18.5 watts maximum power output. Voltage across a speaker voice-coil for this power varies with the speaker impedance, of course. Assume for this example that an 8-ohm speaker is to be used. Then, for an input of .1 volt without feedback, 12.17 volts must appear at the output transformer secondary. This represents a voltage gain of 121.7 without feedback, and 12.17 with feedback, from the input grid to the voice-coil.

Third, find the value of B required. This can be done by substitution in formula 1 above, since A and A' are now known. B is found to be —.074.

Fourth, compute the value of R1 and R2 which will provide this amount of feedback. R1 is the cathode bias resistor for the first stage, and is chosen accordingly. Assume that R1 should be 470 ohms. Then R2 can be determined by a simple proportion, since R1 should be .074 times the total value of R1 and R2. By this means, R2 is found to be 5,890 ohms.

The maximum amount of negative feedback that can be used without encountering oscillation is limited by the phase shift of the amplifier. Phase shift is caused at low frequencies primarily by RC coupling circuits, and at high frequencies by stray and interelectrode capacities. The output transformer, also, accounts for some. Below a certain low frequency and above a certain high frequency, the phase of the feedback voltage is reversed and reinforces rather than reduces the input signal.

In order to prevent oscillation, the feedback must be reduced at those frequencies. The solution, then, is this: at the extremes of the frequency range, the gain of the amplifier must decrease faster than the phase shift increases — a difficult accomplishment, since these factors are mutually dependent. However, it can be facilitated in four ways, as follows:

1. Limiting the number of RC coupling circuits. Normally, feedback in the order of 20 db can be used around only 3 stages and the output transformer, or a maximum of 4 stages and the transformer if direct coupling is employed between 2 stages.
2. Designing individual stages for different high- and low-frequency cutoffs, so that frequency response curve for the amplifier as a whole has gentle rather than sharp slopes at the ends. When pentodes are used as voltage amplifiers, it helps to choose screen and cathode bypass capacitors for different low-frequency cutoff points.
3. Employing a very good output transformer.
4. Providing extensive power-supply decoupling and filtering.

This discussion has been concerned with voltage-proportional negative feedback. Current-proportional negative feedback provides the same benefits as regards the reduction of distortion, but it increases rather than decreases effective output impedance and, therefore, decreases speaker damping. Unbypassed cathode resistors provide negative current feedback in the stages where they are used. They can be employed with beneficial results in voltage-amplifier stages if the loss in gain can be tolerated, since damping in these stages is not important.

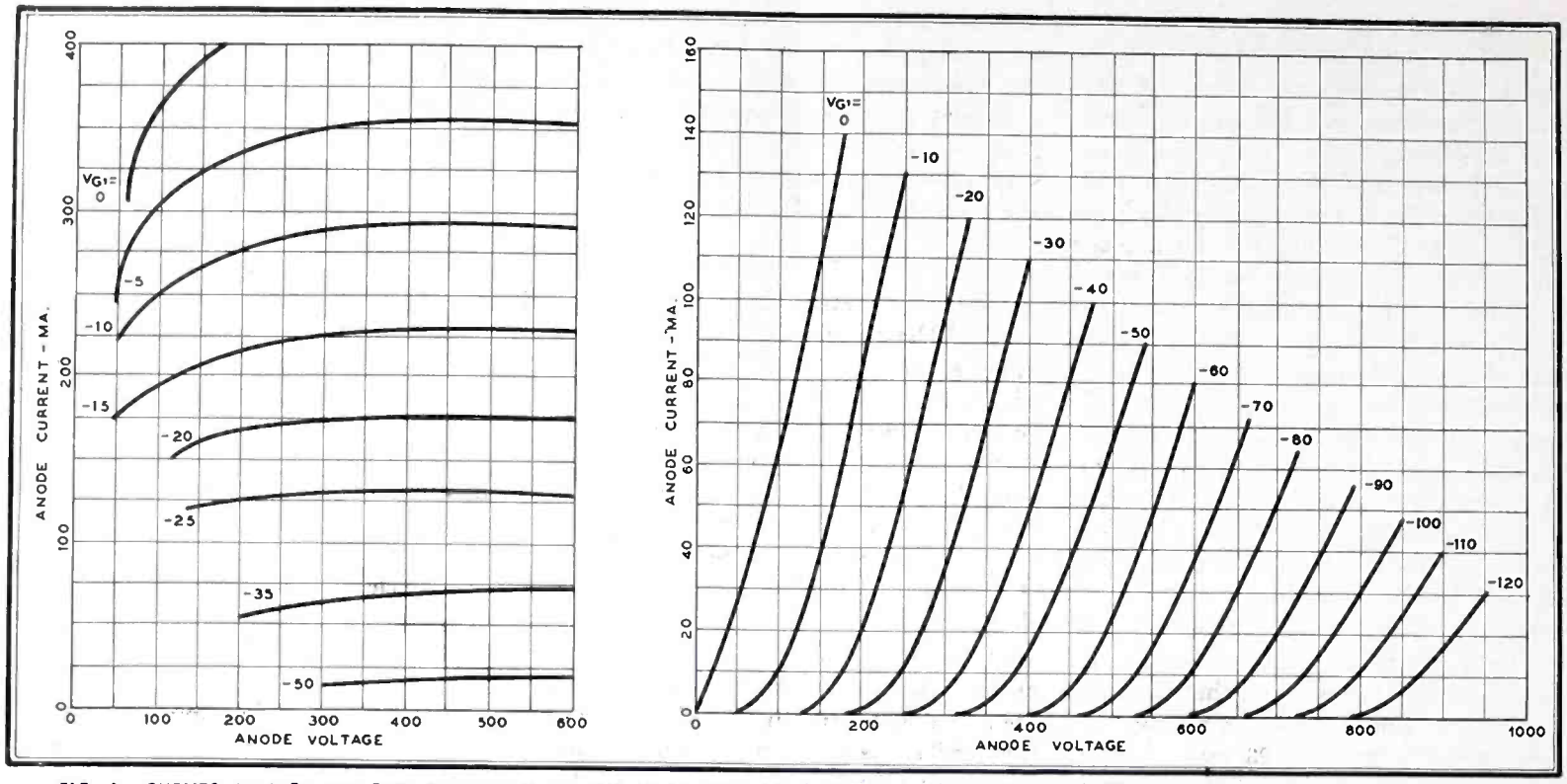


FIG. 1. CURVES AT LEFT ARE FOR OPERATION OF THE KT-66 TUBE AS A TETRODE. THOSE AT THE RIGHT ARE FOR THE TRIODE CONNECTION

REVIEW OF BRITISH AMPLIFIERS

PART 1—GENERAL CONSTRUCTIONAL AND DESIGN PRACTICES IN THE BETTER AMPLIFIERS. DISCUSSION OF THE ACOUSTICAL AMPLIFIER — *By* JAMES MOIR*

THERE are several British audio amplifiers which can truthfully be described as having an international reputation for above-average performance. Some of these designs, such as the Williamson, originally appeared as home constructors' models in the pages of the *Wireless World*, and have become available subsequently as completely assembled units. Others, such as the Acoustical and Leak amplifiers, are the manufacturers' own designs. It is thought that detailed descriptions of some of them will serve to acquaint readers of RADIO COMMUNICATION Magazine with the best British design practices.

General Design Trends:

It is interesting to compare the general trend in our design work with that of your own, so we will commence with a review of the factors that are common to most of the British amplifiers. Constructionally, the two-unit equipment, consisting of a preamplifier with tone control stages, and a separate main amplifier and power pack chassis, is finding increased favor. It has the distinct merit of permitting the main amplifier to be mounted down near the floor in a console cabinet, giving a favorable weight distribution, and of removing the power transformer and smoothing choke to a safe distance from magnetic phono pick-ups and other sensitive points in the input circuits. Operationally, it brings the gain and tone controls to a more convenient location in the cabinet, or even permits them to be mounted adjacent to the operator's arm-chair, a significant advantage not only from the convenience viewpoint but in permitting the operator to adjust the performance from his normal listening position, well away from loudspeaker.

The finish and standards of workmanship are typically British. The wiring on the Acoustical and Leak units, for example, is a delight to the engineer's eye.

Electrical performance is approaching a standard set of specifications which might be tabulated as follows:

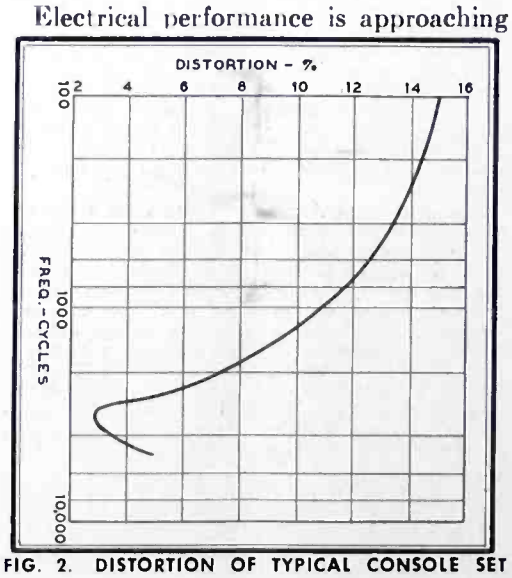


FIG. 2. DISTORTION OF TYPICAL CONSOLE SET

TABLE 1

Power output: 12 to 15 watts
RMS distortions at rated power: .1%
Frequency range: 20 to 20,000 cycles for 1 db down
Signal-to-noise ratio: 70 db
Input to main amplifier for rated power: 1 volt
Input to preamplifier for rated power: .01 volt
Input impedance: 100,000 ohms
Output impedances: 2 to 15 ohms
Damping factor: Greater than 20

For average domestic conditions, 15 watts is adequate power output. Practically all manufacturers obtain this output with a pair of push-pull GEC KT66's in the final stage. This valve, which is intermediate between the 807 and the 6L6 in power output, is a tetrode with aligned grids, having the reliability that results from manufacture over a long period, coupled with a low price (about $5.25 in the USA). In addition, it is widely available.

TABLE 2

	807	6L6	KT66
Heater volts	6.3	6.3	6.3
Heater current, amps.	.9	.9	1.27
Plate voltage, max.	600	360	525
Plate dissipation, watts	25	19	25
Screen voltage, max.	300	270	400
Screen dissipation, watts	3.5	2.5	3.5
Transconductance	6,000	5,500	6,300

TYPICAL OPERATING CONDITIONS, 2 KT66's PUSH-PULL

	TRIODES	TETRODES
Plate volts	400	480
Plate current, Mils	124	175
Screen volts	....	385
Screen current, Mils	....	21
Optimum load, ohms	10K	6K
Power output, watts	13	50
Distortion	2%	5%

*87 Catesby Road, Rugby, England.

Table 2 shows the main characteristics of the KT66 beside those of the 807 and 6L6, for easy comparison. The manufacturer's characteristics are shown in Fig. 1. Operated at maximum rating as a tetrode, a pair will deliver 50 watts for a rated distortion of 5%, but the lower dissipation required for a 15-watt output undoubtedly leads to increased life.

There is no uniformity among amplifier manufacturers in the method of operating the output stage. Some operate the KT66's as tetrodes, and others as triodes with screen and anode strapped through resistors, while Acoustical operates them with the load split between anode and cathode circuits in a manner similar to the McIntosh and Gow circuits. Negative feedback is included in all designs, adequate to bring the total distortion at rated power into the .1% region and to reduce the output impedance to .1 or less of the rated load impedances. This makes the damping factor (load impedance/output impedance) greater than 10. High damping factors are generally claimed to provide good speaker damping for transients, but it has been demonstrated[1] recently that little or nothing is gained by damping factors greater than 5.

Total distortion below .2% is probably completely undetectable, even on a direct comparison with the original sound, but there is distinct merit in minimizing the amplifier distortion and permitting the loudspeaker engineer a little more freedom in his more difficult design task. While frequencies of 400 and 1,000 cycles are standard for audio distortion measurements, no single measurement is adequate to express the performance of an amplifier. A cheap radio receiver with no pretensions to high fidelity may have a distortion factor of 2% between 400 and 1,000 cycles, but this figure may rise to 25% at 100 cycles and 2,000 cycles. The result of an actual check on a medium-price radio receiver is shown in Fig. 2. An advantage of distortion factors below .2% at mid-range is that there is ample margin for the inevitable rise in distortion at the extreme ends of the frequency range, where reactive loading of the tubes cannot be avoided.

Intermodulation measurements are currently popular as distortion indicators. However, it should be emphasized that except at the extreme ends of the frequency range there is a fixed relation between harmonic and intermodulation distortion, as they are merely alternative methods of expressing the same degree of non-linearity in the input-output voltage relation.

A signal-to-noise ratio of better than 70 db is adequate in almost any circumstance, as it is a performance that is not approached by any sources of signal excepting the best magnetic tape and a very good FM transmitter. Checks by Seacord and Hoth of Bell Telephone Laboratories[2] indicate that domestic noise levels average 42 phon, with a lower limit of about 32 phon. The writer has made a considerable number of checks of the domestic noise level in England and, rather surprisingly, finds that our domestic noise levels are just about the same value as your own. The noise level in the author's lounge averages about 40 phon early in the evening and falls to 28 phon on a quiet evening.

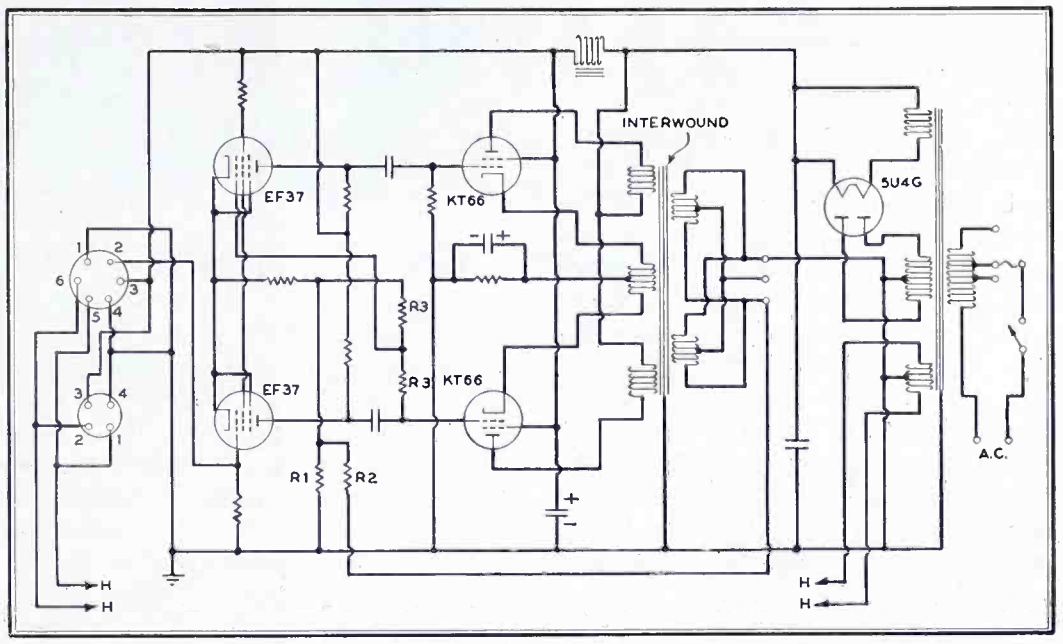
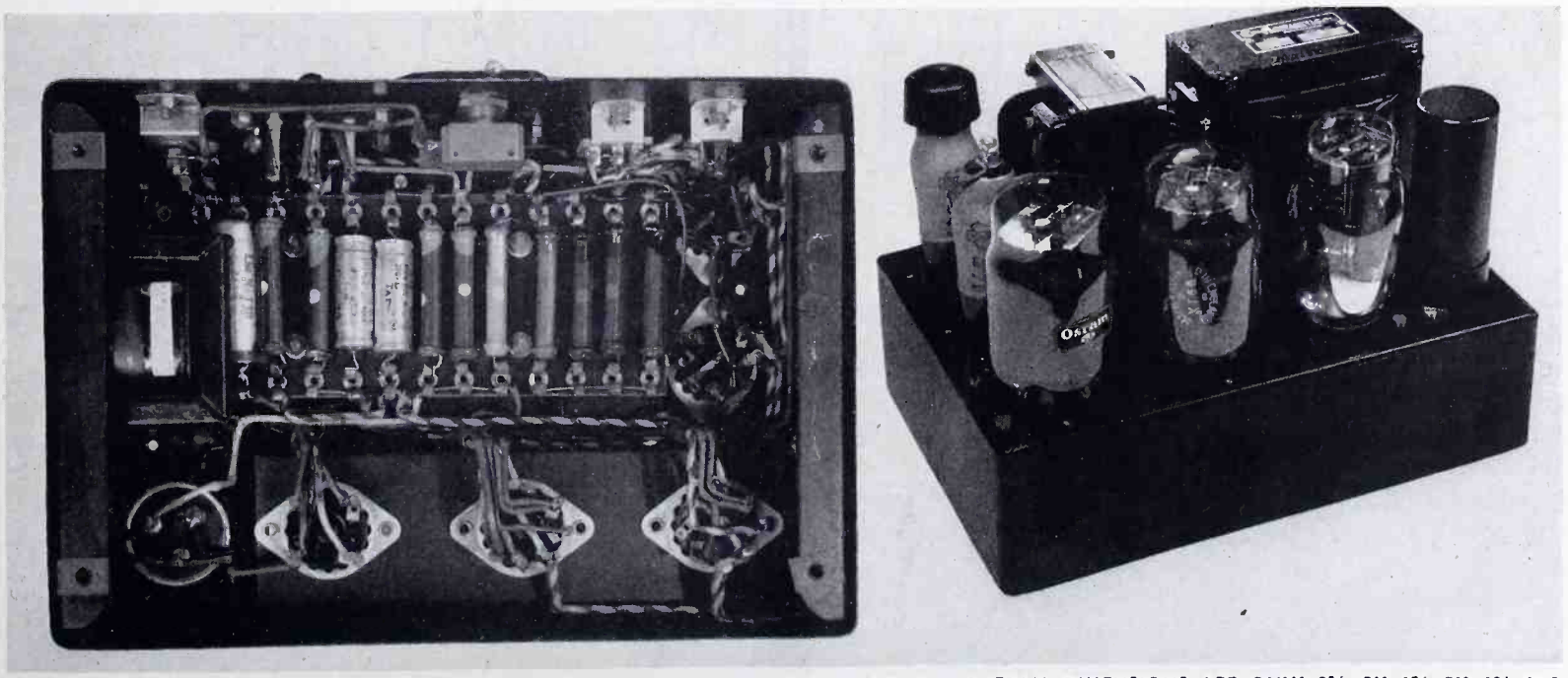


FIG. 3. THE ACOUSTICAL AMPLIFIER, WITH DIVIDED OUTPUT TRANSFORMER PRIMARY WINDING

[1]J. Moir, "Transients and Loudspeaker Damping," *Wireless World*, May, 1950.

[2]D. F. Seacord, "Room Noise at Subscribers' Telephone Locations," *J.A.S.A.*, July, 1940.

D. F. Hoth, "Room Noise Spectra at Subscribers Telephone Locations", *J.A.S.A.*, April, 1941.



FIGS. 6 AND 7. ACOUSTICAL AMPLIFIER AND POWER SUPPLY. NOTE THE CLEAN WIRING. OVERALL DIMENSIONS ARE ONLY 9½ BY 6¾ BY 6⅜ INS.

As peak noise levels greater than 90 phon are, fortunately, rather rare, any reproducer with a volume range greater than 60 to 70 db can be considered extremely satisfactory. The system noise will then be below the room noise under all conditions.

A frequency range of 20 cycles to 20 kc. is as wide as any present loudspeaker combination can justify. The high-fidelity enthusiast is perhaps more interested in the facilities provided to permit restriction of the frequency range. These vary from a simple variable RC combination to a network that makes both the frequency range and rate of cut-off continuously adjustable. A high rate of cut-off inevitably introduces transient hangovers, but there is no doubt that on older records it does give more improvement in the signal-to-noise ratio. Thus, the proper adjustment becomes a matter of compromise on which each listener has his own ideas. The finger-tip control at the listener's chair-side scores heavily in this respect over the older all-controls-on-the-amplifier technique.

The amplifiers to be described are being dealt with in alphabetical order.

Acoustical QUAD Amplifier:

The circuit diagram for this amplifier is given in Fig. 3. It will be seen that a pair of KT66 tetrodes is used in push-pull, but with the output transformer primary winding divided between the anode and cathode circuits of the output tubes to provide feedback. Additional feedback coupling is taken from the speaker winding through R1 and R2 into the cathode circuit of the input tube. Splitting the overall feedback into separate circuits in this manner permits a greater total amount of feedback before the stability limit is reached than does the simple single-loop circuit. Distortion, introduced by the iron circuit of the output transformer core, and phase-splitter unbalance are taken care of by the overall feedback loop. The phase-splitter is a standard arrangement, the out-of-phase tube deriving its input from a potentiometer network composed of R3 and R4 across the output of the in-phase tube. Mullard (Philips) EF37 tubes are used in the phase splitter, which rather paints the lily as these tubes are particularly good low-noise tubes intended for the early stages of an AF amplifier.

The main amplifier chassis is a compactly-engineered unit which also carries the 5U4G full-wave rectifier and the associated transformer and smoothing choke. It will be noted that the anode supply to the output tubes is derived from the rectifier side of the smoothing choke, a procedure that is advantageous in reducing volume compression effects due to the voltage drop in the smoothing choke as the anode current rises on sustained peak signals. This chassis is remarkably small, being 9½ by 6¾ ins. in plan and 6⅜ ins. high including tubes. All metal work is rust-proofed before painting, and all components are suitable for tropical operation.

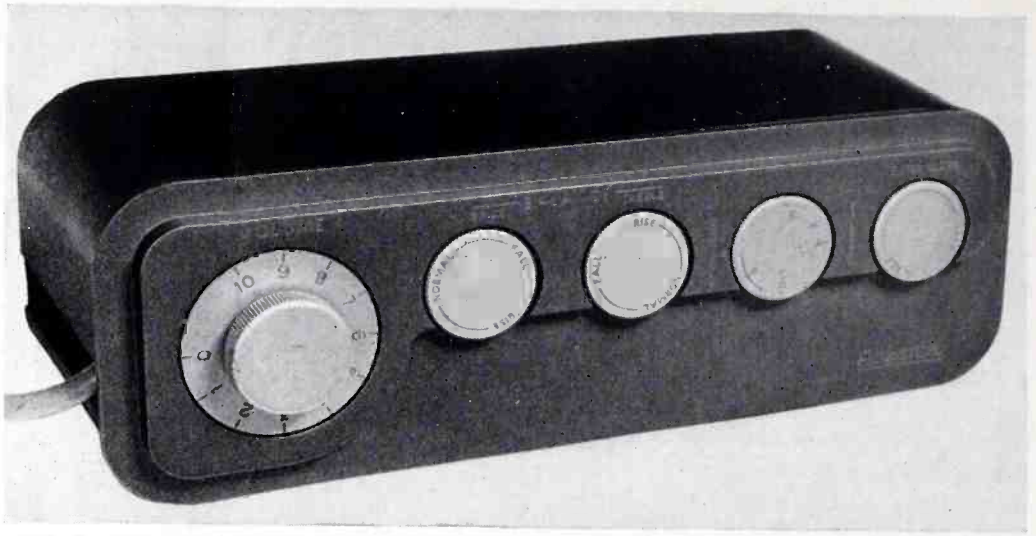


FIG. 5. THE ACOUSTICAL PREAMPLIFIER PROVIDES EXTREMELY FLEXIBLE CONTROL FACILITIES

Acoustical Preamplifier:

A power amplifier is not amenable to feature engineering, but the preamplifier-mixer unit does offer opportunity for ingenuity in design. This opportunity has been well taken in the Acoustical preamplifier. The circuit, shown in Fig. 4, consists of a Mullard ECC35 twin triode in a two-stage amplifier with feedback over the second stage through C1 and R1. The stage operates at such a low signal level that there is no significant distortion introduced. The gain-control potentiometer is introduced between these two stages, with the tone-balance control circuits between the output of the second stage and the main amplifier input.

Four tone controls provide adequate facilities for even the most rabid twiddler of knobs. Referring to Fig. 5, the fourth knob from the left is a switch which inserts the bass and treble con-

(Concluded on page 40)

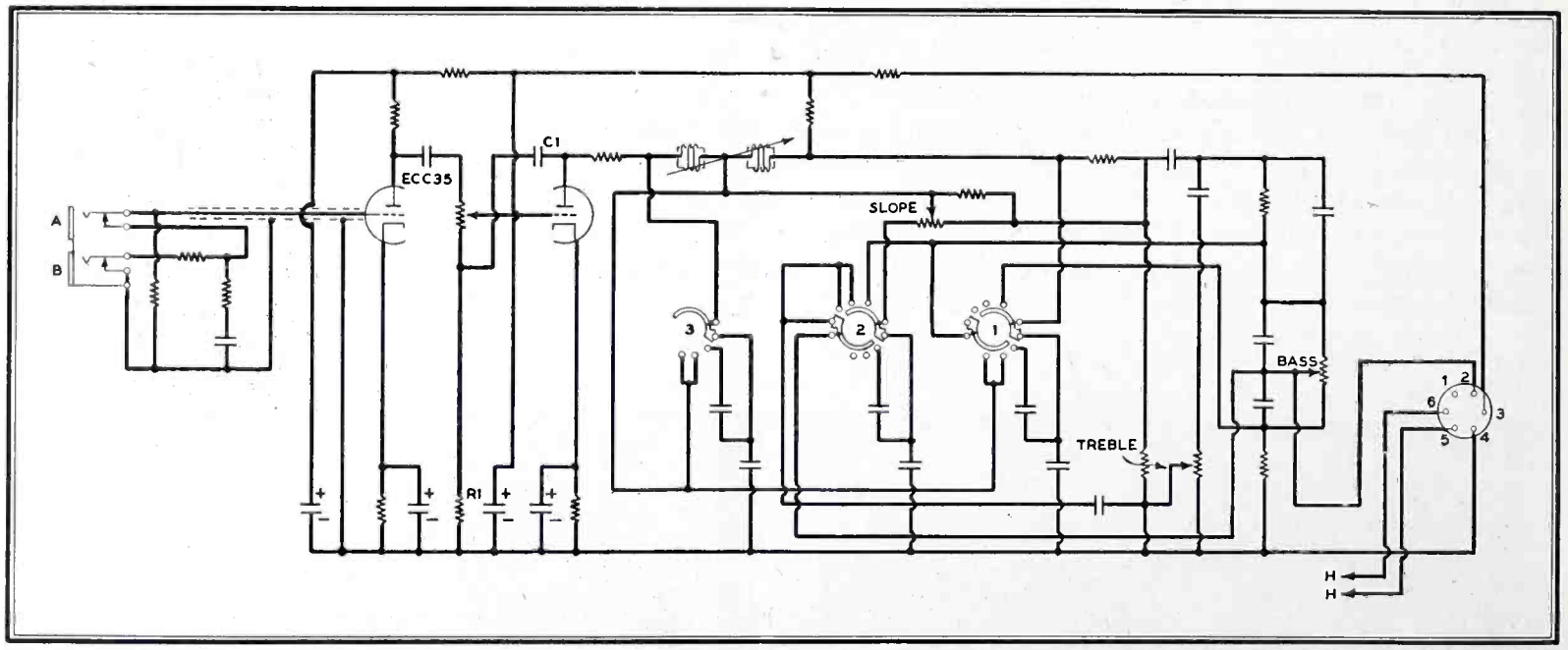


FIG. 4. PREAMPLIFIER DIAGRAM SUPPLIED BY ACOUSTICAL. IT IS STATED THAT POSITIVE FEEDBACK IS OBTAINED AROUND THE SECOND STAGE

MORE FOR YOUR MONEY

WITH BENDIX SCINFLEX ELECTRICAL CONNECTORS

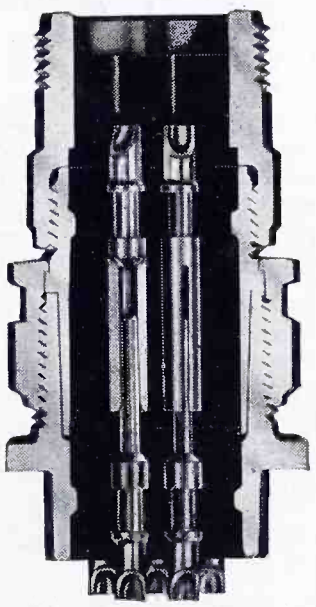
MOISTURE PROOF

PLUS

- Pressure Tight
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

The importance of a completely moisture-proof electrical connector can scarcely be exaggerated. But in addition to this important characteristic, there are a host of other exclusive features that make Bendix Scinflex connectors outstanding for dependable performance. For example, the use of Scinflex dielectric material, an exclusive Bendix development of outstanding stability, increases resistance to flash over and creepage. In temperature extremes, from —67°F. to +275°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. If you want more for your money in electrical connectors, be sure to specify Bendix Scinflex. Our sales department will be glad to furnish complete information on request.

PLUS



SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Low voltage drop.

SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

Bendix

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

FACTORY BRANCH OFFICES:
117 E. Providencia Ave., Burbank, Calif. • 23235 Woodward Ave., Ferndale, Mich. • 7829 W. Greenfield Ave., West Allis 14, Wis. • 582 Market Street, San Francisco 4, Calif.
Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N. Y.

MOBILE RADIO NEWS

(Continued from page 23)

the application will be authenticated and returned to the applicant as his license.

The new 400 form will be used for new stations, modifications, renewals, assignments, and covering licenses in the Services mentioned. The new 400-A form will eliminate the need for completing a complicated application form to secure a minor change in an existing authorization such as a change in the location of the control point of the base station.

Of interest to all manufacturers will be the provisions of the proposals dealing with the equipment to be licensed in those Services in the future, as follows:

"5. The Commission proposes to compile and maintain a list of transmitting equipment which is acceptable for licensing in the public safety, industrial, and land transportation radio services. As a temporary measure, the list will be comprised of that equipment which is now regarded as meeting the requirements of the Rules and as acceptable for licensing in these services. This list will not be available for distribution by the Commission to the general public. However, it will be available for inspection at the Commission's office in Washington, D. C., and at each field offices.

"6. In the near future the Commission proposes to begin the compilation of a list of transmitting equipment which has been tested in accordance with prescribed test procedures and found to be in compliance with the Rules. This list, when complete, will replace the temporary list and it is hoped that it can be put into effect by July 1, 1952. Detailed information concerning the test procedures and the steps to be taken by those persons who desire to have equipment included in the list will be released to the public in a subsequent Notice of Proposed Rule Making."

TAPE RECORDER SPECIFICATIONS

PRESENTED on this and the following pages are concise summaries of the physical characteristics and prices of commercial tape recorders. Additional information on specific models can be obtained from the manufacturers.

AMPEX ELECTRIC CORPORATION, Howard Ave., at Laurel, San Carlos, Cal.

Model 400 — Portable, dual-track, 15 and 7½ ips., weight 75 lbs. Price $925.

Model 300C — Console, single-track, multi-channel, 15 and 7½ ips., available as portable or rack-mounted unit. Price $1,860.

AMPLIFIER CORPORATION OF AMERICA, 396-398 Broadway, New York 13.

Model 810 — Portable, dual-track, dual-channel, weight 42 lbs. Model 810B, 7½ ips., $285. Model 810C, 15 ips., $345.

Model 815 — Console, single or dual-track, 15 and 7½ ips. Price $395.

Model 910B — Portable, dual-track with automatic reversal, dual-channel, 7½ ips., weight 55 lbs. Price $495.

AMPRO CORPORATION, 2835 N. Western Ave., Chicago 18, Illinois.

Model 731 — Portable, dual-track, 3¾ ips., weight 17 lbs. Price $119.75.

BELL SOUND SYSTEMS, 555 Marion Rd., Columbus 7, Ohio.

Model RT-65-B — Portable, dual-track, dual-channel, 7½, 3¾, and 1⅞ ips., weight 33 lbs. Price $186.45.

BERLANT ASSOCIATES, 4917 W. Jefferson Blvd., Los Angeles 6, Cal.

Model 1401 — Console-mounted or portable, single or dual-track, dual-channel, 15 and 7½ ips., weight 50 lbs. Price $345.

BRUSH DEVELOPMENT COMPANY, 3405 Perkins Ave., Cleveland 4, Ohio.

Model BK-443 — Portable, single-track, dual-channel, weight 32 lbs. Model BK-443P, 7½ ips., $279.50. Model BK-443PS, 3¾ ips., $289.50.

Model BK-442 — Table model, single-track, dual-channel, 7½ ips. Price $259.50 mahogany, $269.50 blond.

CALIFONE CORPORATION, 1041 N. Sycamore Ave., Hollywood 38, Cal.

Model C3-C3A — Portable, single-track, 15 and 7½ ips., weight 44 lbs. for C3 recorder, 33 lbs. for C3A amplifier. Price complete, $795.

EICOR, INC., 1501 W. Congress St., Chicago 7, Illinois.

Model 115 — Portable, dual-track, 7½ ips. convertible to 3¾ ips., weight 27 lbs. Price $144.95.

GENERAL INDUSTRIES COMPANY, Elyria, Ohio.

Model 250 — Console-mounted or portable, dual-track, 3¾ ips., with disc recorder and pickup. Price $79.50.

FAIRCHILD RECORDING EQUIPMENT CORPORATION, 154th St. and 7th Ave., Whitestone, N. Y.

Model 125 — Console, single-track, 15 ips., push-button control. Price $2,750.

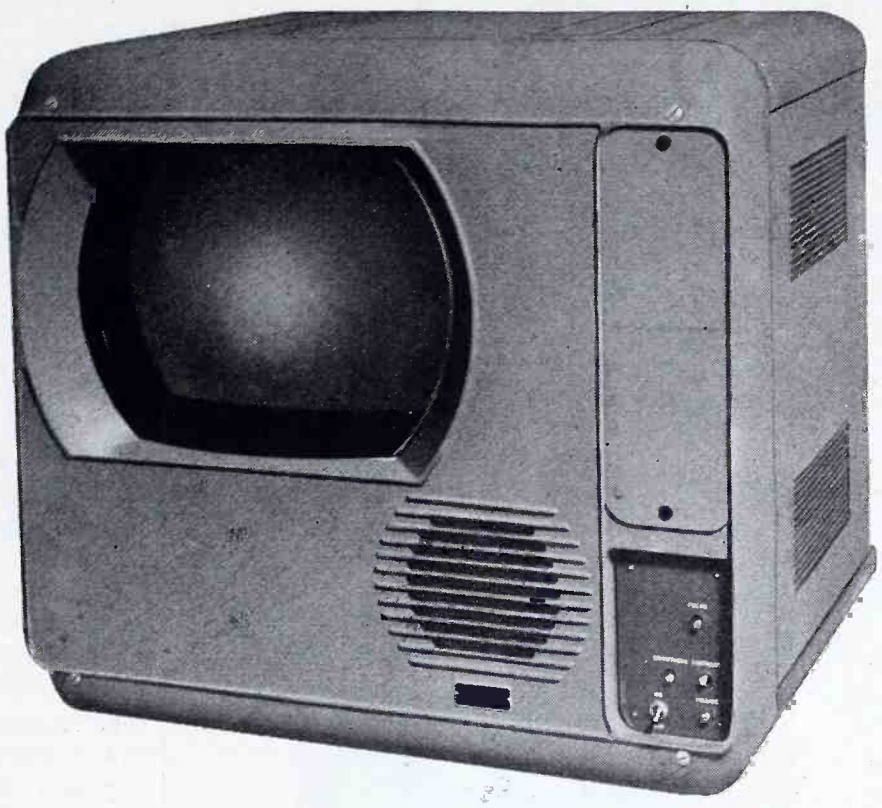
Pic-Sync model — Console, single-track, 15 ips., push-button control, automatic lip-synchronous operation for film. Price $4,000.

Model 140 Control Track Generator — Portable, for use with any portable tape recorder. Supplies control signal for lip-synchronous playback on Pic-Sync recorder. Price $335.

MAGNETIC RECORDING INDUSTRIES, LTD., 30 Broad St., New York 4.

Model VM — Portable, single-track, for dictation and transcription work. Model VM-55, 15, 7½, 3¾, and 2 ips., weight 24½ lbs., $345. Model VM-56SS, 1 ips., weight 24½ lbs., $395.

(Continued on page 36)



in color TV as in black and white, Gray shows the way

Already recognized as a pioneer in black and white TV studio equipment (with the Telop, multiplexer and camera turrets) Gray Research has turned its facilities and technical know-how to the fast-growing color TV field.

Biggest news is the Gray Color Monitor, above, developed in conjunction with CBS and now available to all stations. It is basically a professional broadcast-quality instrument designed to receive color signals off closed studio circuit lines.

In addition, Gray Research has converted black and white camera chains to CBS color field sequential camera chains . . . for Mutual, a combined multiplexer and slide projector . . . and for NBC's new projection facilities, a twin-turret and a remote controlled multiplexer.

Gray Research's success with these and many other undertakings can be your assurance, too, of a job well done.

Please write for Bulletin RC-10 describing the above equipment.

GRAY RESEARCH

and Development Co., Inc., 16 Arbor St., Hartford 1, Conn.

Walter E. Gilmore
President

Division of The GRAY MANUFACTURING COMPANY—Originators of the Gray Telephone Pay Station and the Gray Audograph

TAPE SPECS

(Continued from page 34)

MARK SIMPSON MANUFACTURING COMPANY, INC., 32-28 49th St., Long Island City 3, N. Y.

All models — Portable, dual-track, dual-channel, 7½ and 3¾ ips., with or without AM tuner. Weight less carrying case, 28 lbs. Model LD-37, no case, $221.40 less tuner. Model DC-37, metal cover, $243 less tuner. Model D-37, tweed case, $243 less tuner. Add $43 for tuner.

OPERADIO MANUFACTURING COMPANY, St. Charles, Illinois.

Du-Kane model — Portable, dual-track, dual-channel, 7½ ips., weight 26 lbs. Price $229.50.

MAGNECORD, INCORPORATED, 360 N. Michigan Ave., Chicago 1, Illinois.

Model PT6-A — Portable, single-track, dual-channel, 15 and 7½ ips. Price, less amplifier, $248. Model PT6-J record and playback amplifier, $300.

Model PT63-A — Same as PT6, except simultaneous monitoring and dual equalization switch. Price, less amplifier, $334. Model PT63-J amplifier, $387.

Model PT7A — Portable, single-track, multi-channel, 15 and 7½ ips., push-button controls. Price, less amplifier, $468. Model PT7-P amplifier, $440.

Model PT7-CC — Console, combining PT7-A recorder and line-level amplifier. Price $950. Consolette model, $889.

PENTRON CORPORATION, Chicago 16, Illinois.

Model 9T3-C — Portable, dual-track, dual-channel, 7½ and 3¾ ips., weight 27 lbs. Price $179.50.

PERMIOFLUX CORPORATION, 4900 W. Grand Ave., Chicago 39, Illinois.

Scribe dictating and transcribing unit. Same recorder is employed, with different accessories, for both functions. Speed, 3¾ ips. Price with dictating accessories, $354.50; with transcribing accessories, $361.30.

PRESTO RECORDING CORPORATION, P. O. Box 500, Hackensack, N. J.

Model RC-7 — Portable or stationary, single-channel 15 ips. Price, less amplifier, $425. Model A-920 record and playback amplifier, $324.

Model RC-10-14 — Rack-mounted, single-channel, 15 and 7½ ips. Price $684.

Model RC-10-24—Same as RC-10-14 except push-button controlled, and can be operated remotely. Price $761.

Model SR-950 — Console, single-channel, 15 and 7½ ips., or 30 and 15 ips. Price $2,785.

RANGERTONE, INC., 73 Winthrop St., Newark 4, N. J.

Model R-5P — Portable, single-track, multi-channel; 30 and 15, 15 and 7½, or

(Continued on page 37)

TAPE SPECS

(Continued from page 36)

7½ and 3¾ ips. Weight of recorder, 85 lbs.; record amplifier, 37 lbs.; playback amplifier, 52 lbs. Price, less pre-amplifier, $2,618.

Model R-5C — Console, single-track, multi-channel; 30 and 15, 15 and 7½, or 7½ and 3¾ ips. Available for lip-synchronous operation. Price, less synchronizer, $3,117.

RCA Broadcast Equipment Section, Camden, N. J.

Model RT-11A — Rack-mounted, single-track, 15 and 7½ ips., push-button controlled. Price $1,975.

Model RT-12A—Same as RT-11A, except console model. Price $2,270. Both models can be operated remotely.

Sonar Radio Corporation, 58 Myrtle Ave., Brooklyn 1, N. Y.

Model PTM — Portable, can be console or rack-mounted, single-channel, 7½ ips. Price, less amplifier, $229.90. Model RPA-1 amplifier, $190.

Stancil-Hoffman Corporation, N. Highland Ave., Hollywood 38, Cal.

Model M5A — Portable, single-track, battery-operated, for recording only, 15, 7½, and 3¾ ips., weight 13 lbs. Price $249.

Model R4 — Portable, single-track, 30 and 15 or 15 and 7½ ips. Price $1,670.

Model S5 — Synchronous film recorder and reproducer, for 16 and 17½ mm. film. Price $2,142.

Model CRM-15 — Multi-channel (up to 15) communications recorder, 7½ and 3¾ ips., push-button controlled. Price on request.

Universal Electronics Sales Corporation, 1500 Walnut St., Philadelphia 2, Pa.

Model C-1-A—Portable, dual-track, dual-channel, 7½ ips., weight 34 lbs. Price $219.

Webster-Chicago Corporation, 5610 Bloomington Ave., Chicago 39, Illinois.

Model 210 — Portable, dual-track, 7½ and 3¾ ips., weight 38 lbs. Price $187.50.

Webster Electric Company, Racine, Wisconsin.

Model 109 (3¾ ips.) and model 111 (7½ ips.) — Portable, dual-track, dual-channel, weight 34 lbs. Price $169.50.

(Concluded on page 38)

TAPE SPECS

(Continued from page 37)

Model 101-8 — Portable, single-track, dual-channel, 7½ ips., weight 50 lbs. Price $369.50.

Model 101-9 — Same as 101-8 with remote-control foot switch. Price $395.

WILCOX-GAY CORPORATION, Charlotte, Michigan.

Model 1B10 — Portable, dual-track, 1⅞ ips., turntable and pickup, weight 21 lbs. Price $149.95.

Model 1C10 — Portable, single-track, 3¾ ips., weight 27 lbs., with disc recorder and pickup. Price $187.50.

Model 2A-10 — Portable, single-track, 7½ and 3¾ or 3¾ and 1⅞ ips., weight 20 lbs. Price $149.95.

MACON ELECTRONICS DIVISION, York Radio and Television Corporation, 801 No. Broadway, Decatur, Illinois.

Musictape model — Portable, dual-track, dual-channel, 3¾ ips., push-button controlled, weight 32 lbs., with disc recorder and pickup. Price $199.50.

DUPLEX AIR-COUPLER

(Continued from page 29)

test, we concluded that back radiation must be controlled or eliminated in some way. That is, the Duplex Air-Coupler should be installed in the floor or a closet, or in any manner by which an infinite baffle is provided for the back radiation. Alternatively, if the Coupler cannot be concealed, a reflexing arrangement should be employed.

Listening Tests:

Probably the highest praise that can be given the Duplex Air-Coupler is that it sounds better than the original model. There is unanimous agreement that it does sound distinctly better. Reproduction is much cleaner and crisper, due to improved transient response and, in some measure, to better efficiency at very low frequencies. Power-handling ability is increased. The overall response is smoother and more natural than before, with a degree of realism that is truly amazing.

The most radical improvement is noticed on voice program material when the Coupler is used with a middle-range speaker and tweeter. There is not the slightest trace of the boxiness on voice reproduction that was sometimes contributed by the original Air-Coupler.

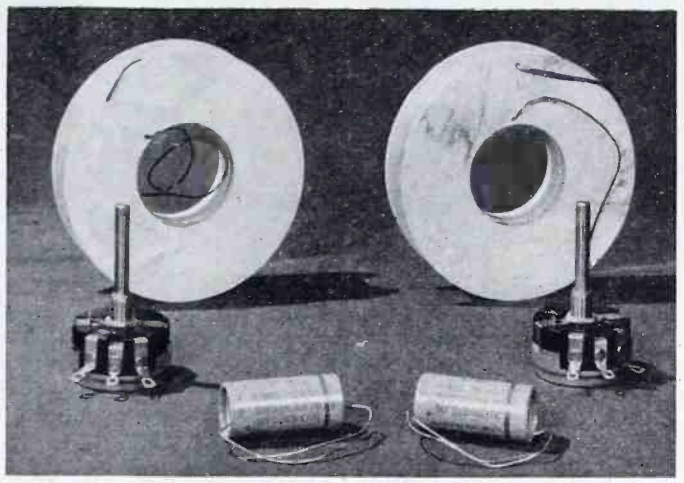
Conclusion:

What began as a simple measuring project on the Air-Coupler turned, quite by accident, into a very important improvement in performance. Thus encouraged, we continued our efforts for the benefit of readers who are using Air-Couplers

(Concluded on page 40)

INDEX OF ADVERTISERS

FOR YOUR CONVENIENCE, TELEPHONE NUMBER OF EACH COMPANY IS SHOWN HERE



G. A. Crossover Networks for

Multiple Speaker Systems

By a judicious selection of associated components, the three coil sizes on which G.A. has standardized enable our customers to secure low-cost crossover networks which will operate at 14 different crossover frequencies! For the experimenter, that means a wide range of choice without having to break the bank to buy dozens of coils. For the man who wants to install his system once and for all, it means money saved, because G.A. saves money by making **only** three coil sizes (10.2, 5.1, and 1.6 Mh) — and it passes on those savings direct to its customers. Where else can you buy a big 10.2 Mh air-core choke, or No. 17 wire, for only $10.00? Here are the combinations possible with G.A. networks:

RAPID ATTENUATION NETWORKS

12 db droop per octave. These networks use **two** inductance coils.

Voice coil or system impedance	Crossover Frequency	Order by Number	Price 2 Coils Only	Price Complete*
16 ohms	2,200	No. 1	$7.00	$11.50
	1,100	2	7.00	12.00
	700	3	12.00	16.00
	350	4	12.00	17.50
	175	5	20.00	24.00
8 ohms	1,100	6	7.00	12.00
	550	7	7.00	13.00
	350	8	12.00	17.50
	175	9	20.00	24.00
	85	10	20.00	26.50
4 ohms	550	11	7.00	13.00
	275	12	7.00	15.00
	175	13	12.00	19.00
	85	14	20.00	26.50

SLOW ATTENUATION NETWORKS

4 to 6 db droop per octave. These networks use **one** inductance coil.

Voice coil or system impedance	Crossover Frequency	Order by Number	Price 1 Coil Only	Price Complete*
16 ohms	1,600	No. 15	$3.50	$6.50
	500	16	6.00	9.00
	250	17	10.00	13.50
8 ohms	800	18	3.50	7.00
	250	19	6.00	10.00
	125	20	10.00	14.50
4 ohms	400	21	3.50	8.00
	125	22	6.00	12.00

* Complete networks include necessary capacitors and level controls. Be sure to indicate whether you want just the coils or the complete network. We recommend buying the complete network since, in some cases, as much as 640 mfd. of capacitance is required.

If you want to use three speakers with crossover points at 350 and 1,100 cycles, for example, just order two of the networks listed above (for an 8-ohm system, with rapid crossover attenuation, it would be No. 6 and No. 8).

Air-Coupler Items . . .

As most everyone has found out by now, G.A. is headquarters for these components; as far as we know, we're the only organization stocking crossover networks designed for the Air-Coupler system. The standard Air-Coupler (available from us, knock down but ready to assemble with a few screws, and with a hole already cut for a 12-in. speaker: only $34.50 in heavy, ¾-in. plywood) requires a crossover network operating at 350 cycles. Pick the one you need from the list above. Most users also find that 1,100 cycles is the best crossover frequency for middle and high-range speakers. And, for those working with the reflex Air-Coupler described in the May '51 issue of **Radio Communication** Magazine, we have in stock the components for the slow attenuation network used with this unit. It's network No. 17 or No. 19, depending on speaker impedance.

At the time when this advertisement was being prepared, there were rumors afoot that the **Radiocom-High-Fidelity** group had a new and greatly improved Air-Coupler close to a point of perfection. We'll have full details in our next advertisement, but it looks as if the new unit will be more complicated to construct, so we're planning to make them available **completely assembled.** We'll guarantee G.A.'s price will be under $50. We'll also guarantee that the rush to get one will swamp us, so if you are in a hurry, put in an order right now ($25 on deposit, balance C.O.D., please) and we'll give you first attention.

Miscellany: we continue to carry in stock . . . **Altec 600-B** 12-in. speakers, a best buy under any circumstances, a must for Air-Couplers only $46.50; **Peerless S-230Q** output transformers, $26.00; **Peerless R-560A** power transformers, $16.00; **Peerless C-455A** power chokes, $10.00 — a new supply of the English **KT-66** tubes (specified for Williamson amplifiers) has just been received; they're only $4.95 each. There's no exact U. S. equivalent.

General Apparatus Co.

South Egremont, Mass. **Phone Gt. Barrington 560**

DUPLEX AIR-COUPLER

(Continued from page 38)

which cannot be concealed in a floor or a closet. Details of a simple Triplex Air-Coupler for corner mounting will be presented for their benefit in a forthcoming issue of RADIO COMMUNICATION Magazine.

In addition, a simple RC bass-boost network, designed to provide an overall amplifier-speaker response curve essentially flat to 10 cycles, has been developed. This network, referred to in the section entitled Duplex Performance, is suitable for use with any amplifier. It will be discussed in a subsequent issue also.

BRITISH AMPLIFIERS

(Continued from page 32)

trols in circuit. There is a total of four positions, including the OFF. The second position inserts the treble and bass boost controls, knobs 2 and 3, both of which are continuously adjustable. The bass control has a range of ±15 db, while the top control has a range of +10 to −22 db. These facilities are usually provided in high quality amplifiers but, in the QUAD unit, an additional filter is available to limit the top response to 6 kc. or 8 kc. as determined by the position of knob 4. In either position, the rate of cut-off above the selected frequency is controlled by knob 5 over the range from 10 to 100 db per octave. The filters and slope control are an admirable combination for dealing with adjacent-channel hash and surface noise on old recordings, leaving the bass and treble boost controls to deal with the average compensation required by the particular room and speaker employed.

The full performance specification is given in Table 3. Data apart, however, there is no doubt that when used in combination with the Acoustical loudspeaker[3] it is one of the top-ranking performers. Its reproduction of glass-breaking noises at a recent London exhibition was a highlight of the show, while the reproduction from records was a revelation in smoothness.

TABLE 3

Power output: 12 watts
RMS distortion at rated power: .25%
Frequency range: .3 db, 20 to 20,000 cycles
Signal-to-noise ratio: 74 db
Input volts: 10 millivolts
Input impedance: 20,000 ohms
Output impedance: 1.2 ohms at 15-ohm output

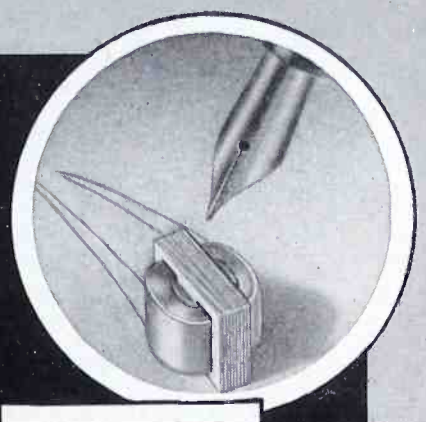
Workmanship and finish are of the highest order, as can be seen in Figs. 5, 6, and 7.

Part 2 of this article, describing the Leak and Williamson amplifiers, will appear in a forthcoming issue.

[3]See RADIO COMMUNICATION for July, 1950.

FOR MINIATURIZATION

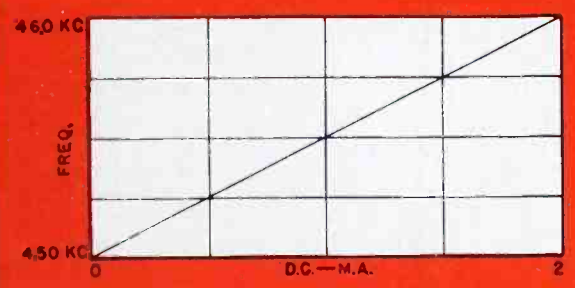
The miniaturization of transformers has been a UTC specialty ever since the development of the Ouncer series in 1937. The importance of this engineering "know how" is reflected by the large number of UTC Miniature components in present military equipment. Some examples of this engineering leadership are illustrated below.

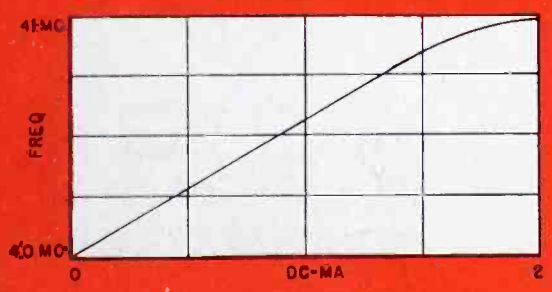


SM Unit ACTUAL SIZE — As photographed with normal pen for comparison.

DC CONTROLLED OSCILLATOR INDUCTORS

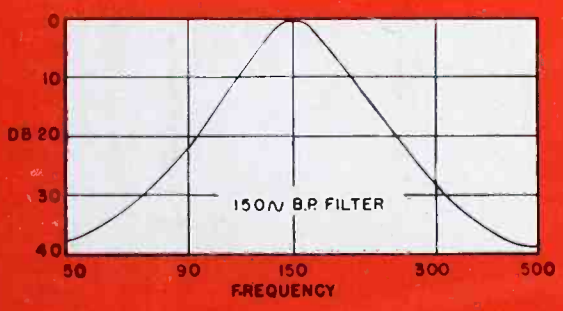
The curves below illustrate oscillator frequency variation using two types of RF inductors varied by the amount of DC through the controlled windings. These units are available in ouncer size and smaller.

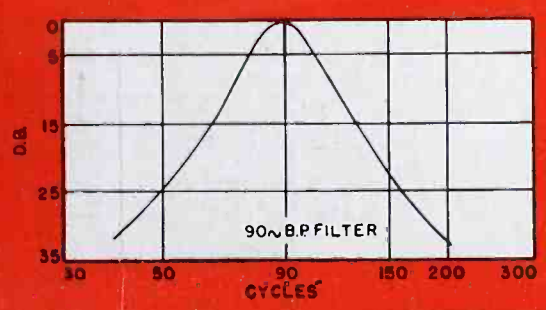




MINIATURIZED AIRCRAFT FILTERS

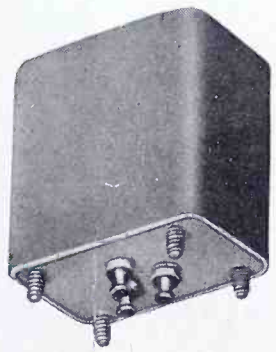
The standard 90-150 cycle aircraft filters have been reduced in size and weight in UTC's miniaturization program. The curves below illustrate the frequency characteristics of these units.





Ouncer case, non hermetic, is 7/8" diameter x 1 1/8" height. Weight — .06 lbs.

Ouncer case, hermetic, is 15/16" diameter x 1 3/8" height. Weight — .11 lbs.

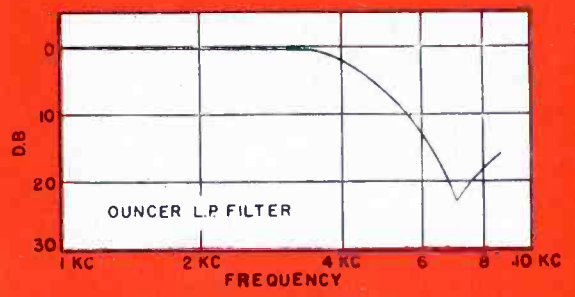


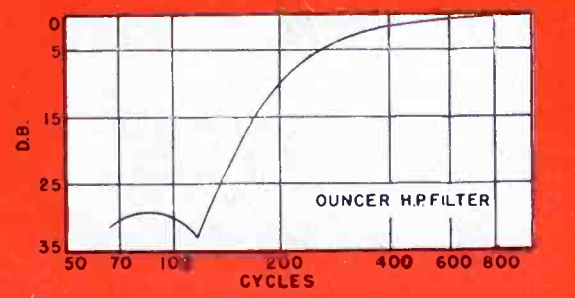
Miniaturized filter case is 1 11/16" x 13/16" x 1 5/8" height. Weight — .3 lbs.

SM sub-miniature audio components, 7/16" x 1/2" x 7/16" height. Weight — .009 lbs.

OUNCER FILTERS

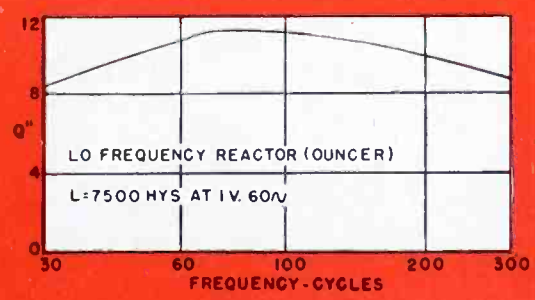
Filter miniaturization is a specialized art. The curves below show a low pass filter and a high pass filter being supplied in the UTC ouncer case.

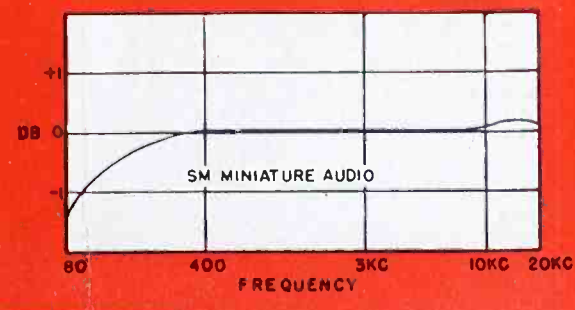




EXTREME MINIATURIZATION

Through the use of specialized materials, extremely compact designs are possible. The curve below illustrates the Q characteristics of a 7500 hy. low frequency reactor housed in the UTC ouncer case.



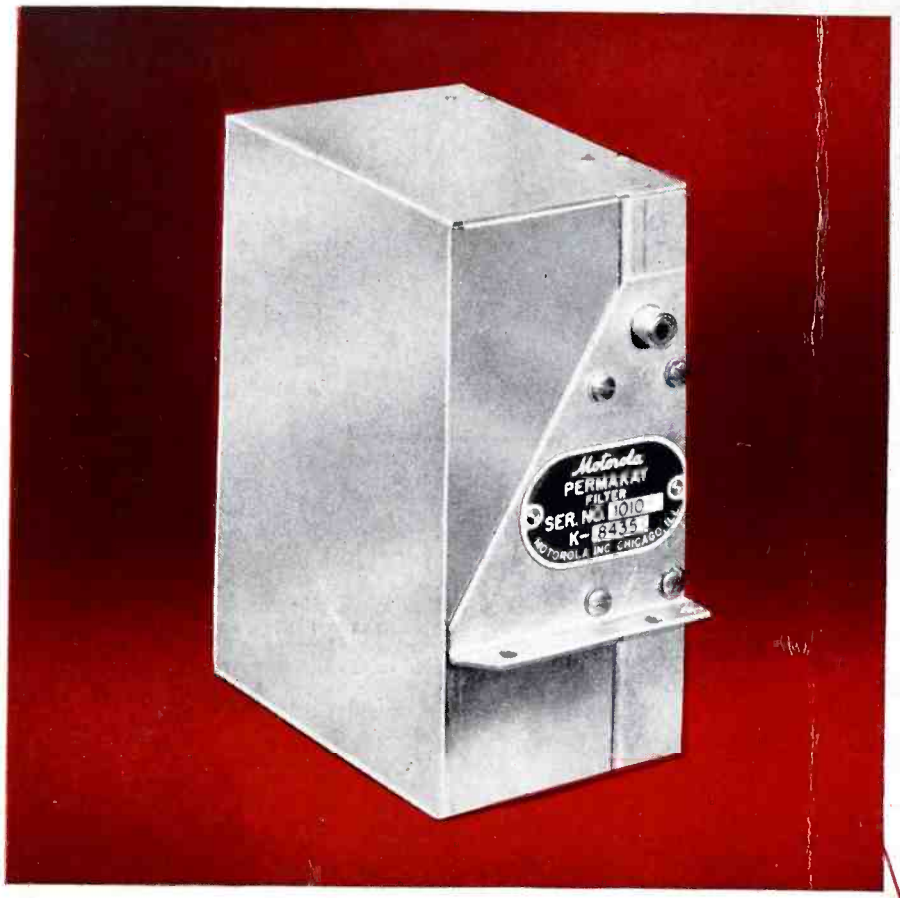


The sub-miniature audio transformer whose frequency curve is shown above, weighs less than one-seventh of an ounce yet provides wide range frequency characteristics. Its impedance ratio is 500 to 50,000 ohms for operation into a 1/2 meg. Loaded grid.

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N.Y., CABLES: "ARLAB"

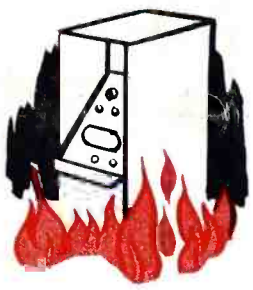


In Sensicon exclusive design the

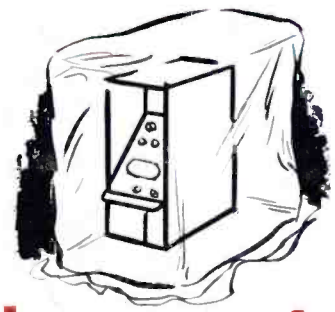
Motorola Wave Filter removes 15 nuisance tuning adjustments

More tuned circuits and superior performance with *fewer* tuning adjustments in the SENSICON Receiver are achieved using the PERMAKAY IF Wave Filter. The modified constant-K, m-derived band pass filter contains 15 tuned circuits . . . BUT . . . you are not burdened with field alignment and complex tuning adjustments. The filter, tuned and sealed during manufacture, requires no further adjustments . . . *ever.* This combination provides over 100 db signal rejection at the *edge* of the adjacent channel while providing a broad band-pass at 6 db for full modulation deviation acceptance.

Motorola's unique Permakay system of linear phase shift adjustment solves the problem of reflection and pulse noise control to provide maximum signal-to-noise ratio for the phenomenally high interference-rejection.



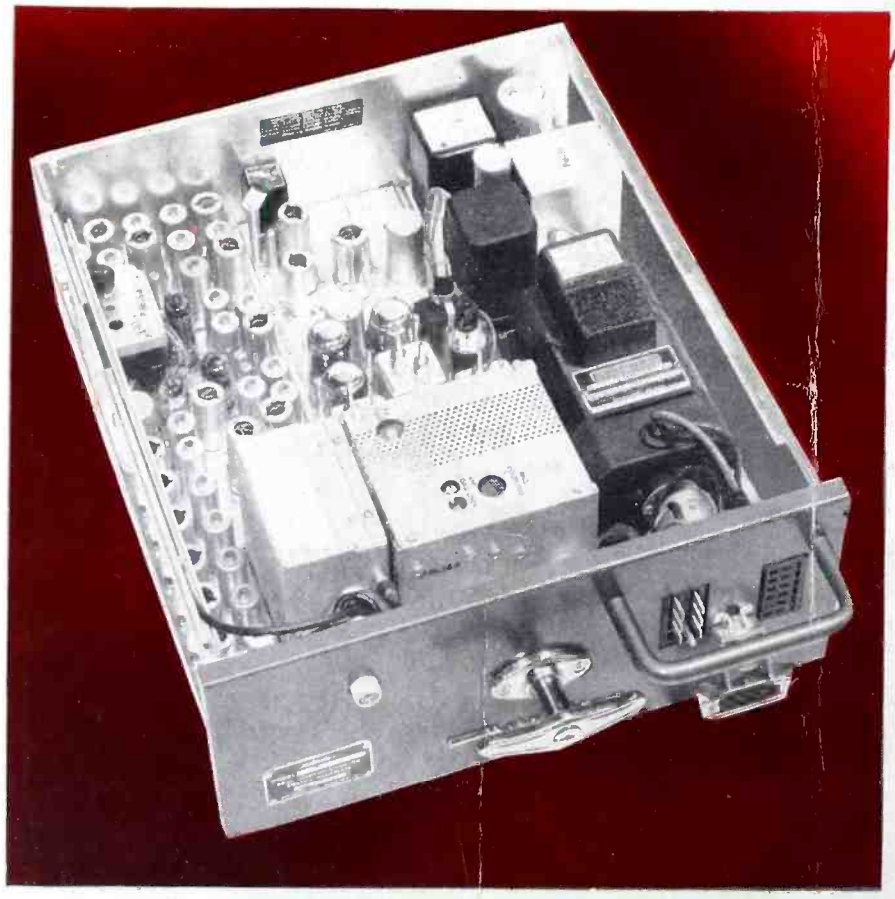
DUST AND HEAT-PROOF



WATER AND COLD-PROOF

TAMPER AND SHOCK-PROOF

Motorola 2-way radio



and guarantees permanent selectivity

The PERMAKAY Filter characteristics are made permanent by casting the entire unit in a solid block of polyester-styrene plastic. Never can the precisely tuned circuitry be affected by water, dirt, heat, cold or mechanical shock. Temperature compensation insures constant performance even at extreme temperatures as demonstrated in all rigid laboratory torture tests. Motorola's *unconditional* guarantee of the PERMAKAY Filter for the life of the set again demonstrates that Motorola is still your best investment.

Over 22 Years of Leadership in Mobile Radio . . .

Year in and year out, Motorola installations number more than *twice* those of all other manufacturers *combined* and more than *five times* those of the nearest competitor.

Motorola

Communication and Electronics Division

4545 Augusta Blvd., Chicago 51, Illinois