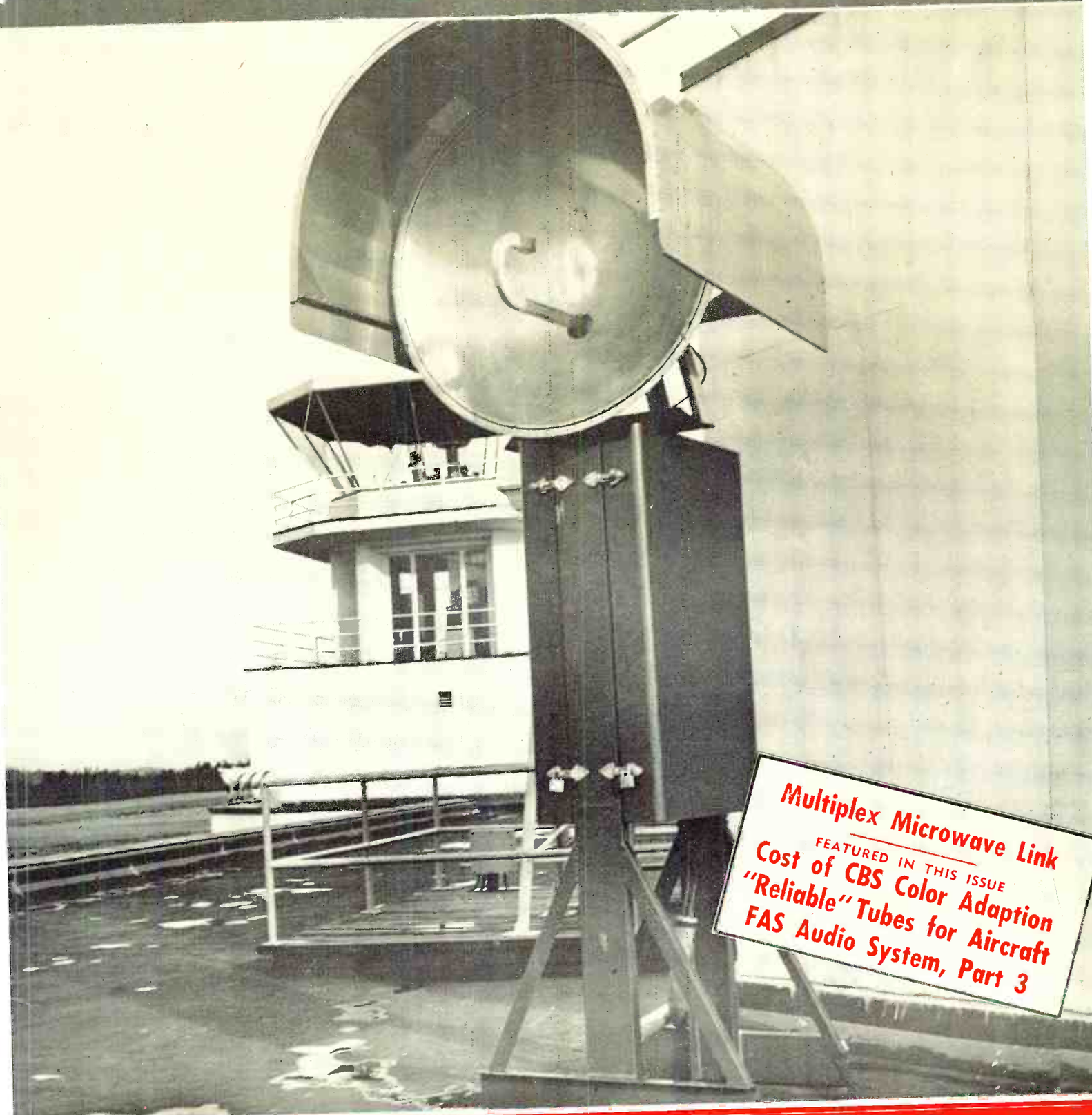
Price 25 Cents Dec. '50

# FM-TV RADIO COMMUNICATION

★ ★ Edited by ★ ★
Milton B. Sleeper

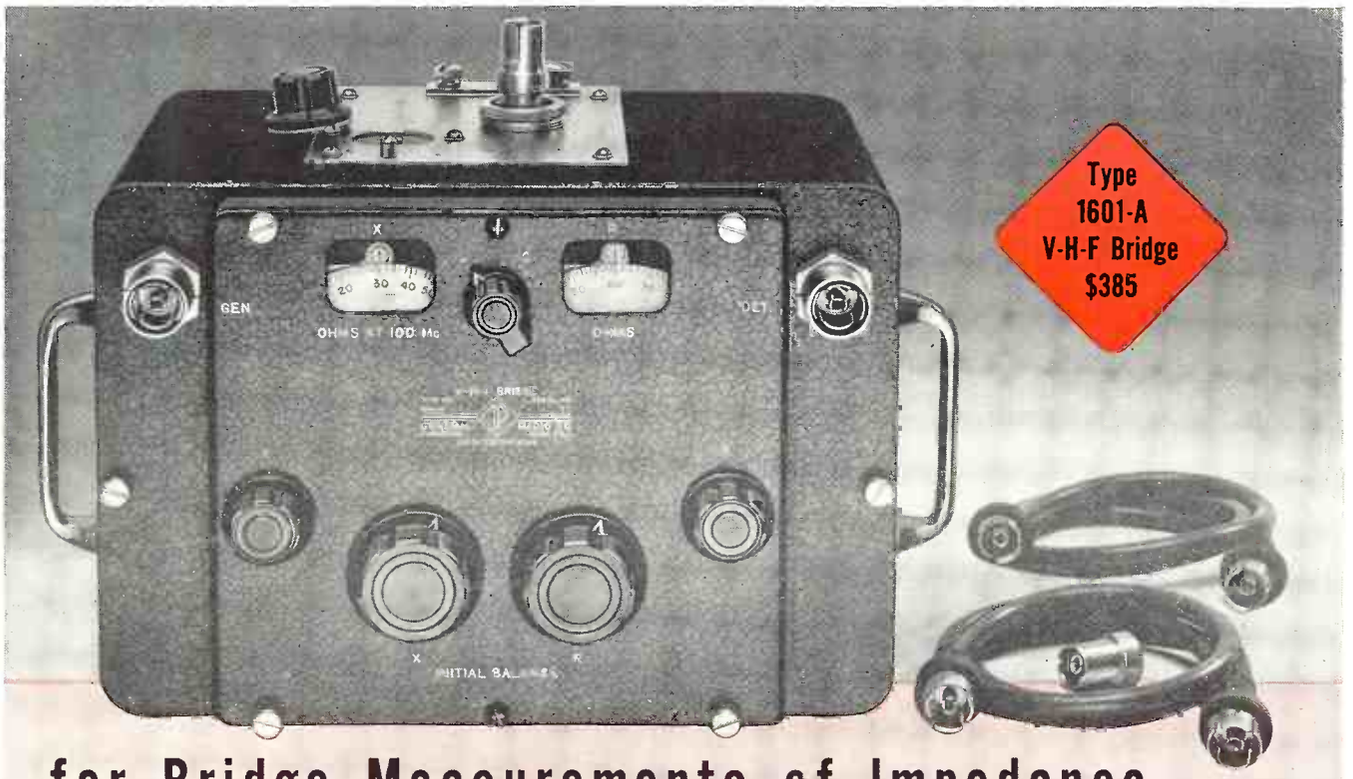


Multiplex Microwave Link

FEATURED IN THIS ISSUE

Cost of CBS Color Adaption
"Reliable" Tubes for Aircraft
FAS Audio System, Part 3

11th Year of Service to Management and Engineering



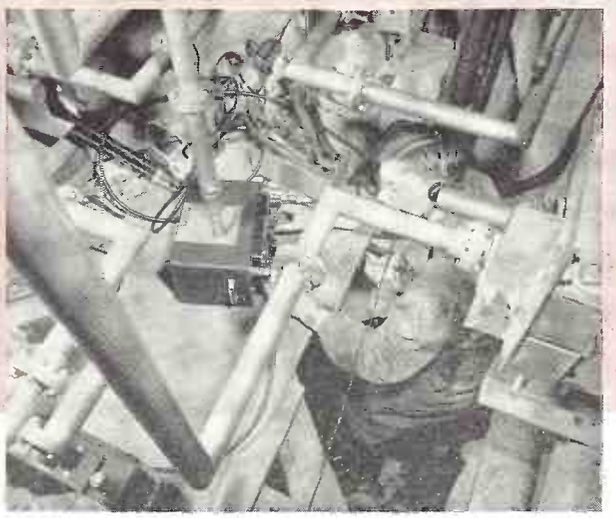

# for Bridge Measurements of Impedance

## BETWEEN 10 AND 165 Mc

**Direct-Reading Resistance Range 0 to 200 OHMS** — *independent of frequency except for small corrections.*

**Direct-Reading Reactance Range 0 to ±230 OHMS at 100 Mc** — *inversely proportional to frequency.*

**Coaxial Adapter Supplied for Measurements on Coaxial Systems** — *eliminates errors from connecting leads and from residual terminal capacitance. Standing-wave ratio of unknown coaxial system unaffected by terminal capacitance of bridge.*



The Type 1601-A V-F-H Bridge set up to measure the antenna of WCBS-TV on the Chrysler Building, New York City. The antenna consists of 16 radiating elements. Measurements of the impedance variation of an individual element over the operating frequency band as well as impedance measurements of the whole array were made easily and accurately.

THE new Type 1601-A V-H-F Bridge brings to the v-h-f frequencies a means for measurements of impedance of antennas, lines, networks and components, having the same accuracy and simplicity of measurement enjoyed by users of the popular G-R low-frequency Type 916-A R-F Bridge.

With this bridge the range of conventional bridge techniques is extended to 165 Mc. It is equally suited to measurements on coaxial-line systems as on lumped parameter circuits.

It is designed for direct-reading measurements of relatively low impedances, but measures high impedances indirectly and equally well.

For resistance measurements the accuracy is $\pm(2\% + 1\ \Omega)$, subject to correction for inductance in the capacitor used to measure the resistance. A correction chart is supplied with the instrument. The ohmic portion of the accuracy statement varies between 0.1 and 1.0 ohm.

For reactance measurements the accuracy is $\pm(5\% + 2\ \Omega)$. The ohmic uncertainty varies between 0.1 ohm at 100 Mc and 2 ohms.

This bridge is especially suited to measurements of resistors, capacitors, inductors, transmission-line networks and antennas.

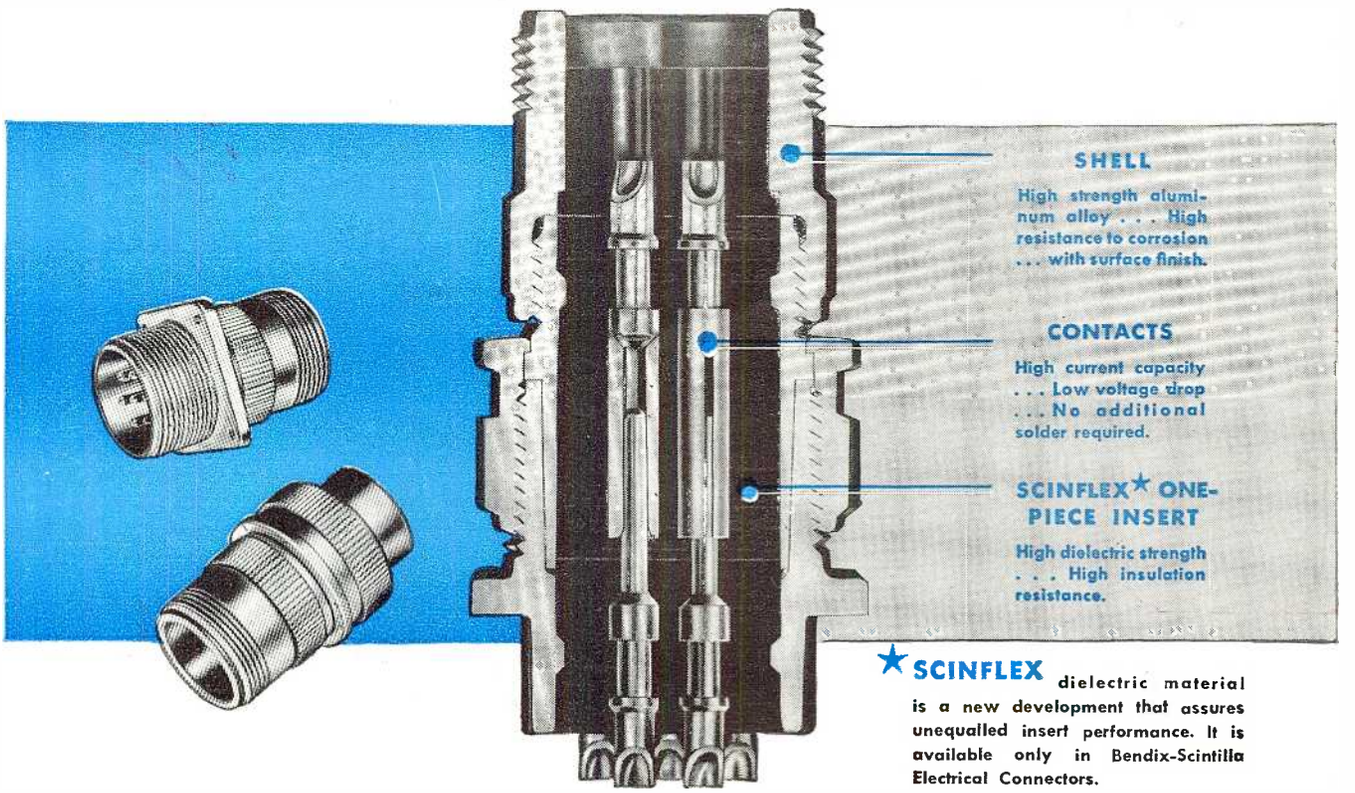
**GENERAL RADIO COMPANY** Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

# ONLY BENDIX-SCINTILLA

## ELECTRICAL CONNECTORS offer you this

## IMPORTANT, EXCLUSIVE FEATURE . . .




★**SCINFLEX** dielectric material is a new development that assures unequalled insert performance. It is available only in Bendix-Scintilla Electrical Connectors.

## . . . PRESSURE TIGHT SOCKET CONTACT ARRANGEMENTS!

Outstanding design and fine workmanship, combined with materials that will meet every requirement, make possible our "pressurized" connectors that include both pin and socket arrangements for ALL sizes of contacts.

### PLUS ALL THESE OTHER FEATURES

- Moisture-proof
- 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

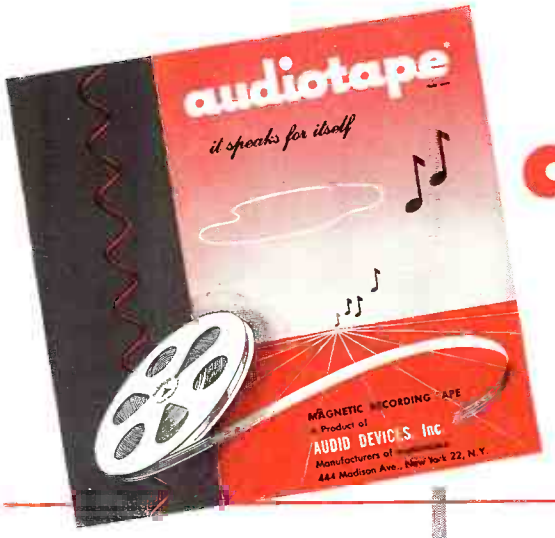
*Write our Sales Department for detailed information.*

BENDIX SCINTILLA

**SCINTILLA MAGNETO DIVISION of SIDNEY, NEW YORK**

Bendix AVIATION CORPORATION

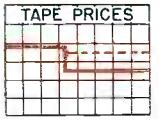
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York




# Here's What These audio "Firsts" Have Done for You

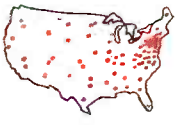
*. . . to lower the cost and improve the quality of magnetic recording tape*

***First*** **with liberal discounts to professional users**




—enabling radio stations, recording studios and educational institutions to save as much as 33⅓% on the cost of magnetic tape.

***First*** **with attractive resale discounts**



— and a nation-wide network of helpful, cooperative sound-equipment distributors in principal cities from coast to coast.

***First*** **with red oxide tape on paper base**

— offering recordists a high-quality tape designed to match the characteristics of the vast majority of recorders, at *lowest possible cost.*

***First*** **with supercalendered kraft paper base**

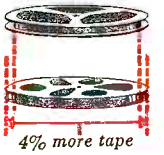
— providing maximum smoothness of texture and minimum noise, without the use of fillers which tend to come out or stiffen the paper.

***First*** **with all-aluminum 7-inch reels**

—mechanically strong, light in weight, and permanently free from warping or twisting even under adverse conditions.

***First*** **to give extra footage on standard size reels**

Audio's "full measure" of 1250 ft., 2500 ft., and 5000 ft. give *4% more tape* on every reel.

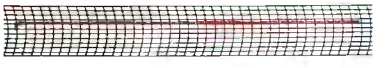



***First*** **with black oxide tape on plastic base**

— offering highest fidelity of recording and reproduction for machines designed to use a high coercive-force oxide.

***First*** **to offer paper base tape in 2500 and 5000 foot rolls**

—permitting maximum economy for professional applications where premium quality recordings are not required.



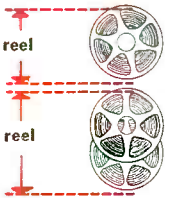
***First*** **to produce a constant output tape**

—made possible by Audio's specially designed coating machinery which controls coating thickness to within 5 *millionths* of an inch.

***First*** **to guarantee output uniformity of**

± ¼ db for 2500 ft. reel

± ½ db from reel to reel in 2500 ft. size



***First*** **to produce a splice-free 2500 ft. roll**

—to *guarantee* that the tape is all one piece, with absolutely no splices in the entire length.

***First*** **to develop the safe-handling package for professional-size rolls**

—permitting tape on hub to be transferred to or from turntable without danger of spilling—and simplifying the attachment of side flanges.

These "Firsts" are proof of the continuous research and development that keeps Audiotape foremost in the field. They are the result of more than a decade of experience — by the only company specializing solely in the manufacture of fine recording materials — both tape and discs.

That's why you can always look to Audio for the latest developments in the recording art. A trial order of Audiotape will speak for itself. Or send today for a free 300-foot sample.

**Trade Mark*

**AUDIO DEVICES, INC.**
**444 Madison Ave., New York 22, N. Y.**

Please send me a free 300-foot sample reel of ☐ plastic base or ☐ paper base Audiotape.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

FM-TV

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

VOL. 10 DECEMBER, 1950 NO. 12



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CPA AUDIT

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


TV receiver production in September by RTMA member-companies exceeded AM receivers for the first time, and was only a little below the total of AM plus FM sets. Probably a substantial part of this TV output was planned to anticipate the excise tax which went into effect on November 1. It may prove to be a record high for a long time to come. Currently, there is much speculation as to the results of limitations on aluminum, steel, cobalt, and copper.

Presumably, public buying will respond to published warnings of impending shortages and higher prices. These will outweigh any consideration of future color developments, for people will reason that it is better to get a black-and-white set than to risk the chance of getting none at all. So we can be sure that there will be ample demand to take whatever production is possible.

Production of home-type AM sets was down to 244,259, hardly twice that of FM models. At this point, it's about time for broadcasters who own FM transmitters to start figuring what they can do to put pressure on the manufacturers to step up FM receiver production. The demand for FM sets of good performance is far in excess of supply, but the purchase of AM models is at a level below replacement requirements. AM portables and car sets do not build audiences that make programs pay off.

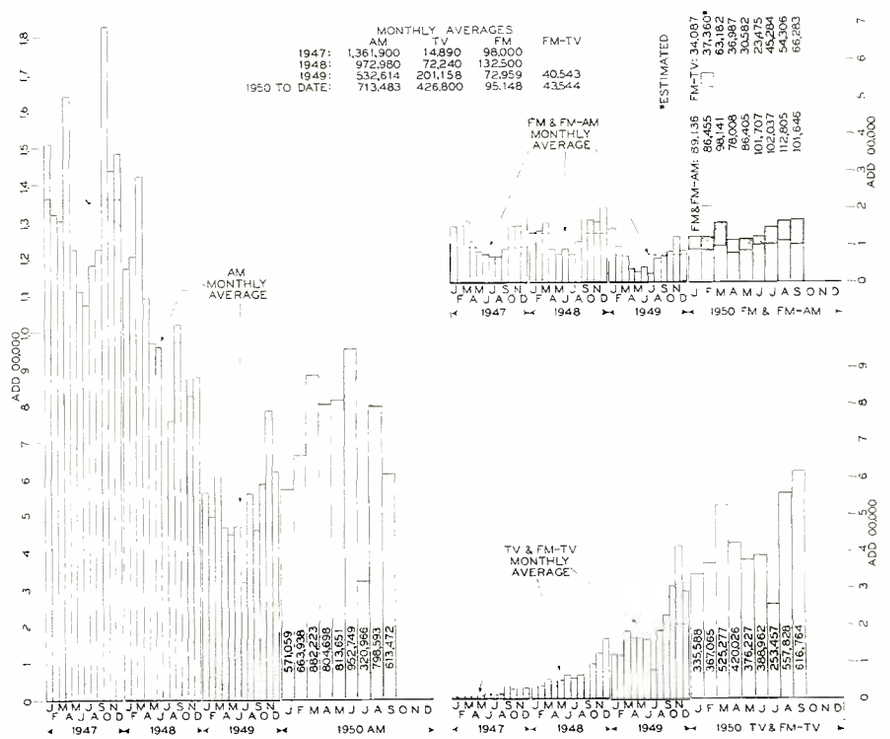
Comparisons of production in September '50 with the same month last year show:

AM 613,472 up 33%
FM 101,646 up 43%
TV 616,764 up 174%

These figures emphasize the continued trend of public acceptance of FM, a shift that is coming about with virtually no promotional support.

Picture-tube sales in September came to 764,913 units, valued at $20,423,353, for set manufacturers. In units this was a drop of 2,138, but the billing was up $87,480. Probable reason is that 87% of tubes produced in September were 16 ins. or larger.

October receiving tube sales were 40,105,611, nearly double the highest month of '49. Of these, 32,305,648 were for new sets, 6,699,448 for replacements, 918,338 for export, and 182,177 for the Government agencies. Despite this record volume, a serious shortage of some tube types still continues.




*TV, FM, and AM Set Production Barometer, prepared from RTMA figures*

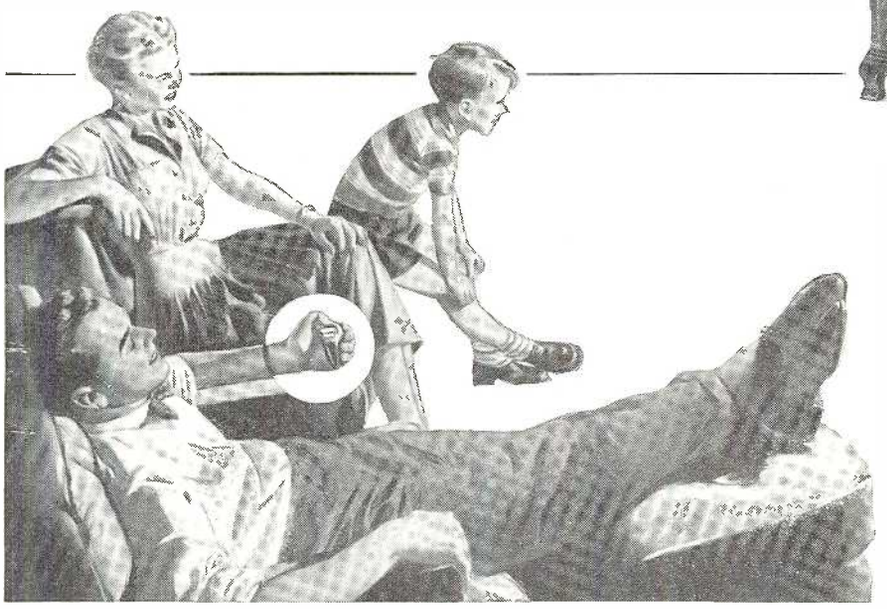
*It's Rocking the Industry in News . . . Excitement . . . Sales!*

## ZENITH'S AMAZING . . . INCREDIBLE

# "LAZY BONES" Remote Control TV

*Complete Television Program Selection From Anywhere in the Room!*

*Changes Station, Picture, Sound at the Touch of a Finger!*



Never before in Zenith history has a television improvement met with such enthusiasm . . . *more* clamoring public interest and demand! Overnight—Zenith's miraculous "Lazy Bones" Remote Control Tuning has set a new standard of enjoyment in television.

Now—from clear across the room—Zenith® television with "Lazy Bones" Remote Control and the famous turret tuner *automatically* change programs . . . *completely* adjust station, picture, sound, from a tiny control in the palm of the hand. And there's nothing more to tune! Not one single knob to adjust or re-tune. All the necessary adjustments are made instantly . . . automatically!

Just one eye-opening demonstration and shoppers become buyers . . . boosters in their own homes for "Lazy Bones" Tuning Ease—the biggest thrill in television yet! Feature it . . . promote it . . . watch your sales climb higher and higher with Zenith—all through '50!

### Demonstrate These "Most Wanted" Television Features . . . You'll Find Them All in Zenith and Nowhere Else!

**1 New Reflection-Proof Blaxide Picture Tube.** In normal viewing position you enjoy pictures free from window and room light reflections, as well as from glare—even in daylight or fully lighted rooms, the way doctors recommend viewing!

**2 New "Super-Range" Chassis.** Brings in pictures far clearer than before . . . in difficult or distant outlying locations where signals are too weak for most receivers.

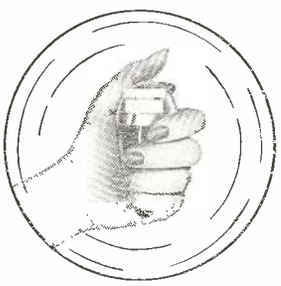
**3 Connection for Phonevision.** If and when this great Zenith development is approved as a commercial service and thereby is made available on present standards, unit may be attached to bring high-class, costly television programs right into your home.

**4 Built-in Provision for Receiving the Proposed New Ultra-High Frequencies** on present standards. With a Zenith, UHF tuner strips can be readily added to the turret tuner, so that you will not have to buy a new set nor will you have to use an external converter.

**5 15 Millionths-of-a-Second "Gated" Automatic Gain Control.** Virtually eliminates picture flutter from airplanes, cars, diathermy, etc. . . . by opening a radionic "gate" for 15 millionths of one second, then closing it against interference!

**6 Pre-Tuned "Picturemagnet" Antenna in All Models**—Built-in, and requires no adjustments. Eliminates need for external antennas in many locations.

ZENITH
•LONG DISTANCE• RADIO and TELEVISION

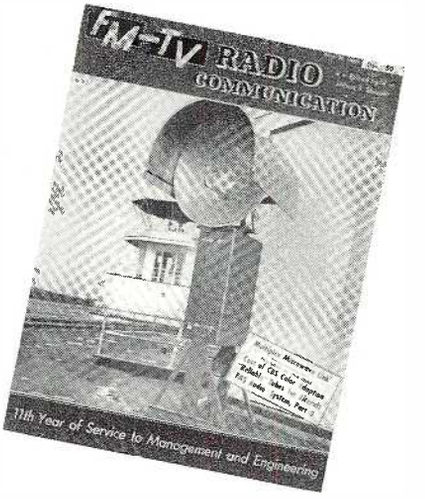


*"Lazy Bones" Remote Control optional at small cost on all 1951 Zenith TV models*

Zenith Radio Corporation, Chicago 39, Illinois • *Over 35 Years of "Know-How" In Radionics Exclusively* • *Also Makers of America's Finest Hearing Aids*

## THIS MONTH'S COVER

This parabolic reflector and RF housing unit is mounted at the control tower building of the International Airport, Seattle, Wash. The equipment is used as a 2-way, multichannel link between the airport terminal and an automatic repeater station approximately 10 miles away. At that point, transmitters, receivers, and antennas are installed for handling long-distance air-ground communication. The use of the Motorola microwave link makes it possible to locate the antennas on high ground, yet far enough from the airport so that they are not flight hazards.




# SPOT NEWS NOTES

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

### DECEMBER 5: COMPATIBLE COLOR

**Soundness of industry's indifferent attitude toward color without compatibility was confirmed emphatically by the remarkably fine performance of RCA's improved, fully compatible color receivers demonstrated on December 5, at Washington.**

**Color quality was on a par with CBS. Monochrome images on color sets seemed somewhat superior to those on black-and-white receivers.**

**Essential difference, not adequately appreciated by newspaper reporters, was that, without any manual switching or readjustment, reception on the color sets changed from color to monochrome and back to color as the cameras were shifted at the WNBW studio. CBS sets require switching, synchronizing, and removal and replacement of the color wheel. Black-and-white sets, also demonstrated, showed no perceptible change in image quality whether transmission was in monochrome or color.**

**Cabinets of color sets were conventional in size, since the 100-tube circuits used at the FCC demonstration last February have been simplified, and now require only 43 tubes.**

**In short, everything has been accomplished that the FCC said was impossible for RCA to do when the Commission decided to adopt the CBS system. From the point of view of the public and the manufacturers, RCA color sets are practical, salable merchandise. As to the date of availability, production of any kind of color set must await a favorable change in international conditions.**

### Red Face Department:

One of our friends reported to the Minneapolis police that his car had been stolen. It was found a week later, standing on the street, decorated with parking tickets.

### Mayer, Rigby & Seeley:

J. Gerald Mayer and Scott G. Rigby have announced the formation of a new law partnership with F. Hamilton Seeley, formerly Chief of Claims and Appeals, Corps of Engineers, Member of the Army Board of Contract Appeals, and General Counsel of the Foreign Liquidation Commission. This partnership succeeds the firm of Mayer, Rigby, and Ryan. Offices are at 1010 Vermont Avenue, Washington 5, D. C.

### Read This One Twice:

A series of questions and answers issued by CBS for the information of the press contains this one: "Q. Does color add to the cost of transmitting television programs? A. No. In the movies, of course, printing a film in color does increase costs substantially. But there is no such added cost in transmitting color TV programs." From this we deduce that CBS knows how to transmit color from black-and-white film, or that they expect to limit color to live shows.

### IRE Officers for 1951:

Ivan S. Coggeshall, general traffic manager of Western Union's overseas communications, has been elected president, with Jorgen C. F. Rybner, professor of tele-communications at the Royal Technical University of Denmark, as vice president. Directors are: William H. Doherty, Bell Laboratories, Murray Hill, N. J.; George R. Town, Iowa State College, Ames, Ia.; Harry F. Dart, Westinghouse Electric, Bloomfield, N. J.; Paul L. Hoover, Case Institute of Technology, Cleveland; William M. Rust, Jr., Humble Oil & Refining Company, Houston; and Allan B. Oxley, RCA Victor, Montreal. Offices of secretary, treasurer, and editor will be filled at the January directors' meeting.

### VU and DB Meters:

Miniature types, conforming with JAN-1-6 specifications, are in production at International Instruments, Inc., 331 East

*(Continued on page 8)*

## SPOT NEWS NOTES

*(Continued from page 6)*

Street, New Haven 11, Conn. These D'Arsonval types are designed to give performance comparable to 2½- and 3½-in. types. Cases 1½ ins. round or square are for waterproof or commercial seals.

**Groucho vs. Hamlet:**

One difference between them is that Hamlet would say: "It is I."

**Police Radio Supervision:**

In cities where radio communication was first put under the supervision of the superintendent of police and fire alarms, there is a growing tendency to shift this responsibility to a radio supervisor in the employe of the police department. Reason seems to be that men who handle fire alarms and traffic signals are inclined to discount the importance of radio communication equipment.

**Miss Hennock Speaking:**

In an address before the New York Women's Advertising Club, she referred to audio broadcasting as "television's poor, blind sister." Also, she said that TV outranks audio "by almost 1,000 per cent in popularity." We wonder if she was just swinging a huckster's line, or if she was stating the position of the Commission.

**Turnpike Radio System:**

The Maine Turnpike, extending 45 miles from Kittery to Portland, will have an 11-station radio system. William B. Getchell, Jr., director of the Turnpike Authority, will be responsible for the installation.

**Fifth Factory in Operation:**

Production has started at Simpson Electric's new plant at Aurora, Ill. The two-story building, of 31,000 square feet, was occupied formerly by the Elgin Watch Company.

**Hank Russell:**

Following the retirement of Ben Miller from United Transformer Company, Hank Miller has been appointed general sales manager.

**License-Exchange Agreement:**

RCA has concluded a four-year agreement with IT & T and its subsidiaries which provides for an exchange of licenses under inventions relating to audio and TV broadcast equipment, radar, and cathode-ray and transmitting tubes.

**Producers OK Phonevision Test:**

Film companies have finally decided to release a total of 90 feature pictures for

*(Concluded on page 9)*

## Professional Directory



## SPOT NEWS NOTES

*(Continued from page 8)*

Zenith's Phonevision test, and the American Federation of Musicians has approved the use of the sound tracks for TV broadcasting. Outcome of the 3-month test will be watched with intense interest. If it is successful, FCC will be asked to authorize Phonevision as a public service.

**Microwave Relay Systems:**

Put down multiplex microwave systems as an added source of sales for communication equipment that will run to very big dollar volume in 1951. First of these systems are just getting into use. Initial performance gives assurance that such systems can serve many purposes in a wide range of industrial applications. Thus, many pending projects will be released early next year. Undoubtedly, some will be expedited for reasons of national security.

**NAB Convention:**

Will be held April 15 to 19 at Hotel Stevens, Chicago, with concurrent engineering and management sessions. Eugene S. Thomas, of WOR, is the convention chairman. Shorter session will have a fast-moving pace, and reduce cost to the exhibitors.

**Radiocom for Export:**

It's surprising to see how much radio communication equipment is being built for export. Much of it is going to industrial projects financed by US money.

**New Officers Appointed:**

Two old-timers at Eitel-McCullough, Inc. have been named vice presidents. They are George F. Wunderlich, vice president and general manager, and Harold E. Sorg, vice president in charge of research.

**Frequency Shift Converter:**

Specifications are now available on a new, compact unit developed by Northern Radio Company, Inc., 143 W. 22nd Street, New York 11. It is a dual-channel design, for single and diversity receiving systems, carried on a 19-in. rack panel only 7 ins. high. Mark and space tones are converted into DC pulses to drive teleprinters, tape, and other recorders directly with keying speeds up to 600 words per minute. A 2-in. panel-mounted oscilloscope provides a tuning pattern for adjusting the receiver.

**Engineering Sales Office:**

Opened by Andrew Corporation at 18A Georgian Court, Bergenfield, N. J. The manager is Karl Sterne, who has come on from the Chicago factory. Telephone number is Dumont 4-5688.

## Special Services Directory

# and now--
# the **magic link**
# for closed circuit tv

*Camera Signal* *The Dumitter* *Standard TV Receiver*

# the **dumitter**

Actually a miniature closed-circuit television transmitter. Takes signal directly from any standard camera chain, modulates a carrier frequency of either Channel 2 or 3, and feeds via cable directly through the antenna posts of standard TV receivers. Receivers operate exactly as though tuned to a telecast on that Channel.

Performance superior to other forms of transmission. Audio and video reception absolutely free from outside interference. Truly, the MAGIC LINK for closed-circuit television.

Ideal for use in industrial television applications, for field demonstrations of TV receivers, for studio use, for sales meetings, and countless other uses. Does away with expensive, bulky equipment and circuitry modification of receivers.

- Feeds up to 125 standard TV receivers.
- Distributes signals on standard TV Channel 2 or 3 via cable through regular antenna posts of receivers. No modification of receivers necessary. Receivers may be switched to regular telecast reception at any time.
- Feeds receivers both video and audio through single coaxial cable up to several thousand feet.
- No terminal equalization necessary as attenuation is only at carrier frequency.
- Uses signal from any standard camera chain without interim equipment.
- Completely stable — requires no operator.
- Light, compact, completely stable.
- No license required.

DUMONT

*First with the Finest in Television*

ALLEN B. DU MONT LABORATORIES, INC.
Television Transmitter Division, Clifton, N.J.

# WHAT'S NEW THIS MONTH

## AN OBSERVER'S COMMENTS ON THE ARGUMENTS PRESENTED IN RCA'S SUIT TO RESTRAIN THE FCC FROM ADOPTING INCOMPATIBLE TV COLOR STANDARDS

WHAT will be the final outcome of RCA's suit to block the adoption of CBS standards for color television? We can't even venture a guess because it will be determined by both findings of fact and conclusions of law. The Court promptly issued a temporary restraining order, halting the adoption of CBS standards by the FCC, pending a final decision. That, Judge J. Earl Major said, will not be "today, tomorrow, nor in the right near future."

If we have read the FCC's reply brief correctly, it will not contest an adverse decision if the Court finds that the Commission's action was arbitrary. On the other hand, we expect that if the Commission is upheld, RCA will appeal to the U. S. Supreme Court.

In any case, there is no reason to expect the production and sale of equipment for any color system as long as the industry is confronted with increasing limitations on materials for civilian goods, a growing shift of engineers to work on Government contracts, and the possibility of going back to all-out military production.

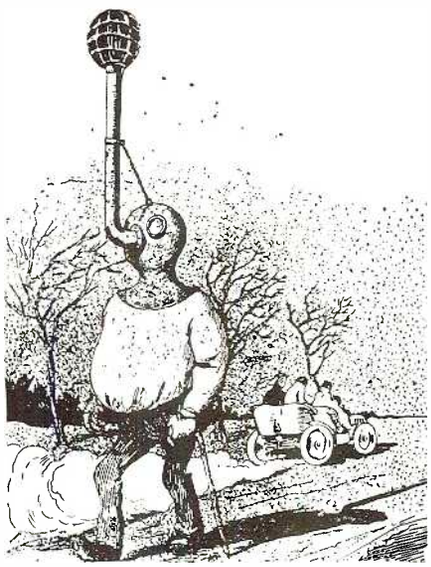
If space were only available, a fascinating story could be told of the hearing at Chicago on November 14 and 15, for the whole future of color television hung in the balance of persuasion as the lawyers, presenting their arguments, seemed to add weight on this side or that.

The scene was laid in one of the big, somber court rooms in Chicago's Old Post Office Building. Behind the high bench sat Judge Major, a Chief Justice of the U. S. Court of Appeals, flanked by District Judges Philip L. Sullivan and Walter J. La Buy, each in a huge, high-backed rocking chair. Directly below them, grouped around big tables, were the lawyers and their associates. At the extreme right and left were the contingents of the defendants and plaintiffs, and a few reporters. To our surprise, we seemed to be the only representative of the radio-electronics papers.

The hearing was a compelling drama, with each lawyer playing a leading role in the succeeding acts. John T. Cahill, general counsel for RCA, was forceful and convincing. He had the advantage of an offensive position, for he was supported by the reasonable assurance that science has not reached a dead end in the compatible color project.

The current volume of TV set sales is convincing evidence that there is no great urgency about color. Why, then, should the FCC be allowed to high-pressure the industry into furnishing stopgap means to provide the public with inferior black-and-white reception from color transmissions on present sets, or color receivers limited to picture tubes so small that, as sales records show, the public doesn't want them. Under these circumstances, how can the FCC's decision to adopt CBS standards be considered anything but arbitrary, and subject to restraint by the Court? That, in brief, was the case presented by RCA and the other companies who joined in this action.

John F. Baecher, Special Assistant to the Attorney General, Max Goldman, Assistant General Counsel of the FCC, and former judge Samuel I. Rosenman were in the more difficult position of supporting a cause which has been repudiated by virtually the entire radio industry, shunned by the broadcasters, and looked upon with indifference by the public.



*In 1902, a year before the first Ford was built, the odors and smoke from automobiles were considered so objectionable as to inspire this cartoon. Suppose a Federal Health Commission had told the car manufacturers: "In the interest of public health, the sale of gasoline will be stopped on January 1, 1903, unless this Commission receives assurance that internal combustion engines sold after that date will not emit noxious odors, smoke, or poisonous gases." If that had happened, we might be limited today to transportation powered by storage batteries. Today the FCC's attempt to regulate TV set manufacturers by indirection may well put a comparable limitation on the development of television.*

A review of the legal aspects of the hearing would not be within our province or capabilities. We can, however, present our views of the argument, in relation to our considerable knowledge of the facts.

First and foremost, we had the feeling throughout the presentation of the FCC's case that the Little Man Who Wasn't There, the one who received the least consideration from Messrs. Baecher, Goldman, and Rosenman, was Mr. John Q. Public, although his interests were most at stake.

To anyone who would accept Judge Rosenman's statement the "electrons send out red, blue, and green colors through the air," it might have appeared that the defense was concerned, at least in some respects, with public interest, convenience, and necessity. But it seemed to us that the entire effort was directed toward sustaining the Commission's decision on color TV standards.

Mr. Baecher quoted findings of various courts to support the FCC's contention that there are no grounds under which its decisions, having been reached by proper legal process, can be set aside. However, he did not claim that the Commission acted with any assurance of public demand for color reception of miniature-size images. Nor that the Commission is empowered by Congress to tell manufacturers that they must produce merchandise of certain limited characteristics whether their customers want it or not.

Mr. Goldman made a great point of the problem of registration on RCA's three-tube color receiver, in contrast to the CBS system that does not require registration. Perhaps he didn't know it, but the three-tube design was only intended to represent one stage in the development of an all-electronic, compatible system.

He stressed the fact that present sets could not give color reception from the RCA color system. He implied that this would be possible with the CBS system by the addition of an adapter and converter. We hoped that one of the Judges would inquire about CBS color on sets with tubes larger than 12½ inches, or ask if he knew that more than 90% of the tubes in use are too big to take the color wheel.

*(Concluded on page 36)*

# FM IN CANADA

## HOW CJSH-FM HAS QUADRUPLED FM LISTENERS IN ONTARIO WITHIN A YEAR — *By* DAVID I. KER*

FM broadcasters in Canada are confronted with problems similar to, but more acute than those which exist in the United States. The basic issue we must all concentrate on is that of getting a respectable number of FM sets in the radio homes we can reach. In this, the most densely populated and prosperous part of Canada, only 6% of radio homes have FM receivers. There is no FM-only set sold in Canada, and the cheapest FM-AM table model costs over $70. And CJSH-FM is one of the only two FM-only broadcast stations in the country!

In spite of these drawbacks, we have built an FM audience of over 20,000 Ontario homes in less than a year of operation, and probably as many more in upper New York State. Needless to say, this phenomenal success was not achieved accidently, but through a carefully-planned campaign. Details of our FM promotion are given in the following pages.

Apart from the difficult and somewhat frustrating task of overcoming the apathy of manufacturers and dealers toward FM, we have concluded that the success of our efforts to attract listeners and to create a demand for FM radios is dependent upon the following three factors:

1. Good equipment and a clear signal within a radius of at least 40 miles, to cover the Toronto-Hamilton market area.

2. Programming that will encourage people to buy FM radios in order to receive our station.

3. Effective promotion of our station and its activities.

These factors will be discussed in the order presented.

**Studio & Transmitting Equipment:**

The studios and offices of CJSH-FM are located in a renovated three-story stone mansion, Fig. 1. Our broadcasting operations are conducted on the ground floor. The second floor contains offices, and the third floor is an apartment for the assistant manager, who is also the program director.

The operating section consists of a control room with two announce booths of identical size on one side. A medium-sized studio is on the other. All these rooms are air-conditioned. The three studios have been given careful acoustic treatment. The floors of the control room and announce booths are of cork tile, and the floor of the large studio is of soft rubber tile, set on Ten-Test.

In addition, we have a small auxiliary control room adjacent to one of the announce booths, which we are at present equipping to handle our disc- and tape-recording work.

In the main control room, Fig. 2, four turntables enable us to play recordings of any speed or cut in current use. Also in the control room are two Magnecorder tape-recording units, which we find quite invaluable. These can be seen in the left-hand rack just behind the control console. At the top of this rack is the transmitter remote-control unit, and at the top of the right-hand rack is a Browning tuner.

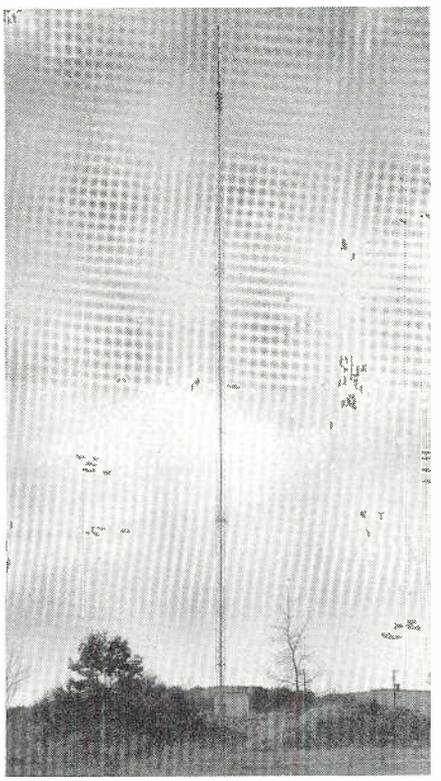
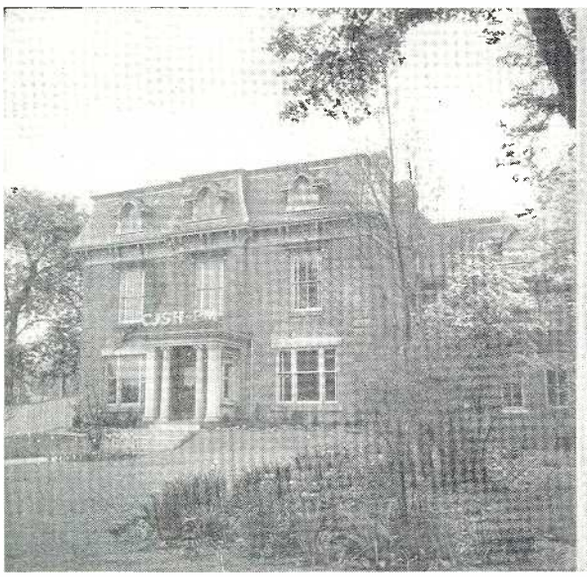


*Fig.3. The antenna and transmitter house*

Our transmitter and mast are located on Flamboro Heights, a 500-foot escarpment approximately 4 miles from our studio building. We have a 3,000-watt General Electric transmitter and a four-bay, circular GE antenna which provides an effective radiated power of 9,200 watts. This 60-foot antenna surmounts a 300-foot mast, which overlooks the Niagara Valley and the surrounding countryside from a height of over 1,100 ft. above sea-level. Fig. 3 shows the

* Manager, station CJSH-FM, Hamilton, Ontario, Canada.



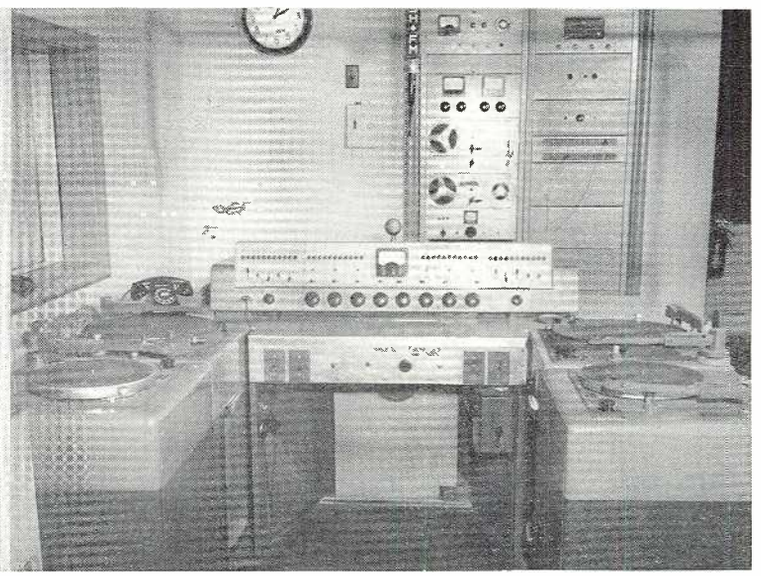



*Fig. 1. CJSH-FM studios, control rooms occupy first floor of this old stone house. Fig. 2. Main control room facilities*

antenna, mast, and the small transmitter house.

The transmitter is controlled from our studio building by a GE 26BCR1B2 remote control unit. By using two pairs of connecting lines, operation of the transmitter and the observation of pertinent circuits is accomplished. Indications of all the important transmitter circuits can be seen on the meter in the studio apparatus, which is switched by a dial mechanism. The transmitter is unattended, and is visited by the Chief Engineer only two or three times a week.

The location and power of our transmitter give us coverage with full limiting action beyond Toronto and Buffalo to the east, and as far west as London, Ontario, about 70 miles away. Our station has also been heard in New York City, Bay City, Michigan, and Montclair, New Jersey, all of which are over 200 miles distant.

When we went on the air last November, we started broadcasting with a 250-watt transmitter. The limitations of this low-power operation became obvious quickly to us and to our listeners, and we didn't waste much time upping our power. From our experience, I conclude that one of FM's major stumbling blocks in Canada at present is the operation of 250-watt FM transmitters by relatively high-powered AM stations. In general, FM in Canada has been a Cinderella with too many vain and near-sighted big sisters.

To improve our remote pickup facilities, we expect delivery soon of an REL 695 mobile FM transmitter, the first of its kind to be used by a private radio station in Canada. This 50-watt transmitter has a frequency response of 15,000 cycles and an operating range of approximately 35 miles.

### Importance of Programming:

At the present time, we begin broadcasting at noon and sign off at 11:15 P. M. Like many another FM station, our programming is slanted toward the middle- and high-brow music lover, whose attention is not cultivated by the local AM stations. These listeners constitute a somewhat select, but gratifyingly appreciative and faithful audience.

Every evening from Monday to Friday we have an hour and a half of classical music from 8:30 to 10:00. This begins with the half-hour Deems Taylor concert, and continues with an hour-long program featuring high-fidelity records, which we call "Masterpieces of Music." A typical example of our autumn schedule is given in Fig. 4.

There is a notable exception to our high-brow programming on Saturday evenings when, from 9:00 until midnight, we play popular dance music. This three-hour Dance Party program is presented to supply dance music for any high-school club or similar group. All they need to get their music is an FM receiver.

Another incentive for people to turn on their FM sets is news coverage every hour on the hour. Our association with the Hamilton Spectator is a big help to us in this respect. Local news is sent up to us from the Spectator by teletype. We obtain our national and international coverage by teletype from Press News, which combines the facilities of Canadian Press, AP, and Reuters.

Last winter we conducted a highly successful musical scholarship series, featuring fifteen-minute recitals by local amateur pianists and vocalists who competed for two $150 scholarships donated by the Hamilton Spectator. After selection of the four best recitals in each classification, a final adjudication was held in the spring before an audience in the Hamilton Conservatory of Music auditorium. We plan to hold a similar scholarship series this winter.

| TIME | FRIDAY | SATURDAY |
|---|---|---|
| 12.00 | Melody Magic | Melody Magic |
| .15 | Melody Magic | Melody Magic |
| 12.30 | News | News |
| .45 | Noonday Show | Noonday Show |
| 1.00 | News | News |
| .02 | Melodies by the Masters | Victor Record Album |
| .15 | Melodies by the Masters | Victor Record Album |
| 1.30 | Melodies by the Masters | Victor Record Album |
| .45 | Melodies by the Masters | Victor Record Album |
| 2.00 | News | News |
| .03 | Intermezzo | Intermezzo |
| .15 | Intermezzo | Intermezzo |
| 2.30 | Reflections | Jazz Corner |
| .45 | Easy Aces | Jazz Corner |
| 3.00 | News | News |
| .10 | Souvenir Songs | Souvenir Songs |
| .15 | Ray Block | Evelyn Knight |
| 3.30 | Daily Almanac | Daily Almanac |
| .45 | Daily Almanac | Daily Almanac |
| 4.00 | News | News |
| .03 | Varieties | Bandstand |
| .15 | Varieties | Bandstand |
| 4.30 | Listener's Request | Listener's Request |
| .45 | Listener's Request | Listener's Request |
| 5.00 | News | News |
| .03 | Tune Time | Tune Time |
| .15 | Children's Hour | Children's Hour |
| .45 | Blackstone | Children's Hour |
| 6.00 | News | News |
| 6.10 | Sports | Sports |
| .15 | David Ross | David Ross |
| 6.30 | Candle Light and Silver | Candle Light and Silver |
| .45 | Candle Light and Silver | Candle Light and Silver |
| 7.00 | News | News |
| .03 | So the Story Goes | Music of the Americas |
| .10 | Studio Guest | Music of the Americas |
| .15 | The Stars Sing | Music of the Americas |
| 7.30 | Language of Literature | Saturday Night Serenade |
| .45 | Music from the Shows | Saturday Night Serenade |
| 8.00 | News | News |
| 8.03 | Salon Musicale | Cavalcade of Music |
| .15 | Recital | Cavalcade of Music |
| 8.30 | Deems Taylor Concert | Curtain Calls |
| .45 | Deems Taylor Concert | Curtain Calls |
| 9.00 | News | News |
| 9.05 | Masterpieces of Music | Dance Party |
| .15 | Masterpieces of Music | Dance Party |
| 9.30 | Masterpieces of Music | Dance Party |
| .45 | Masterpieces of Music | Dance Party |
| 10.00 | News | News |
| .15 | Vic Damone | Dance Party |
| 10.30 | Studio Stage | Dance Party |
| .45 | Studio Stage | Dance Party |
| 11.00 | News | Sports |
| .05 | Sports | Dance Party |
| .15 | Sign-off | Till Midnight |
| 11.30 | | |
| .45 | | |

*Fig. 4. A representative program schedule*

Generally, we have tried through good programming to raise the cultural level of radio broadcasting in our area. Judging from the enthusiastic letters we receive, our efforts have been appreciated. Our announcers have been chosen carefully for voice quality and sincerity. Commercials are delivered in a restrained manner, and none of them is sung! While building up an audience, we have made little attempt to commercialize our time. This has become one of our strongest attractions, described by our listeners as too good to last. We are inclined to agree with them wholeheartedly.

I might say that we are not particularly clock-conscious. If a program is good enough we broadcast it in its entirety, even though it be two or three hours long. For instance, we recently broadcast a series of excellent BBC Shakespearian plays, most of which ran uninterrupted for over two hours.

By special dispensation from CBC, we have occasionally exchanged live programs with CFCA-FM in Kitchener, using a mast-to-mast pick-up. This is a precedent in Canada.

### Promotion of FM:

FM got off to a bad start at the hands of Canadian AM broadcasters. Little has been done, except in our area, to educate people to FM's superiority over AM. The interested support of our parent, the Hamilton Spectator, has been of invaluable assistance to us in tackling this problem. Without this support, it would have been next to impossible to establish an FM station here at present.

When we began broadcasting in November, 1949, the Spectator ran a special 12-page section devoted to the station, its programming plans, and the advantages of FM broadcasting. This section alone was credited by radio manufacturers with selling more FM sets in our area before Christmas than were sold in all the rest of Canada during that period.

The Spectator is the only daily newspaper published in Hamilton; its daily circulation of 80,000 copies blankets this market area. Each night the Spectator lists our programs in detail. We have an understanding with promoters so that when any celebrity visits the area, we make certain that his picture appears in the Spectator providing we are granted a live interview. From the celebrity's point of view, such a deal is far more advantageous than being interviewed at one of the two local AM stations. From our point of view, unlimited money couldn't replace the good will of the Spectator.

Besides newspapers and trade periodicals, our promotional media include cards, shadow boxes, and direct mail.

Generally speaking, we have found that our most effective promotion has been concerned with our activities and programs, rather than the advantages of FM over AM. The reason for this is, probably, that most FM radios sold up here are not good enough to demonstrate these advantages.

Our promotional efforts have been so successful that radio manufacturers consider our coverage area to be the softest market in Canada for FM sets. Consequently, the number of FM homes in this area has better than quadrupled since we went on the air a year ago.

*Why it is not Practical to Attempt*

# SET ADAPTION FOR CBS COLOR

## CBS AND FCC ESTIMATES OF ADAPTION AND CONVERSION COSTS CANNOT BE MET IF EQUIVALENT OPERATION IS REQUIRED — *By* ROY F. ALLISON

ACCORDING to impressions given by CBS and the FCC, there are two general methods of adapting conventional TV sets to receive CBS color transmissions in black and white. One approach is to make the necessary changes inside the set. Alternately, a small auxiliary unit containing the critical circuits can be connected to the set and switched in when required. It will be shown that neither method is economically practical if equivalent performance on both standards is required; that the cost of internal modifications which will provide even degraded performance with wide-angle tubes will be prohibitive; and that adapter units will exceed FCC estimates considerably in both cost and size. Internal modifications necessary to adapt a present receiver for both monochrome and color reception in black and white will be discussed first.

**Horizontal Deflection Circuits:**

Horizontal drive circuits usually incorporate some means of stabilization, and the modifications necessary for this section of the receiver would vary according to its complexity. In simple AFC circuits, at least three components must be switched: the capacitors across the discriminator transformer secondary and the reactance tube, and the RC network across the horizontal drive tube. The horizontal drive control could be used in both switch positions by proper choice of these RC loads. Depending on the specific circuit, it may or may not be necessary to switch the horizontal hold control.

In modern horizontal drive circuits, the switching requirements are not so simple. The horizontal lock and hold controls, discharge capacitor, drive capacitor, and stabilizing control must all be switched to provide satisfactory dual operation.

The horizontal output stage must undergo even more drastic revision, because of the greatly increased power requirement on CBS standards and because the CRT high-voltage circuit is involved.

A most significant factor of the increased line-scan and field rates necessary for CBS reception, so far as receiver adaption is concerned, is the reduction in both horizontal and vertical blanking times. This requires that the beam retrace time be reduced to less than ½ the retrace period permissible with present monochrome standards. Since the peak deflection current would remain unchanged, while the time of collapse would be halved, it followed that the peak retrace voltage and current would be doubled in the deflection circuits.

Thus, both the horizontal output transformer and the deflection yoke would be required under CBS color standards to handle at least twice the present peak voltage, and about 40% more average power. The horizontal output stage must be able to deliver this added power. In most cases another tube must be added in parallel with the present output tube, and the power supply called on to provide an extra 12 to 15 watts.

The deflection yoke and output transformer must be replaced with components designed to handle the increased power for the CBS standards. In addition, width and linearity controls must be provided for both switch positions.

If a new horizontal output transformer were used in both switch positions, the voltage fed to the high-voltage rectifier in the color position would be about twice that in the monochrome position because of the shorter retrace time. Consequently, there would be a noticeable change in brightness and width. Two practical solutions are possible:

1. Employing the shorter retrace time in both switch positions. This would require changes in the high-voltage circuit, because the voltage regulation would then be inadequate in the monochrome position.

2. Incorporating an automatic retrace-erase circuit, and retaining the longer retrace time in both switch positions. This procedure might well be less expensive and more satisfactory, even though some of the picture would be lost in the color position of the switch. It would eliminate the need for replacing the discharge element and high-voltage wiring, and for changes in the high-voltage circuit. However, it would still be necessary to replace the deflection yoke and output transformer, and to add a tube to the output stage.

Another advantage to the latter procedure is that the damper tube would not have to be tapped at a lower point on the output transformer because of the higher voltage caused by a shortened retrace time. It is highly probable that linearity would be affected detrimentally if a lower tapping point were necessary.

Where narrow-angle deflection tubes and low second-anode voltages are employed, it might be possible to make less drastic revisions. The present output tube and deflection yoke might be capable of handling moderately increased power. However, the output transformer must still be replaced, and high-voltage switching would be required. Also, picture size, brightness, and linearity could not be expected to be the same in both switch positions.

**Vertical Deflection Circuits:**

Extensive switching and replacement of components would be necessary in the vertical deflection circuit, also. In the vertical drive section, the following components must be switched:

1. Vertical integrator circuit
2. Discharge component
3. Vertical hold control (existing control used as fine adjustment)
4. Linearity control
5. Height control

Some difficulty might be experienced in attempting to force a vertical multivibrator to operate at 144 cycles, and it would probably be found necessary to switch the stabilizing coil if one is used. Most blocking oscillator circuits should be adaptable, however.

As in the case of the horizontal output circuit, the vertical deflection system must handle greatly increased power in the color position, because of the faster field rate and the decreased retrace time. A few receivers are designed with a safety factor sufficient to accommodate the extra load and higher voltage on the output tube and transformer but, in the great majority of cases, these components would have to be replaced with others of larger power- and voltage-handling capabilities. Output-circuit wiring must be replaced also because of the higher retrace voltage.

Some sets are supplied with vertical retrace-erase circuits. It would be possible to eliminate some modifications, at the cost of losing a part of the picture in the color position, by retaining the longer retrace time in both switch positions. A vertical retrace-erase circuit must be added if it is not provided. This would obviate the need of switching the dis-

charge element and replacment of the high-voltage wiring. However, the output tube and transformer would still require replacement. Such a circuit, obviously, is more practical in the horizontal deflection system.

**The Power Supply:**

With the increased scanning rates of both horizontal and vertical deflection circuits, about 50% more power would be required for these circuits in the color position of the selector switch. Thus, the power supply would have to furnish about 15 watts extra B power. In most receivers, this would be impossible without alterations. It would be necessary to replace the power transformer at least, and possibly the rectifier tube and the power supply choke if one is used.

The power supply components would require re-working for another important reason. When operating on the non-synchronous 144-field color standards, the 60-cycle supply and its harmonics could cause noticeable interference in both sound and video channels unless special precautions were taken.

A CBS color signal contains a component of 48 cycles, which is the color-field frequency. This component is especially strong when a scene is televised which contains a marked preponderance of either one or two of the three primary colors. It is zero only during a gray or white scene. When a 60-cycle hum component is present also, at almost any signal point in the transmitter or receiver, a 12-cycle beat frequency could be generated. This would produce a noticeable flicker.

Another type of picture interference, line jitter, could be caused by beats between a 60- or 120-cycle hum signal in the deflection system and the 144-cycle field-scan waveform. It should be emphasized that this type of interference could be generated not only by power-supply ripple, but by radiation.

The most obvious change required is that of additional filtering, both at the power supply itself and at strategic points throughout the set. High-voltage, high-capacity electrolytic condensers must be employed generously.

The extent of shielding required could be determined only by experiment. It is certain, at least, that both the power transformer and filter choke should be banded and shielded tightly.

Another problem would be presented by intercarrier receivers. If the intercarrier beat frequency were reduced to zero amplitude during the line-scan period, a buzz would be produced in the sound channel at the 144-cycle field rate. This effect could be caused by an overloaded receiver stage. Some protection could be obtained by increasing the AGC voltage, or by an input attenuator in high-signal areas.

**Summary:**

In order to provide reasonably equivalent performance on both CBS color and present monochrome standards, the following components or circuits would have to be switched:

Horizontal lock control
Horizontal hold control
Stabilizing control
Horizontal drive capacitor
Width control
Horizontal linearity control
Vertical integrator circuit
Vertical discharge component
Vertical hold control
Height control
Vertical linearity control
Stabilizing coil.

Thus, at least 12 switch sections would be required. Some trouble could be expected in properly locating the switch, since the sections serving the horizontal drive circuits must be placed in their immediate vicinity to provide short lead lengths. Two of the sections would have to handle heavy current.

In addition, the following components would require replacement or extensive alteration:

Deflection yoke
Horizontal output stage (add tube)
Horizontal output transformer
High-voltage circuit
Vertical output stage (replace or add tube)
Vertical output transformer
Power transformer and power-supply circuit
AGC circuit (intercarrier receivers)
Wiring in deflection output circuits.

It should be noted that these components are not all available readily. Suitable deflection yokes, components for the high-voltage circuit, and output transformers are not being manufactured at the present time.

However, it should be obvious that the cost of such alterations, when labor charges are included, would be such as to make internal modification quite impractical. Anything less than the modifications outlined would not provide acceptable performance on both sets of standards. It would also place severe strain on some components, with an increased vulnerability to breakdowns.

The Chapin-Roberts rate-recognition switch is not an adaptor, but merely an automatic switch for changing from CBS to standard monochrome reception. Its much-publicized installation in a Bendix 235M1 chassis has not been fully explained, but it is certain that the 5 switch sections shown do not provide performance in both positions equivalent to that of the original black-and-white circuit.

**Conclusion:**

It has been shown that internal modification is not a practical solution to the adaption problem. If a separate adaptor unit were designed, it would have to include complete sync and deflection circuits for the CBS color standards, exclusive of the deflection yoke. High-voltage switching, always dangerous, would be involved at the deflection yoke. Such an adaptor would be, in effect, a slave set without a picture tube. It is difficult to see how it could be built and sold at the FCC's estimate of $30 to $50. This is only a fraction of what it would actually cost at the retail price.

Since an external adaptor would represent such a considerable investment, it seems reasonable to suggest that a converter be included at the same time. This would require the addition of a 10- or 12-in. picture tube and related components, the color wheel, and provision for the extra sync circuit.

Then the owner would use his present set for monochrome reception, and the separate unit for CBS color. It might be necessary to move out part of the living room furniture to make space for this bulk of television equipment. More serious, however, is the fact that the added unit, complete with its whirling disc, would cost about as much as the original black-and-white receiver. But there would be only a small saving in omitting the color converter feature from the extra unit, and then the owner would have nothing but degraded black-and-white reception of CBS color to show for his new investment.

Considering the expense, inconvenience, and the uncertainty of satisfaction from present sets after they have been reworked so extensively, most owners will feel that conversion to CBS color is quite impractical.

**ABOUT THIS ARTICLE**

WHENEVER the question of compatibility has reared its ugly head, CBS color promoters have attempted to make it less frightening by proclaiming that adapters can be manufactured and sold for $30 to $50, and that a good serviceman can do the job for even less. The FCC, in attempting to defend its indefensible color decision, has echoed CBS to the syllable.

Unfortunately, the problem of adaption for CBS standards is not one which can be solved so simply or inexpensively. This is because the new standards require greatly increased scanning power, impose double the voltage stress on deflection circuit wiring and components, and reveal any power-supply ripple or radiation with embarrassing efficiency. Existing television receivers are, as a rule, unable to meet these added demands safely without extensive alterations — much more than $50 worth of alterations.

It would hardly be practical to convert an automobile so that it could fly, even though an airplane is another means of transportation. And, as is explained on these pages, the problems encountered in adapting a TV receiver to operate on radically different standards are relatively as sweeping — CBS and FCC notwithstanding.

*A Portable, Direct-Reading*

# FREQUENCY METER FOR VHF

## DESCRIBING A WIDE-RANGE VHF FREQUENCY METER WHICH CAN BE READ DIRECTLY WITH BETTER THAN .005% ACCURACY — *By* LEONARD CUTLER*

THE rapid expansion of VHF radio communication has emphasized the importance of strict frequency control, and the need for a versatile frequency meter to meet FCC requirements[1] under all conditions. Such a meter should have the following features:

1. Accuracy well within FCC requirements.
2. Extended coverage range.
3. Portability.
4. A dial reading *directly in frequency.*
5. Simple means of calibration.
6. Ease of operation.
7. Stability of calibration.
8. Relatively low cost.

The FM-1 frequency meter, shown in Figs. 1, 2, and 3, was developed by Gertsch Products to meet uncompromisingly every requirement listed above. This article describes the evolution of the circuits finally used to achieve our objective.

### General Considerations:

Several good frequency meters were developed just before and during World War II. Of these, the LM, BC221 and the TS323 Models had the desired features of portability, compactness, wide range, and accuracy. The LM and the BC221 covered frequencies from 125 kc. to 20 mc., and the TS323 covered frequencies from 20 to 450 mc. All three were heterodyne-type frequency meters, which measure the frequency of a signal with a calibrated oscillator by heterodyning the two signals and tuning for zero difference-frequency, indicated by headphones.

Assuming that the oscillator is calibrated accurately, the limiting factor of accuracy with these meters is the precision with which the frequency dial can be read. For example, if an accuracy of .005% is desired, the dial must be readable to one part in 20,000. Obviously, a single dial cannot be read with such accuracy. In the LM, BC221, and TS323 models, this difficulty was overcome by using a spring-loaded worm drive on the capacitor. This resulted in two dials, one on the worm gear and the other on the worm itself. The ratio of this worm drive is 100 to 1.

If, as in the T323, a 270° capacitor is used, there are 75 divisions on the worm gear dial. Every time the worm dial completes a revolution, the worm gear dial advances one division. This gives a potential accuracy of one part in 7,500. By using a vernier on the worm dial, this accuracy is increased to one part in 75,000. Therefore, better than .005% reading accuracy has been obtained. However, there are two undesirable features of this system:

1. *The dials cannot be read directly in frequency.* This is because it is practically impossible to obtain a linear relationship between dial reading and frequency to one part in 20,000. A linear relationship is required because two dials are used, one of them rotating many times throughout the tuning range. A capacity-tuned oscillator cannot be made linear to .005% with respect to the dials because the mechanical tolerances on any dimension of the capacitor must be held to one part in ten thousand which, in terms of plate spacing, amounts to about .00001 in., or 10 one-millionths of an inch. Such precision is difficult to obtain, and almost impossible to maintain. For this reason the dial is calibrated in arbitrary units, and a book must be supplied which indicates frequency as a function of the dial reading.

2. *The instrument is susceptible to change or loss of calibration.* If the calibration is disturbed by damage to the instrument, stress relief caused by aging of the variable capacitor or any other change in the oscillator tuned circuit, or if the calibration book is lost, the instrument must be recalibrated and supplied with a new book. This is a major project. For example, to calibrate a TS323 a secondary standard with 100-kc. harmonic output is required. The instrument is calibrated every 100 kc., and requires a total of 200 calibration points over the frequency range covered. The book is further subdivided to read in 10-kc. in-

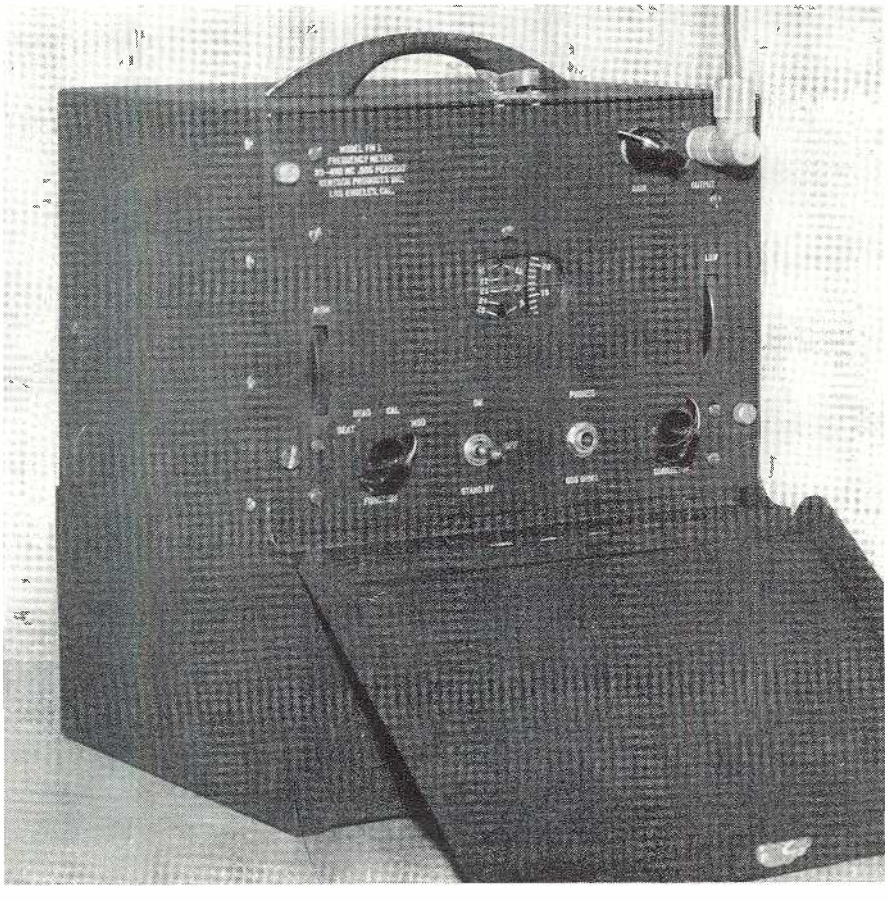


*Fig. 1. The FM-1 VHF frequency meter, which covers the range from 20 to 40 mc.*

*Chief Engineer, Gertsch Products, Inc., 11846 Mississippi Avenue, Los Angeles 25, California.

[1]Frequency-control requirements for each class of service are given in the MOBILE RADIO HANDBOOK, Chapter 2. Published by *FM* Company, Great Barrington, Massachusetts.

crements, making it necessary to interpolate between the 100-kc. calibration points in order to make the entries. A total of 2,000 entries must be made. Thus, it is apparent that the process is laborious and expensive.

The FM-1 overcomes these undesirable features, yet retains the accuracy and portability of the early models. It has three dials reading directly in frequency, no calibration book, and a simple calibration procedure. The dials are so divided that the smallest division represents 1 kc. Since the fundamental range of the FM-1 is 20 to 40 mc., reading the dials directly without interpolation or the use of a vernier gives an accuracy, at worst, of .005%. By interpolation between divisions, this accuracy can be increased about five times.

### Development of the FM-1:

Many ideas were tested before the basic FM-1 circuit was evolved. Most of the ideas examined can be grouped into two categories, as either single-oscillator methods or double-oscillator methods.

Our first design attempts utilized the single-oscillator method. Among these were the following variations:

1. An oscillator with a bandspread capacitor as well as a main tuning capacitor. The main tuning capacitor dial was to be calibrated in megacycles from 20 to 40. The bandspread capacitor dial was to be calibrated from 0 to 1 mc. in 1-kc. steps. Harmonics of a 1-mc. crystal oscillator would be used to calibrate the variable-frequency oscillator at 1 mc. and at .5-mc. points. To generate a desired frequency, say 27.15 mc., the main dial would be set at 27 mc. and the bandspread dial at 0 mc. The oscillator would then be calibrated by activating the 1-mc. crystal oscillator and adjusting a trimmer across the oscillator's tuned circuit until zero beat occurred with the twenty-seventh harmonic. The crystal oscillator would then be turned off and the bandspread capacitor dial set for .15 mc. The variable oscillator would, theoretically, be generating 27.15 mc.

This system works nicely in theory, but was found to be quite impractical. In order to have the bandspread capacitor cover exactly 1 mc. over the whole range of the main tuning capacitor, it was obvious that there would have to be some form of correction applied, such as a cam operated trimmer, padder or both. Even if such a correction were applied, the necessity for maintaining incremental calibration of the bandspread capacitor over the range of the main tuning capacitor presented formidable mathematical and mechanical problems.

2. An oscillator with a bandspread variable inductor as well as a main tuning capacitor. This was found to be impractical for the same reasons as the bandspread-capacitor method.

3. An oscillator with a mechanical bandspread. This, again, was found to be impractical because of the exceedingly fine mechanical tolerances required to comply with accuracy specifications.

Results of the investigation of specific single-oscillator methods indicate clearly that the general method is inadequate. It follows logically, therefore, that the use of an auxiliary oscillator is necessary. If two oscillators were employed, the main oscillator signal could be mixed with the signal from the auxiliary oscillator. The sum or difference frequency would be the desired output. For example, if it were desired to generate a signal of 27.15 mc., the main oscillator could be set at 27 mc. and the auxiliary oscillator at .15 mc. The sum would be the desired 27.15 mc. None of the difficulties of the single-oscillator method would be encountered, since the auxiliary or bandspread oscillator would be entirely independent of the main oscillator.

However, a new problem is evidenced. Not only is the desired signal of 27.15 mc. present, but also the main oscillator frequency of 27 mc., the auxiliary oscillator frequency of .15 mc., and the difference frequency of these two, or 26.85 mc. The final circuits employed in the FM-1 utilize the basic two-oscillator method, with refinements which reduce the undesired or spurious signals to a practical minimum.

It is necessary to have a standard of frequency in any heterodyne method of measurement. A 1-mc. crystal oscillator was chosen for this purpose. The harmonics of this crystal form an ideal main oscillator signal for the double-oscillator method. All that is necessary to generate a 27.15-mc. frequency is the twenty-seventh harmonic of 1 mc. plus a .15-mc. signal from an auxiliary oscillator. Thus, the crystal oscillator serves not only as a calibration device for the auxiliary oscillator, but also as the main oscillator.

A slight modification is necessary to make the system practical. To cover the band from 27 to 28 mc., using the twenty-seventh harmonic of the crystal, the auxiliary oscillator would be required to cover from 0 to 1 mc. This is an impossible task for any simple oscillator. However, if the twenty-sixth harmonic of the main oscillator were used, the auxiliary oscillator would then have to cover only the range from 1 to 2 mc. That can be more easily accomplished. This

*(Continued on page 28)*

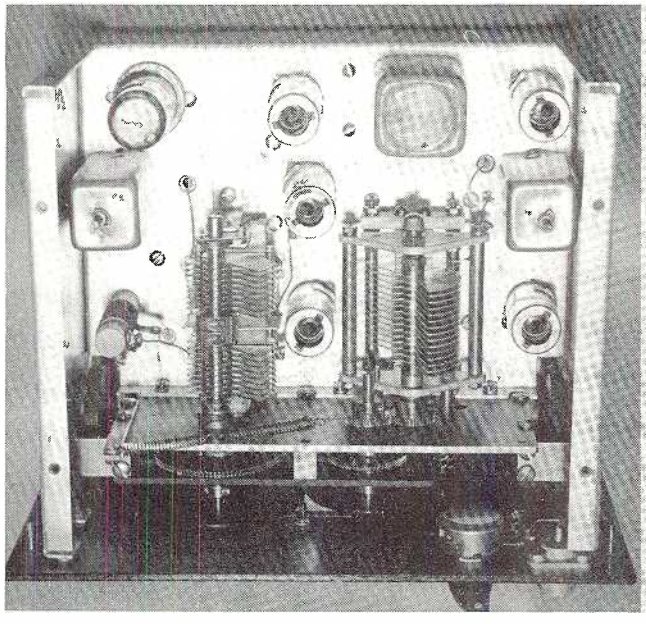


*Fig. 2. Top of FM-1. Note spring-loaded tuning mechanism. Fig. 3. Bottom view. Calibrating control is in left foreground*

# JEREMIAH COURTNEY'S MOBILE RADIO NEWS AND FORECASTS

IF you've ever wondered what happened to a mobile radio application after you sent it winging through the mails to FCC Secretary T. J. Slowie, who receives more fan mail than any ten movie stars, you are referred to the chart below.

### Central Relay Systems:

Commissioner E. M. Webster, in his French Lick, Indiana address before the Communications Section of the Association of American Railroads, has forecast the approval of central relay systems in the land transportation and industrial radio services. Although presently permitted in the public safety radio services, the Commission has not yet approved their use in any other services.

Webster made it clear that the authorization of central relay systems would be limited to the following cases:

1. Where there was an operating requirement as distinguished from an economic need for the central relay system; and 2. Where "the necessary extra frequencies are available locally from among those already allocated" to the service.

The utility of such systems appears from Webster's description of that method of operation as "involving transmission by a mobile unit, control station, or base station on one frequency; receipt of this transmission by a receiver at the relay station; automatic retransmission by the relay station on a second frequency; and receipt of this second transmission by receivers of all mobile, control, and base stations within range of the relay except the stations originating the message."

Desirable as these systems may be for particular users the fact is, as Webster emphasized, that each transmission simultaneously occupies two frequencies, i.e., the frequency on which the transmission originates and the frequency on which it is relayed; and the interference potential is extended equally with the mobile-to-mobile range of the central relay system. For those reasons, it was his opinion that these systems could only be authorized under the two conditions indicated.

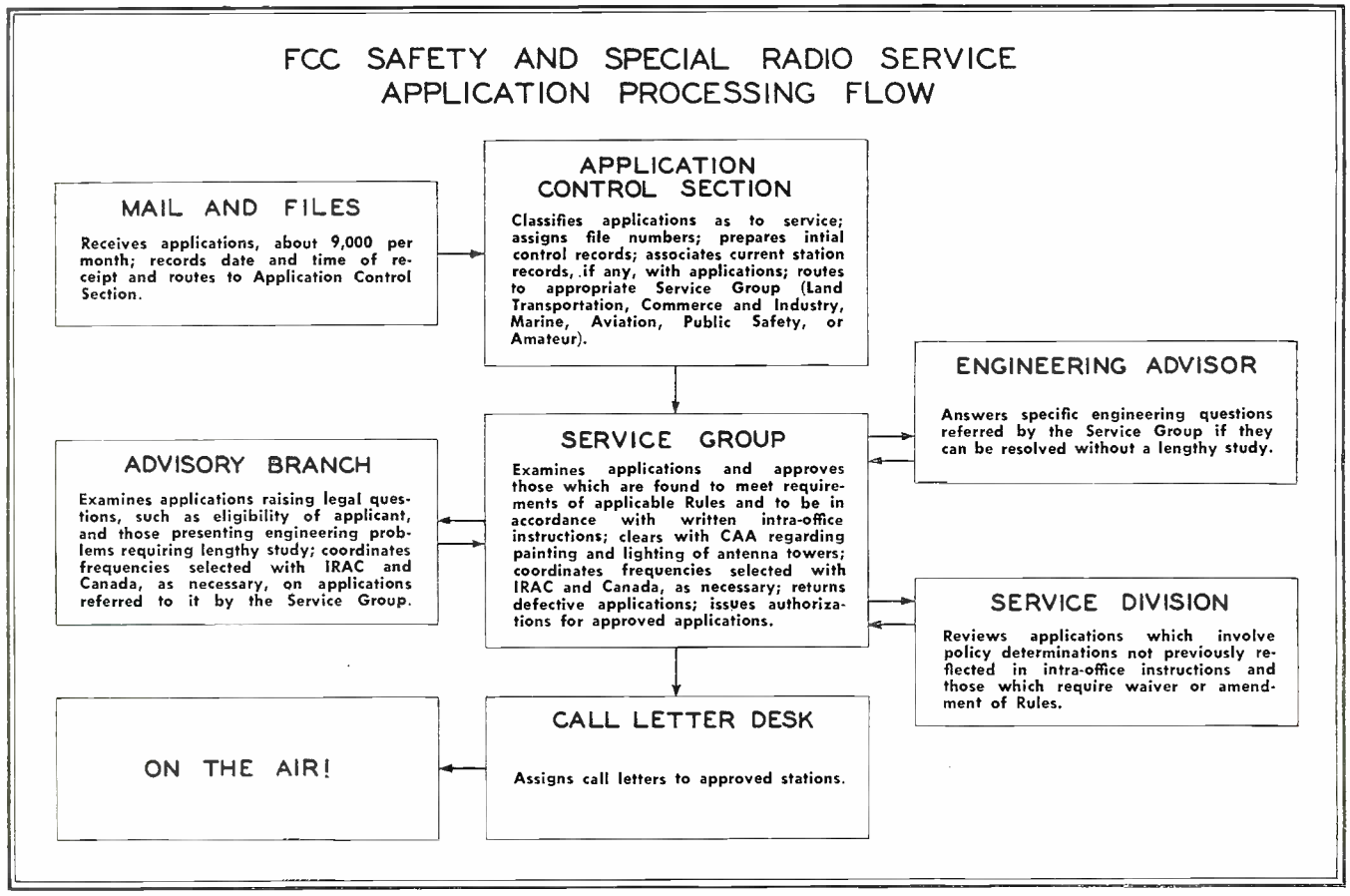
Reading between the lines, this proposal suggests that 152- to 162-mc. central relay systems will probably be permitted in low-population areas where frequency congestion is not a problem; but that the interference potentialities of the lower frequencies may require a further waiting period before opening up the 25- to 50-mc. band to such use, even in low-population areas. Definitive FCC proposal was expected shortly.

### 60 Kc. for Common Carriers:

National Mobile Radio System, country-wide association of miscellaneous common carriers, opened its second annual convention in Chicago simultaneously with Commission announcement that assignments in domestic public mobile radio service would henceforth be made on a basis of 60-kc. channel separations.

*(Continued on page 30)*

* 1707 H Street, N.W., Washington, D. C.




*This chart shows the flow of an application for radio communication facilities through the various offices of the Commission*

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*Reliable Electron Tubes for*

# AIRCRAFT COMMUNICATION

## HOW ARINC'S RELIABLE TUBE PROGRAM HAS REDUCED EQUIPMENT MAINTENANCE EXPENSES AND INCREASED DEPENDABILITY — *By* E. K. MORSE*

ELECTRONIC devices, like mechanical equipment, require periodic inspection and maintenance for reasonably dependable operation. However, the components of electronic equipment do not give the same degree of reliability as their mechanical counterparts. Of all these components, the electron tube is the least dependable. But reliability is of the utmost importance in airborne equipment. This article tells of the program undertaken by Aeronautical Radio, Inc., to improve the reliability of electron tubes, and the results we have obtained.

**Background of the Program:**

When navigation, communication, and traffic-control systems were first projected for the purpose of expanding air travel in the United States, it became evident that large quantities of air-borne electronic equipment would be utilized. Unfortunately, the nature of these electronic systems requires the use of tubes in series. Like a chain, the performance of their functions depends upon the soundness of each link. Adding more links, or tubes, increases the likelihood of failure proportionately to the number of tubes. Carried to a possible extreme, these systems would require a tube replacement every few minutes if tube reliability were not of a high order. Approximately 50% of present airborne electronic equipment failures are caused by failure of electron tubes.

During and since the war, considerable effort has been expended to improve such components as resistors, transformers and condensers. With the increasing numbers of tubes in equipments, and the greater dependability of other components, the reliability of these systems becomes more and more that of the electron tubes used.

Inspection and overhaul of the electronic equipment used in commercial aircraft is usually scheduled at the same time as the general aircraft maintenance. No equipment servicing is done away from the main overhaul base, but complete units can be replaced at certain stations along the route in case of failure. Equipment replaced at these stations is returned to the base for repair, and spare equipment is sent to the station. The faulty equipment is given a complete overhaul before it is returned to service. These off-schedule replacements are an expense over and above normal maintenance cost, which becomes very high when aircraft delays are caused. It was evident that greater reliability of the equipment would have to be obtained before full use of navigational aids could be made. After World War II, the commercial airline industry made a study of the problem with a view toward expansion of radio operations. Past records showed failure of one equipment using 14 tubes of a certain type every fifty hours, on the average, due to the failure of that type of tube. Plans for larger aircraft with electronic equipment containing three or four hundred tubes would have encountered a tremendous obstacle in maintenance costs alone.

Faced with this problem, the airlines initiated a program through its communications agency, Aeronautical Radio, Inc., to improve the reliability of electron tubes. In order to alleviate the situation immediately, a plan was formulated which would yield early improvement.

Since new equipment for aircraft was being designed for miniature tubes, it was felt that the program should concentrate on miniatures. Only those types required to provide the minimum functions necessary for airborne equipment were included. The group of ten tubes shown in Table 1 was chosen as a result of several meetings with other services concerned with mobile communications, and

TABLE 1

RELIABLE LONG-LIFE MINIATURE TUBES PREFERRED FOR AIRCRAFT EQUIPMENT

| TUBE TYPE | PURPOSE |
|---|---|
| 1. 5654 (6AK5) pentode | RF and Wide-band IF |
| 2. 5670 (2C51) twin triode | RF and AF |
| 3. 5726 (6AL5) double diode | Detector |
| 4. 5725 (6AS6) pentode | RF and wide-band IF (similar to 6AK5 with suppressor pin available for use in circuit designed to minimize receiver desensitization from noise pulses). |
| 5. 5749 (6BA6) pentode | Medium-frequency and low-frequency RF and narrow-band IF |
| 6. 5686 pentode | AF, RF oscillator and RF amplifier |
| 7. 5751 (Z-1764) hi-mu twin triode, similar to 12AX7 | AF and noise suppression |
| 8. 5750 (6BE6) pentagrid converter | LF and MF converter-timing circuits |
| 9. 5814 medium mu twin triode, similar to 12AU7 | AF amplifier |
| 10. 5727 (2D21) engineering not yet scheduled | Thyratron |

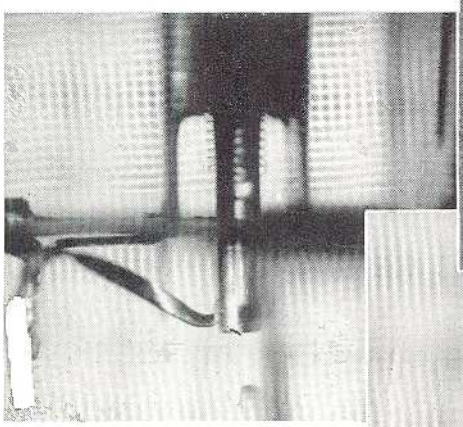


*Fig. 1, right: Miniature grid, common pin*

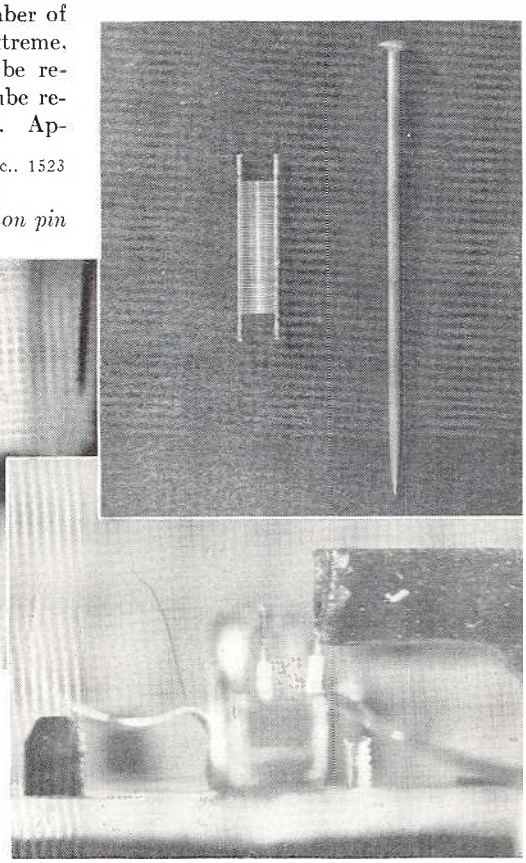


*Fig. 2, above: Grid-to-cathode spacing, greatly enlarged*

*Fig. 3, right: A magnified view of miniature-tube heater leads*

*Project Engineer, Aeronautical Radio, Inc., 1523 MAGAZINE, October and November, 1950.

with equipment and tube manufacturers.

Two tube manufacturers elected to participate in the program. Table 2 shows their estimate of the reliability which they felt could be obtained. Improvement was to be brought about by including, in the construction and manufacture of these tubes, materials, processes, and methods known to contribute to reliability and, as other factors which would increase reliability were determined, they were to be introduced.

TABLE 2

| Type of Failure | Per Cent Failures | Number of Tubes Failing* All Occur in Flight | Number of Tubes Failing* All Occur on Ground** | Tube Life per Failure* All Occur in Flight | Tube Life per Failure* All Occur on Ground** |
|---|---|---|---|---|---|
| Low gm | 0.2 | 2 | 2 | 500,000 | 500,000 |
| Broken glass | 0.1 | 1 | 1 | 1,000,000 | 1,000,000 |
| Broken base | 0.5 | 5 | 5 | 200,000 | 200,000 |
| Noise | 0.2 | 2 | 1 | 500,000 | 1,000,000 |
| Permanent short | 0.4 | 4 | 4 | 250,000 | 250,000 |
| Intermittent short | 0.5 | 5 | 2.5 | 200,000 | 400,000 |
| Open filament | 0.2 | 2 | 2 | 500,000 | 500,000 |
| Gas | 0.2 | 2 | 2 | 500,000 | 500,000 |
| Miscellaneous | 0.2 | 2 | 2 | 500,000 | 500,000 |
| **TOTAL** | **2.5** | **25** | **21.5** | **40,000** | **46,500** |

* Per 1,000 tubes operated 1,000 hours.

** Computed using ARINC formula given in Fig. 8.

NOTE: Above figures will not apply after first 1,000 hours of tube operation.

As their part in the program, the airlines agreed to return to the manufacturers all defective tubes with complete service data showing hours of service, equipment in which it was used, and the function for which it was employed. The defective tubes would be analyzed by the manufacturers and, based on their findings, remedial measures introduced in manufacture to eliminate the causes of failure.

### Production Techniques:

Basically, an electron tube is a mechanical structure composed of metal, glass, and mica, and is subject to failures common to all mechanical structures such as breakage, warping, and loosening of joints and supports. In addition, it is an electrical device whose function depends not only upon the geometry of the structure and the maintenance of that geometry but also upon the uniformity of the thermionic characteristic of the cathode throughout the life of the tube.

Improper mechanical design or faulty assembly results in early failure of the tube because of shorted or loose elements, heater breakage, microphonics or unstable operation; improper mixtures of cathode coating material result in failure from low emission. Other factors which affect the operation of an electron tube are the presence of gas within the bulb, and the conductivity of leakage paths which may form between elements of the structure.

It can be seen that many problems beset the manufacturer who would produce a tube with a high order of reliability. Careful and rigid controls must be imposed on all operations, from the selection of materials to the final test of the finished product.

In the ARINC reliable electron-tube program, every precaution is taken in the manufacture of the tubes to guard against all possible causes of failure. Tolerances permitted in the manufacture of the reliable tubes are much less than those of regular production. Critical grid dimensions of certain types are held to ± .0005 in. Fig. 1 shows a GL5670 grid beside a common pin. Enlarged views of the grid-to-cathode spacing and the heater connections are given in Figs. 2 and 3.

Other dimensions are of the same order. Adherence to small tolerances is insured by inspection of the parts at each stage of assembly, Fig. 4, employing a binocular microscope or similar device. Each major grid is checked by a contact micrometer or optical projection, as shown in Fig. 5. Welding of the cathode tabs is performed under a large magnifying glass, as are many other critical operations.

Assembly operators are compensated on a daily wage scale, and their earnings are independent of production quantity. They are encouraged to discard any part or assembly which does not measure up to the highest quality of workmanship. Fig. 6 shows a reliable tube assembly line at General Electric's Owensboro, Kentucky tube works, where the other photographs for this article were taken.

### Performance Tests:

The air exhaust machine is tested before each day's run to insure proper functioning. Strain patterns of the miniature glass button stem are checked before the regular run is started, and an hourly glass-quality test is made. As part of the manufacturing process, all reliable tubes are given a 50-hour burn-in run under

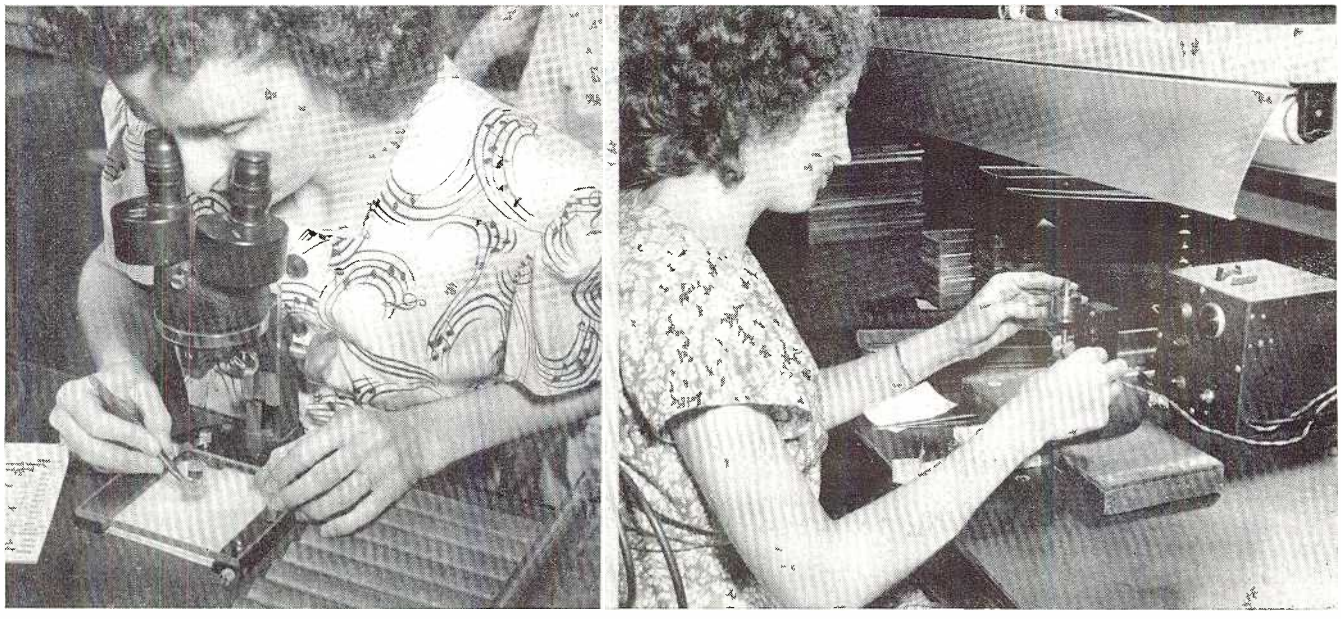


*Fig. 4. A binocular microscope is used at each assembly stage. Fig. 5. This girl is checking grids with a contact micrometer.*

element rated-voltage conditions. This process tends to stabilize emission and tube characteristics.

If new methods of manufacture or new techniques are proved to be applicable, they are adopted immediately. The effectiveness of the care which is taken in the selection of materials, methods, and operators in producing the reliable tubes is shown by shrinkage of the production during final test as compared with that of regular production. Shrinkage of reliable tube production is approximately 1%, while shrinkage in regular tube production is approximately 5%.

Maintenance of performance uniformity is controlled by application of the distribution-curve method rather than by a set of limits.[1] The following tests are applied to 100% of all production until sufficient data is built up to justify sampling, and the quality of the product is evaluated by this method:

Plate Current
Plate Current Cut-off
Heater Current
Emission
Transconductance
RF Noise

While JAN limits are used to determine the maximum spread of acceptable value variation, the median of the distribution curve of the product for the characteristic under test is allowed to vary only a small percent above and below bogie value. This results in a production with a high percentage of tubes whose characteristics are more nearly uniform than one which is controlled by limits only.

[1]See "Quality Control in Radio Tube Manufacture," by J. A. Davies, *Proceedings IRE*, May, 1949.

**ELECTRON TUBE RATING SYSTEM**

1. Two classes of rejects. Tubes causing:
   (a) Airborne equipment failure.
   (b) Tube failing or rejected during routine maintenance.
2. All defective tubes to be returned to ARINC. These tubes are to be accompanied by pertinent information and hours of operation as per attached Vacuum Tube History Sheet. These tubes will be analyzed in one of several tube laboratories.
3. Tube ratings will be prepared from airline reports and from the tube manufacturers' test of defective tubes.
   (a) The highest order of demerit is when a tube causes an airborne failure (equipment failure in flight).
   (b) The second order of demerit is an unsatisfactory tube below standards. These tubes are potential flight failures and are weighted accordingly.
4. The manufacturer will accept the airline Class A tube defect report and charge a demerit of 100% for all tubes reported. Class B tube defects reported by the airlines will be rated by the tube manufacturer as per the weighted values in 5.
5. (a) Inoperative — 100%
   (b) Noise and intermittent — 50%
   (c) Low-sensitivity, low power and all other causes — 100%. (Any tube defect causing an equipment outage will be rated 100%)
6. Average tube life per failure. This is the tube figure of merit.

$$\text{Tube life per failure} = \frac{\text{Total number of tube hours}}{\text{Number of failures (failures weighted per 5)}}$$

*Fig. 8. Outline of the system for keeping accurate records of tube performance*

Further control of reliability is maintained through sampling tests. Not all of these are applied to regular production. The following sampling tests are employed:

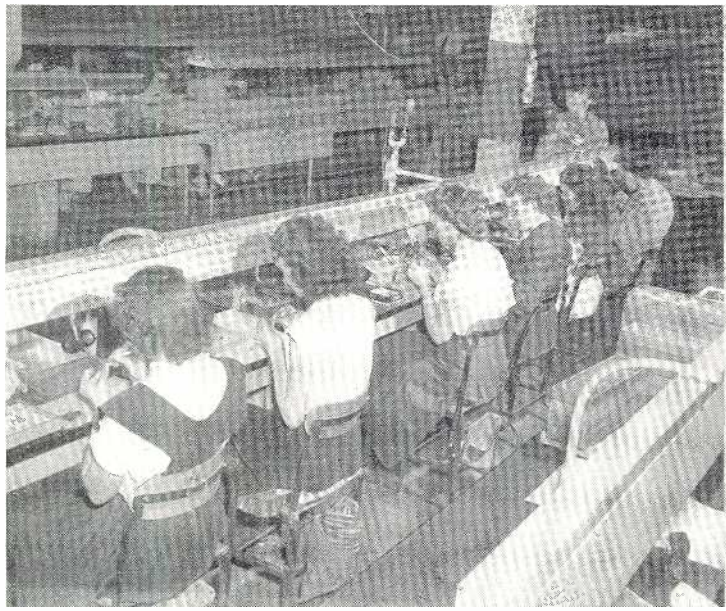
1. *Glass Quality Test.* An hourly glass quality test is conducted by subjecting a quantity of tubes from each hour's production to complete immersion in boiling water, from room temperature, for twenty seconds. The pins are subjected to outward pressure by a 5° cone inserted in the pin circle during this test. An additional test is sometimes made by permitting the cone to exert outward pressure on the pins of the tubes for 48 hours, without immersing them in the water.

2. *Heater Cycling Test.* A group of about fifteen tubes from each day's production is subjected to 2,000 heater on-off cycles. The schedule is one minute on and one minute off, using elevated filament voltage. One per cent failure is allowable. When sufficient history showing substantially less failure is accumulated, the number of tubes used in this test is reduced. However, if at any time the 1% figure is exceeded, testing of the larger quantity is again resumed. One manufacturer has not had a failure during this test for the past year.

3. *Shock and Vibration Test.* A small percentage of the daily production is subjected to the latest ruggedized JAN requirement of withstanding a 500G shock. Fatigue vibration tests are in accordance with the new JAN specifications for rugged tubes.

4. *Life Test.* A 500-hour life test is conducted with a small group of tubes from each week's production, selected to include samples from each day. Fig. 7 shows tubes on a life-test rack. The production represented by these tubes is withheld from shipment until the tests

*(Continued on page 34)*



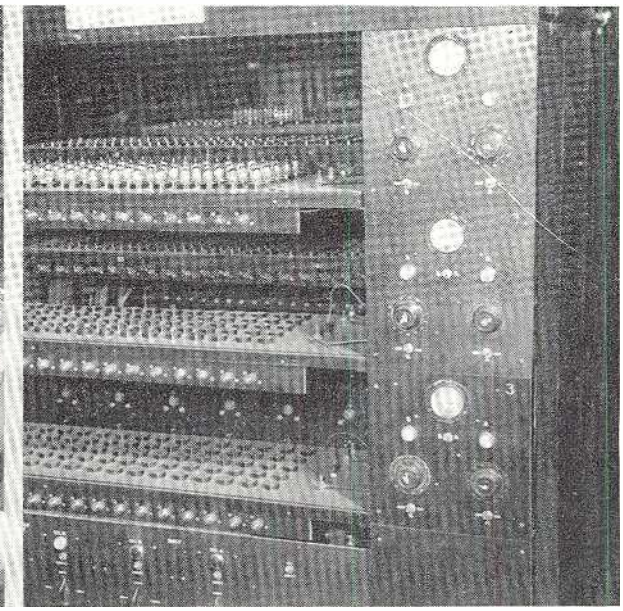


*Fig. 6. Reliable tube assembly line. Fig. 7. A tube life-test rack. Samples from each day's production must pass this test*

# NEWS PICTURES

1. Measurements Corporation has completed transfer of manufacturing and laboratory facilities to this new air-conditioned plant on Intervale Road, Boonton, New Jersey. The new building contains 25,000 ft. of usable floor space. Glass-block construction is employed in top sections of walls to admit maximum sunlight.

2. Multiple TV and FM antenna for erection on Empire State Building is inspected at RCA Camden plant by RCA and Empire State officials. Shown from left to right are Dana Pratt and W. W. Watts, respectively Manager, RCA Broadcast Transmitter Section, and Vice President, RCA Engineering Products; H. I. Gihring of RCA; General H. A. Drum, President of Empire State, Inc.; T. A. Smith and L. J. Wolf, General Sales Manager and engineer, respectively, RCA Engineering Products; and C. W. Lyon, Executive Vice President of Empire State, Inc.

3. Allied Radio Corporation's Auditioner console can select any one of 371,000 combinations of 60 custom high-fidelity components for customer comparison. Illuminated name-plates show which units are playing. Demonstration room duplicates listening conditions of average home living room.

4. In the first 2-way closed-circuit television conference on record, DuMont executives discussed mutual problems and answered questions of network affiliates. From left to right are Robert F. Jamieson, Commander Mortimer W. Loewi, Dr. Thomas T. Goldsmith, Jr., and Dr. Allan B. DuMont.

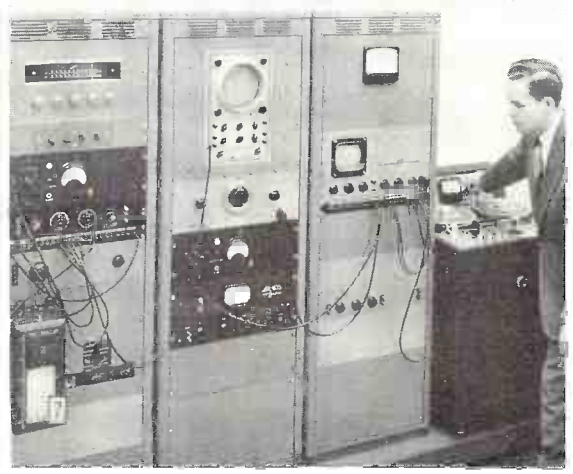
5. Seven Skylift materials-handling trucks at Johnson & Johnson shipping center in Metuchen, New Jersey, have been equipped with Motorola 2-way FM units. Trucks are controlled from a central dispatching station, with marked increase in efficiency.

6. Part of the 2-way FM radio network of the National Park Service, this repeater station at Olympic National Park contains one of the first installations of Motorola's new 3-kw. VHF transmitter. Three cabinets at right hold receiver and exciter, power supplies and control circuits, and power amplifier.

7. Minnesota Mining and Manufacturing Company has developed this laboratory analyzer for recording tape, recorders, and playback units. Output amplitude and uniformity at any frequency, signal-to-noise ratio, dynamic range, wow, flutter, modulation noise, harmonic distortion, or intermodulation can be measured in minutes.

8. Designed for extremely rough service, this adjacent-channel equipment by Bendix incorporates transmitter and receiver in a sturdy wrap-around housing with shock mounts. Unit provides 12 watts on 152 to 162 mc.

9. Hycon Manufacturing Company, 2961 East Colorado Street, Pasadena 8, Calif., announces a miniaturized oscilloscope designed for mobile applications. Response is said to be flat from DC to 2 mc., with no ringing or overshoot.

# THE FAS AUDIO SYSTEM

## PART 3 — HOW TO ADD AN AIR-COUPLER — HOW TO ADAPT THE COMPLETE FAS SPEAKER SYSTEM FOR ANY GOOD AMPLIFIER — *By* MILTON B. SLEEPER

IT has been emphasized in previous articles[1] on the FAS audio system that the design of the entire system is quite flexible, and that components of a quality equivalent to those used would produce comparable results. A logical corollary to this suggests that individual FAS components, or any combination of FAS components, could be used to improve the performance of an existing high-fidelity installation weak in certain respects. Fortunately, this is true. Those who have considerable sums already invested in audio equipment can obtain FAS performance at a minimum of cost. Thus, the FAS speaker system can be used in its original form with an amplifier having an 8-ohm output tap, or it can be adapted easily for use with one which does not. Alternatively, the air-coupler alone can be added to an existing speaker system to provide the missing bass.

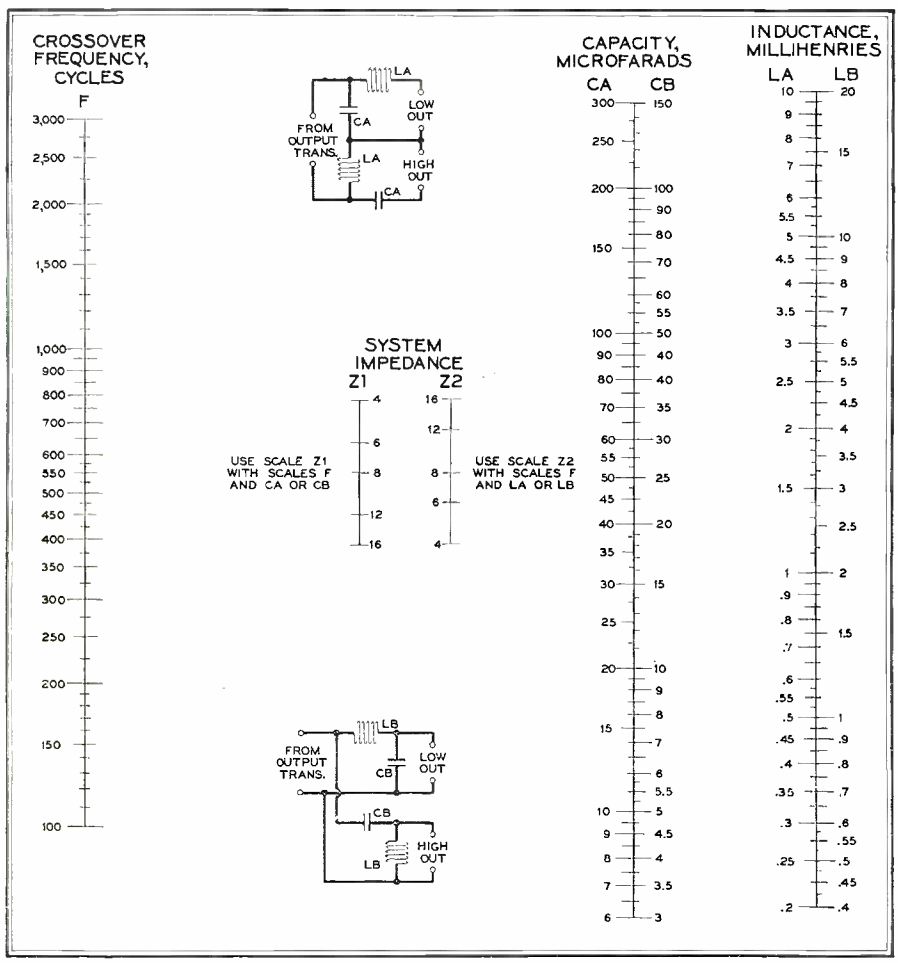



*Fig. 1. Component values for both series and parallel constant-impedance networks*

[1]*The FAS Audio System,* Parts 1 and 2. *FM-TV* MAGAZINE, October and November, 1950.

### Crossover Networks:

Since crossover networks are essential for satisfactory operation of the FAS speaker system, it might be well at this point to review the characteristics of typical networks.

The purpose of a simple crossover network is to divide the composite output from an amplifier into two frequency bands. Frequencies above a certain reference, called the crossover frequency, are routed to one network output; frequencies below the crossover point are directed to a separate output. The low frequencies are then fed to a large speaker, which is best suited for bass reproduction. Higher frequencies are usually supplied to a small cone speaker or a tweeter horn, which reproduces highs well but cannot handle lows efficiently. Better reproduction of both high and low frequencies is obtained in this way, because each speaker is operated within its most efficient range. Also, the tendencies toward intermodulation and high-frequency breakup are reduced.

There are two basic types of crossover networks, as follows:

1. The filter type. This is simply a high-pass and a low-pass filter, connected so that one circuit arm of the first half-section of each filter is provided by the other filter.[2]

2. The constant-impedance type. Values of chokes and capacitors are chosen so that a constant impedance is presented to the amplifier at all frequencies, providing the impedances of the speakers do not change with frequency.

Each type of network can be connected either in series or in parallel, as shown in Fig. 1 at A and B.

The 4-element filter type of network provides an attenuation to unwanted frequencies at the rate of 12 db per octave from the crossover point. However, component sizes differ in the two arms of the network.

For the constant-impedance network, attenuation to the undesired frequency band is 10 db at one octave from the crossover frequency, increasing 12 db per octave beyond. This attenuation is sufficiently close to that of the filter-type network so that, for practical purposes, they are equal in this respect. The advantage of constant impedance is more theoretical than actual, because speaker impedance varies considerably with frequency. Thus, the constant-impedance characteristics are questionable, and the two types are similar in performance.

However, there is one real advantage to the constant-impedance network. Components in each arm are identical, which simplifies computations and construction of the networks. It is for this reason that constant-impedance networks were used in the FAS system. Data given here is for this type.

One other characteristic of these networks should be mentioned. They are, in a certain sense, impedance transformers. When adjusted for any given input impedance, each output is of the same impedance as the input. This is true of both series and parallel circuits. Thus, if two 4-ohm speakers are to be used with the crossover network, the network should be designed for and connected to the 4-ohm output transformer tap.

[2]*Motion Picture Sound Engineering,* Chapters 29 and 30, D. Van Nostrand Company, Inc., New York.

### Use of the Nomograph:

Crossover network component values are determined by three factors: the system impedance, the crossover frequency desired, and the network configuration (series or parallel). Values for both series and parallel constant-impedance networks, for any crossover frequency from 100 to 3,000 cycles and for any impedance from 4 to 16 ohms, can be found from the nomograph in Fig. 1. CA and LA scales apply to components for the series type; CB and LB scales are for

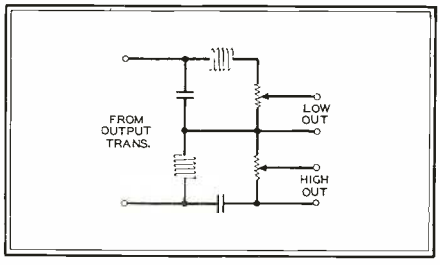



*Fig. 2. Series network and level controls*

the parallel type. Impedance scale Z1 is used with either capacitance scale, while Z2 is used with either inductance scale.

Performance-wise, there is little or no difference between the series and parallel circuits. However, one may offer constructional advantages over the other, as will be explained. An examination of the CA and CB scales in Fig. 1 reveals that the capacity required for the parallel network is always exactly half that needed for the series type. On the other hand, twice the inductance is required. The following factors should be considered when deciding which configuration to use:

1. Type of capacitors used. If it is planned to use paper or oil-filled capacitors, the parallel network will be considerably less expensive. But it is easier to wind chokes for the series type, and they are not so large physically. Therefore, a series network may be more satisfactory when electrolytic capacitors are employed.

2. Size of coil wire. Instructions for winding chokes of 2 wire sizes are given in the Design Data Sheet on page 26, this issue. If No. 16 wire is used, there is very little resistive loss in any choke size. But if the coils are wound with No. 26 wire, the performance of a series network will be much better than that of an equivalent parallel type, because of the smaller resistive losses incurred.

### Level Controls:

Fig. 2 shows a series network provided with speaker level controls. As can be seen, potentiometers are simply connected across both outputs, and the speakers fed from the movable contact arms. The resistance of these potentiometers should be as close as possible to 1.5 times that of the network impedance, in all cases. At least one level control is necessary, and two are preferable, for simple 2-way networks.

These controls serve two purposes. They can be used to adjust for differences in speaker efficiencies, which is their primary function. Another very important function is that of matching speaker impedances. For instance, it may be found necessary to use one 8-ohm speaker in a 4-ohm system, or a 15-ohm tweeter in an 8-ohm system. A mismatch which might otherwise be noticeable can be reduced to insignificance by the use of a speaker level control, set at the proper position. The control for the speaker of the incorrect impedance should be set to give the best possible impedance match. Then the other control or controls should be adjusted for correct relative volume.

There are two distinct schools of thought on the use of these controls. One camp holds that they should be used as operating controls, so that they can be adjusted to suit the mood or the particular musical selection. Certainly, some unusual effects can be achieved by their manipulation, especially when the individual speakers are well separated.

However, we are inclined to hold the opposite view. There are enough operating controls in the usual amplifier as it is. Besides, nearly the same effects can be obtained with the FAS speaker system by operation of bass and treble controls, if such are provided, and in a more satisfactory way. It has been our experience that the level controls, once set for optimum balance, should be tucked away inside a speaker cabinet or, alternatively, mounted on the back of a cabinet.

### Adding an Air-Coupler:

The circuit of Fig. 2, or the equivalent parallel network, is all that is needed to add an air-coupler to an existing speaker system. The input of the present system should be connected to the high output of the crossover network, and the air-coupler to the low output. The present speaker system should be used in its entirety, without alteration, on the high end. This is because the air-coupler is not a replacement for the usual bass speaker, but a means to extend the lower range smoothly from the point where the conventional bass speaker begins to falter. A tweeter cannot handle the full range above the air-coupler crossover point. Therefore, the present bass speaker must be retained in order to cover the middle range.

It is likely that the present woofer is well baffled. If it is, the crossover frequency can be made as low as 100 cycles. Such a low crossover point is desirable because the air-coupler is incapable of reproducing the higher frequencies without serious distortion. In no case should the low crossover point be made higher than 350 cycles.

### Complete Speaker System:

In order to construct a complete FAS speaker system adapted for use with other amplifiers, a 3-way crossover network operating at the amplifier output impedance is required. Networks of both series and parallel configuration are shown in Fig. 3. It can be seen that each is composed of a basic low-frequency network, as in Fig. 2, to which a high-frequency crossover network of similar configuration has been added at the high output. Thus, the low output of the high-frequency network contains frequencies between the low and high crossover points.

Computation of component values is carried out as follows:

1. Taking into account the factors outlined previously, the circuit configuration

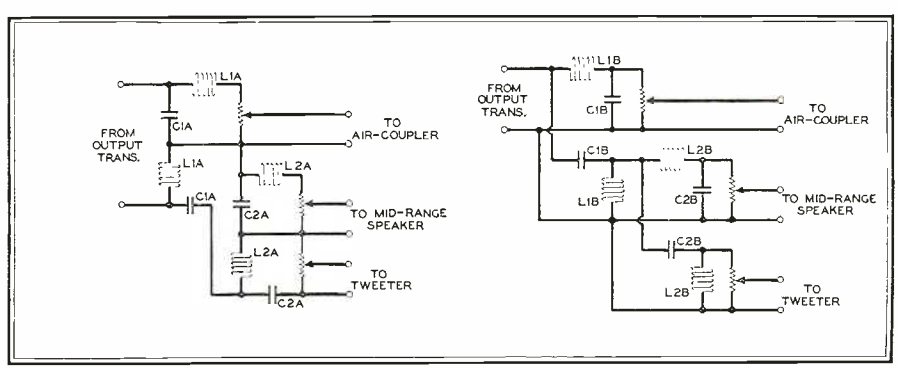



*Fig. 3. FAS three-way crossover networks. Three level controls are desirable*

and low crossover frequency is determined. Then the required values for L1A and C1A, or L1B and C1B, are found from Fig. 1 for the amplifier output impedance.

2. Using the same impedance and configuration, values of L2A and C2A, or L2B and C2B, are obtained from the nomograph for the high crossover frequency. This can be anywhere from 600 to 2,000 cycles, depending on the recommended frequency for the tweeter employed. If a small cone speaker is used

rather than a tweeter, 1,500 cycles is a good general crossover frequency.

3. Level controls are all of the same value, approximately 1.5 times the system impedance. These should be capable of handling about ¼ the maximum power of the amplifier. For general home use, a rating of 4 watts is usually sufficient for these components.

Complete data required for winding chokes of the correct value, using either No. 16 or No. 26 enameled copper wire, is given on page 26. The same general rules apply for choke mounting, speaker mounting, and positioning of the speaker enclosures as were given in Part 2 of this series.

### Speaker Phasing:

A most important requirement, that of phasing the speakers, was not discussed in Part 2 of this series. If the speakers are not phased properly cancellation will occur in the region of the crossover points, where two speakers are fed comparable amounts of power at the same frequency.

Phasing the speakers can be accomplished easily after all have been mounted in their cabinets. A frequency test record or, if the installation does not provide for phonograph reproduction, an audio signal generator is required. The high- and middle-range speaker cabinets are placed as close together as possible, in the same plane, and pointed in the same direction. Then a steady tone, at about the high crossover frequency, is supplied to the amplifier. Connections to one of the speakers are alternated to give the louder tone output, at which time the two speakers are in proper phase.

The air-coupler is then placed so that the port is close to the middle-range speaker, and a tone at about the low crossover frequency is fed to the amplifier. The air-coupler speaker connections which give the louder combined output are determined. All three speakers are then in phase. The polarity of these connections should be noted and marked permanently, so that they can be reconnected properly.

### Air-Coupler Performance:

The remarkable feature of the air-coupler is that it provides a full musical bass down to 20 cycles, it does this without any bass boost, and it maintains proportionate bass-frequency sound-power output down to low volume levels without the use of a compensated volume control.

One of the common complaints about "high-fidelity" systems is that they must be operated at a very high volume level in order to get optimum bass response. That is why enthusiastic listeners object to turning the volume down to a point where others can talk, or the children can study their lessons, or the baby can go to sleep. In apartment houses, the finest music may still be an annoyance to the neighbors.

The FAS system is a perfect and complete answer to all such complaints, because the relation of treble to bass is not altered when the volume is cut from maximum to bare audibility. Pedal notes from the organ, and the lowest tones of the tuba, bass drum, or piano are not lost at a level that does not interfere with conversation on a nearby telephone.

EDITOR'S NOTE: *An error was made in the parts list for the FAS amplifier, which appeared in FM-TV for October, page 29. C5, C6, and C7 are actually 16-mfd., 600-volt electrolytic capacitors, rather than 40 mfd., 600 volts.*

*Part 4 of this series will appear in FM-TV for February, 1951, and will cover experimental air-coupler designs.*

# DESIGN DATA for AF AMPLIFIERS — No. 6 Audio Chokes

**HOW TO WIND AIR-CORE AUDIO CHOKES FOR ANY INDUCTANCE VALUE FROM .1 to 15 MILLIHENRIES, USING EITHER NO. 16 OR NO. 26 COPPER WIRE**

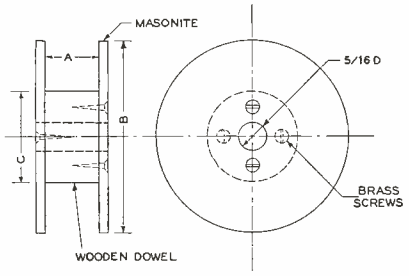



Fig. 1. Construction details of simple coil form

AIR-CORE AF chokes having low resistive losses are required for many special audio circuits, such as crossover networks, noise-suppressors, tone controls of the booster type, and miscellaneous filters. While inductance values for these purposes are generally available from tables, simple formulas, or nomographs, there seems to be little specific information on the design of coils for a given inductance. This is probably because the inductance of a coil is determined not only by the number of turns, but by the coil dimensions as well. These dimensions are in turn dependent on the diameter and length of the coil form, by the size of the wire used, and by the number of turns required. Thus, computations for a given inductance can become quite involved. It is necessary to reduce the number of variables in some way.

Some simplification is possible if a reasonable coil-form size and shape, such as in Fig. 1, is assumed for the appropriate wire size. This fixes the inner diameter and length of the coil, and the number of turns per layer. Then the inductance for any number of layers can be calculated easily, the resulting values plotted on a graph, and a curve drawn smoothly between the points to show the approximate inductance for any intermediate number of turns. Such a curve is, of course, valid only for a specific coil form and wire size.

Two series of coils are described in this Design Data Sheet, one wound with No. 16 and one with No. 26 enameled copper wire. Where resistance losses must be held to a minimum, or where a high Q is required, No. 16 wire is recommended. However, this results in chokes of rather large physical dimensions. If space is at a premium, or resistance losses not critical, No. 26 wire can be used.

Dimensions for the coil form shown in Fig. 1 are as follows:

| WIRE SIZE | DIMENSIONS, INCHES | | |
|---|---|---|---|
| | A | B | C |
| No. 16 | 1 | 4 | 1¼ |
| No. 26 | ½ | 2 | 1 |

Dimension B is not fixed, but should be slightly larger than the outer diameter of the coil. Values given are for 10-millihenry chokes. For larger or smaller inductance values, B can be adjusted accordingly.

The curves in Fig. 2 provide an accuracy of better than 5% for any inductance from .1 to 15 millihenries. This is sufficient for most applications similar to those listed previously.

Dowels of the correct diameter can be purchased at most hardware stores. The core should be cut accurately to the length given, for this dimension determines the number of turns per layer. There should be 19 turns per layer of No. 16 wire, or 29 turns per layer of No. 26 wire.

The center hole shown in the coil form is for the insertion of a ¼-in. bolt, secured by a washer and nut. The end of the bolt can then be fastened in a hand-drill chuck, and the coil wound quickly and easily; if the bolt is used to mount the coil, it should be of brass.

To minimize mutual inductance effects, pairs of coils should be mounted at right angles.

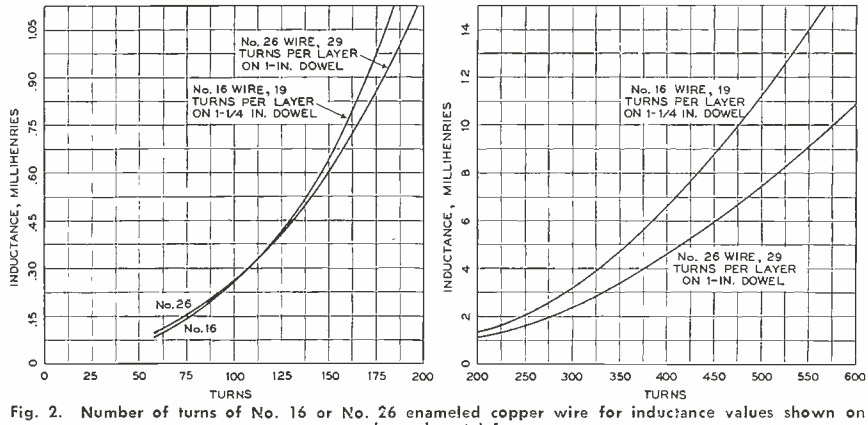



Fig. 2. Number of turns of No. 16 or No. 26 enameled copper wire for inductance values shown on the scales at left

Testing for sound lost between telephone receiver and ear. Many subjects were used in these tests.

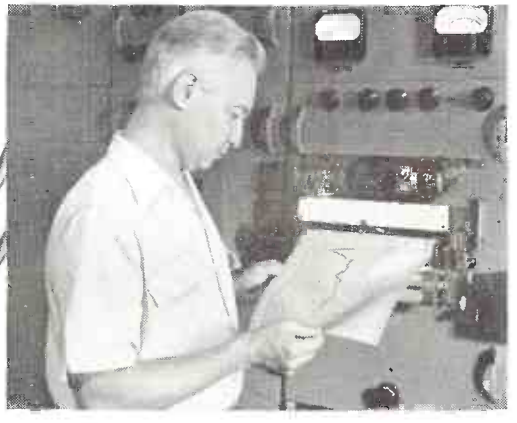
# How to compensate for a curl . . . and add to your telephone value

Bell scientists know that the telephone is not used under ideal laboratory conditions. There is never a perfect seal between receiver and user's ear. A curl may get in the way, or the hand relax a trifle. And ears come in many shapes and sizes. So some sound escapes.

Now, sound costs money. To deliver more of it to your ear means bigger wires, more amplifiers. So Bell Laboratories engineers, intent on a thrifty telephone plant, must know how much sound reaches the ear, how much leaks away. They mounted a narrow "sampling tube" on an ordinary handset. The tube extended through the receiver cap into the ear canal. As sounds of many frequencies were sent through the receiver, the tube picked up a portion, and sent it through a condenser microphone to an amplifier. That sampling showed what the ear received.

As a result, Bell scientists can compensate in advance for sound losses—build receivers that give *enough* sound, yet with no waste. That makes telephone listening always easy and pleasant.

It's another example of the way Bell Telephone Laboratories work to keep your telephone service one of today's biggest bargains.



Automatic recorder plots sound pressures developed in the ear canal at different frequencies.

BELL TELEPHONE LABORATORIES

Working continually to keep your telephone service big in value and low in cost.

## VHF FREQUENCY METER

*(Continued from page 17)*

method is employed in the FM-1, with the exception that the difference frequency is used rather than the sum.

**The Transfer Oscillator:**

If the system described were used without modification the output would contain, in addition to the desired signal, the undesired signals mentioned earlier plus sum and difference frequencies for every crystal harmonic, as well as the crystal harmonics themselves. All these undesired signals are actually eliminated in the output by means of a third oscillator, called the transfer oscillator. It is calibrated in megacycles over the fundamental range of the instrument. Provision is made to match the frequency of this oscillator to any frequency within the 20- to 40-mc. range that is generated by the combination of the crystal harmonics and the auxiliary oscillator signal. Then, by disabling the main oscillator and the auxiliary oscillator, the pure output signal of the transfer oscillator is obtained.

This process is reversed for measuring a frequency. The unknown frequency is first matched with the transfer oscillator, and the frequency is read to the nearest megacycle. Then the crystal oscillator and the auxiliary oscillator are activated and set up to zero the transfer oscillator frequency. The unknown frequency can be read directly from the dials.

Even though there are no undesired frequencies in the output of the instrument, there still remains the problem of undesired responses when the transfer oscillator is being zeroed to the difference frequency between the auxiliary oscillator and the crystal harmonics, or vice versa. It is obvious that if all the harmonics of the crystal oscillator were present during this matching process, many confusing beat notes would result. Such spurious beat notes have been reduced to a minimum in the FM-1. This has been accomplished in the following ways:

1. A crystal harmonic multiplier-amplifier is gang-tuned with the transfer oscillator. This selects and amplifies the proper crystal harmonic for the measurement being made and, at the same time, attenuates all other crystal harmonics.

2. A balanced modulator is used to mix the selected harmonic with the auxiliary oscillator signal. The crystal harmonic

*(Concluded on page 30)*

# *Information for Company Executives and Public Officials Responsible for the Operation of*

# COMMUNICATION SYSTEMS

THE Radio Inspector from your local FCC office is not only authorized but required to close down your radio communication system if he finds that adjustments affecting your mobile or fixed transmitters are made by anyone who does not hold a 1st or 2nd class radiotelephone license issued by the Commission. This has happened already in a number of cases.

### *Shortage of Licensed Operators:*

There is a serious and growing shortage of licensed radiotelephone operators. This is due to the large number being drawn off into military service, and to the fact that new radio systems are being installed at a faster rate than new operators are being trained.

You may have a full-time licensed operator in your employ now, or perhaps your maintenance is handled by an independent organization. But tomorrow, or next week, or next month your man may be in Government service, or hired away to work on one of the many new systems now being installed.

If that happens, no one can do any repair or service work that may affect the frequency of any transmitter in your system—until you can find another licensed operator!

### *The Problem of Replacements:*

Perhaps you haven't thought about this situation. Perhaps you have assumed that it wouldn't present any serious problem. But the fact is that you may be faced with shutting down your system for an indefinite period.

A shortage of operators licensed by the FCC now prevails throughout most of the United States. The faculty of the Cleveland Institute of Radio Electronics is aware of it because we see it on a national basis. From day to day, we receive letters, telegrams, and long-distance telephone calls from company executives and public officials asking if we can give them immediate information on Institute graduates available to handle the maintenance of communications equipment for public utilities, taxi fleets, air carriers, pipe lines, or police and fire departments.

Many of these requests are from companies whose operators have been hired away to work on newly installed systems, or have been called into the Armed Forces.

In years past, we have been able to fill most of these requests within a reasonable time. But now, although CIRE is graduating more licensed operators than any similar school, most of our students have jobs awaiting them when they enroll!

### *How to Anticipate Emergencies:*

The situation is now critical to the point that we strongly urge company executives and public officials to anticipate such emergencies without delay. Here is our recommendation:

Select a man, preferably within your organization, to be trained as a 2nd class radiophone operator, in accordance with FCC requirements. He should be at least a high school graduate who received high marks in mathematics and physics, and who has had radio experience as an experimenter, amateur operator, serviceman, or with the use of military radio equipment.

Then enter him for the CIRE correspondence course in Radio Communication. On request, we will send you our enrollment application. If we accept his qualifications, the Institute will guarantee that, upon completion of the course, should he fail to pass the FCC examination for 2nd class radiophone operator, he will be given further, special instruction without any extra charge, until he does pass. Our records show, however, that CIRE students are almost invariably successful the first time. Many pass the examination before they complete the course.

About 200 hours of study are required. Many companies are now putting their men on half-time schedules so that they can complete the course within 10 weeks. The total cost of the course is $89.75, payable in advance. This amount is subject to refund in full in case of any dissatisfaction within five days after receipt of the first group of study lessons. Currently, most employers are standing the full expense as an inducement to the men they select for training. Others are paying one-half, and making a small weekly payroll deduction to cover the balance. In either case, the cost is a minor matter compared to the security of having a licensed operator available to meet any emergency. The important thing is to act now to protect your radio system against being closed down before an emergency situation arises. The coupon below is provided for your convenience.

**Cleveland Institute of Radio Electronics**
**4900 Euclid Ave., Cleveland, Ohio**
**Att.: Edward Guilford, Vice-President**

Please forward enrollment application for CIRE Course, preparatory for FCC 2nd class radiophone operator examination. If you accept the qualifications of the man we select, we will promptly forward check for $89.75 to cover the total cost of the Course, subject to the guarantee that:

1. Our remittance will be refunded in full if, for any reason, within 5 days after receipt of the first group of study material, we are not completely satisfied.

2. If the man we select does not pass the FCC examination after completing the course, CIRE will provide additional instruction, without further charge, until he does pass the FCC examination.

Name .....

Company .....

Address .....

.....

**Note: This CIRE Course is approved for Veteran Training under GI Bill.**

## VHF FREQUENCY METER

*(Continued from page 28)*

is supplied from the tuned harmonic multiplier to the balanced modulator as a carrier, and the auxiliary oscillator signal is applied as modulation. The output consists principally of the sum and difference frequencies, if the modulator is perfectly balanced. Since perfect balance is impossible to attain, some crystal harmonic and auxiliary oscillator signals are passed. However, they are greatly attenuated. Harmonic output from the balanced modulator does not present any problem, since it is far removed from the frequency of operation. The net result is that the transfer oscillator can be zeroed with the proper difference frequency, with little interference from spurious signals.

A detector and an audio amplifier, to provide an audible indication of zero-beat, complete the instrument. The audio amplifier can also be used as an oscillator to modulate the transfer oscillator, if a modulated output is desired.

## MOBILE RADIO NEWS

*(Continued from page 18)*

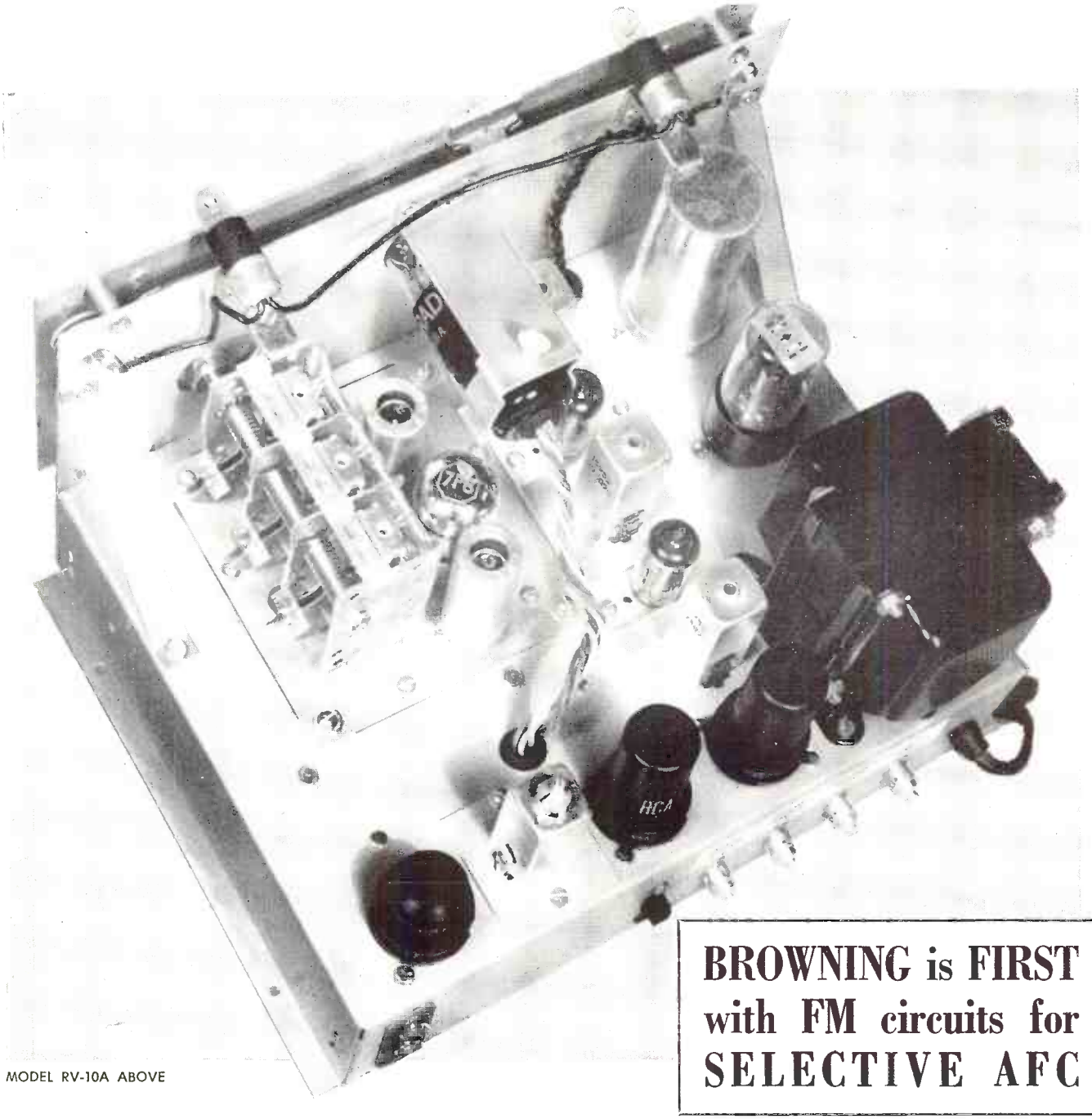
Arthur A. Gladstone, FCC head of common carrier mobile radio activities, spent a good deal of his first day at the convention explaining the import of the decision. He succeeded in gaining from the assembled carriers a high measure of acceptance for the Commission's action, despite the premature obsolescence involved for many of present 120-kc. equipments in use.

Although Gladstone didn't say so, the color television decision undoubtedly rates an assist on this one. After disposing of the argument concerning investment in 8,000,000 non-compatible black-and-white TV receivers, it was child's play to send a few thousand mobile transmitter-receiver units into untimely retirement, without even allowing oral argument on the subject. Only difference is that most mobile carriers own quite a few more receivers, and more expensive ones, than most TV viewers.

FCC withheld administering the *coup de grace* to the miscellaneous common carrier service by announcing that adoption of 60-kc. channel assignment policy did not necessarily mean that four separate carriers would be authorized in any one area on the four 2-way channels now available for assignment in that service. The number of miscellaneous common carriers to be authorized in any area was left to "careful case-by-case determination" instead.

Until some general principles are formulated on the amount of competition

*(Continued on page 32)*



MODEL RV-10A ABOVE

**BROWNING is FIRST with FM circuits for SELECTIVE AFC**

# Your Choice of These Three New Models

**Custom installation designers consistently prefer BROWNING tuners because they have such a long and consistent record of pleasing particular people.**

**Now that they have had a chance to check the advantages of Selective AFC on FM tuning, they are unanimous in their praise of this exclusive feature, now available in every BROWNING model.**

**There's another reason why so many experienced custom designers use BROWNING tuners in nearly all their installations. It is because the three different models afford such a wide latitude in mechanical and electrical arrangements.**

**Model RV-10A is the compact, low-cost, straight-FM type, to which the simplest or the most elaborate audio system can be added.**

**Model RJ-12B, for FM-AM, has a separate power supply so that the tuner can be fitted into spaces too small for a single-chassis design.**

**Model RJ-20A is a de luxe FM-AM tuner with such added features as adjustable IF bandwidth on AM, and an audio stage for treble and bass boost up to 18db.**

**All models have front-of-panel switching for FM, AM, TV audio, phonograph, and recorder, with separate inputs at the rear. All employ Armstrong dual limiter and discriminator circuits for extreme FM sensitivity and noise elimination. Each is priced for top over-all performance. For technical bulletins and price information, address:**

## Browning Laboratories, Inc.

**700 Main Street, Winchester, Mass.**

In Canada, address Measurement Engineering, Ltd., Arnprior, Ont.

## MOBILE RADIO NEWS

*(Continued from page 30)*

that is to be allowed in any one area, and the extent to which a single market is to be subdivided, it is difficult to see how any of the carriers can invest any large sums for equipment or lay any sound plans for the promotion and expansion of their service to the public.

**Mobile Use of 450 Mc:**

With two largest taxicab companies in Chicago (two of the largest in the country) filing first mobile applications for 450-mc. band, the mobile radio world stood by to watch developments. Incidentally, that is present status of 450- to 460-mc. mobile frequency assignments: developmental. However, as Colonel White, FCC mobile radio head, explained to ATA convention in Chicago, the developmental tag is not intended to scare anyone away from using the frequencies. In the case of the taxicab assignments in that band, the FCC has issued a long-outstanding invitation to taxicab operators and manufacturers alike to use the frequencies assigned there. Back in May, 1949, the Commission in its final report of allocations in the general mobile radio service docket proceeding observed:

"Finally, the Commission wishes to direct the attention of both taxicab operators and equipment manufacturers to the allocation of two megacycles of space between 450-460 mc. to the Land Transportation Service, one-half of which has been sub-allocated to the taxicab service."

**Developmental Advantages:**

The developmental assignment simply gives the radio manufacturer and user the widest latitude in the development of radio equipment suitable to the operational needs of the industry involved. In this case, the Chicago companies — Yellow and Checker Taxi — are both using Link equipment. Both companies plan to employ a network of eight base stations to cover the difficult, highly-industrialized Chicago area. Plans call for placing the first base station and mobile units in operation within one or two months after the FCC authorization is received.

**Miscellaneous Notes:**

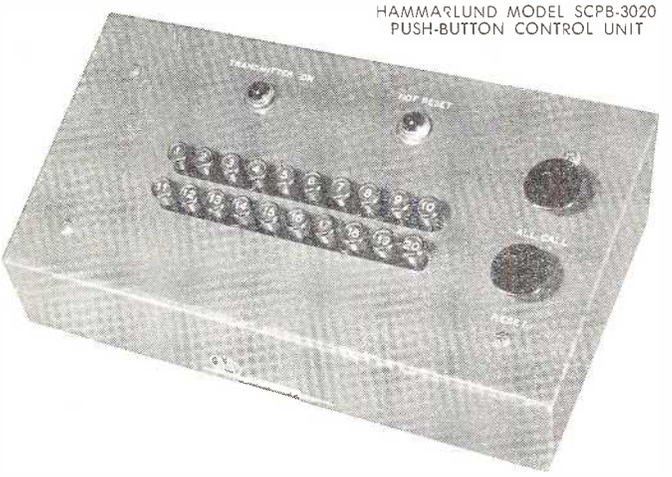
State Guard radio service has been re-established, with proposed Rules adopted in final form without change. Commission has announced that the entire allocation to the non-government fixed and mobile services between 1,850 and 13,200 mc. will be subject to reconsideration when television broadcast allocations are completed. Reconsideration announcement was made in connection with Com-

*(Concluded on page 34)*

# HAMMARLUND

## PUSH-BUTTON SELECTIVE SIGNALING SYSTEMS

HAMMARLUND MODEL SCPB-3020
PUSH-BUTTON CONTROL UNIT



**Hammarlund Selective Signaling Systems, successfully field-tested over a period of years, are specified by leading manufacturers of 2-way radio for all selective signaling applications because of guaranteed customer satisfaction.**

**Hammarlund Selective Signaling Systems permit greater utilization of manpower in public utilities, public safety, and industrial operations.**

**Hammarlund Selective Signaling is the only system fulfilling all requirements for selective control under exclusive supervision of the dispatcher.**

**Unsurpassed in economy, versatility, and reliability, due to the following features:**

**1) Instantaneous operation. Less than one second to complete a call.**

**2) Central operator can supervise length of ringing interval at remote unit.**

**3) Continuous alert signaling by bell, horn, or blinker light until locally reset.**

**4) Indicator lamp shows if you were called while absent.**

**5) Can be used with any manufacturer's receiver and transmitter. Any serviceman can make installation.**

**When used for Selective *Calling*, all features described for Selective *Signaling* also apply. Privacy equal to private-line telephone is provided. Speaker is silent until you are called. All stations except station called can be locked out if desired. Busy light shows when channel is in use.**

**Address all inquiries to:**

# HAMMARLUND MFG. COMPANY INC.

460 WEST THIRTY-FOURTH STREET, NEW YORK CITY, N. Y.

## MOBILE RADIO NEWS

*(Continued from page 32)*

mission decision to hold in abeyance petition of Federal Telecommunication Laboratories, Inc. for reallocation of the frequency band between 2,110 and 2,200 mc. to common carrier fixed service.

M. O. Sharpe, leaving FCC to become Superintendent of Communications for Trunk Line Gas Company of Houston, will be sorely missed as one of leading engineers on the Industrial and Commerce mobile radio staff. Mo has cushioned the blow somewhat by grooming of able engineer replacement. William H. Watkins, who has been working closely with him and Douglas Anello, legal advisor to the division, for several years.

Postponement of November 15 deadline, probably to December 15, for comments or objections to proposed marine radio service rules appeared certain as Mackay Radio & Telegraph Co., with others, asked for additional time. FCC has approved brief two-page annual report form of revenues and expenses (FCC Form L) for use by mobile radio common carriers. Commission has issued proposal looking to increase in tolerance from .4 to .5% for Class B citizens radio service stations, to facilitate the production of inexpensive walkie-talkie transmitter-receivers for this service.

## RELIABLE TUBES

*(Continued from page 22)*

are completed satisfactorily. The average life-test rating must exceed 90%.[2] When sufficient data is obtained showing continuous maintenance of satisfactory average life-test rating, the number of tubes tested from each week's production can be reduced. However, if at any time the rating falls below 90%, all stocks represented by that group of tubes are returned to the factory and full-quantity testing of sample tubes is resumed. The average life-test rating of recent lots of reliable tubes, representing all types now in manufacture, exceeds 97%. In some instances, life tests are continued up to 5,000 hours for additional data. It is planned to continue tests to 10,000 hours on a small percentage of the tubes.

**Results of the Program:**

A review of the service data compiled by ARINC on the first tube-type produced, the 5654, reveals a continuous improvement in quality. The initial production was far superior in performance to the commercial tube then available, and steady improvement in reliability has been noted.

In order to evaluate the reliability of tube performance, and to provide a basis for comparison of representative groups of tubes from time to time, a figure of merit derived in accordance with the ARINC formula is used. An explanation of this formula is given in Fig. 8. The figure of merit for tubes used in the second year of the program showed an increase in reliability of 30% over those produced in the first year. Obviously, such remarkable increases in reliability cannot continue, but smaller gains will be made until the ultimate reliability possible is reached.

The first tube considered under this program was the 6AK5. This tube showed the highest failure rate and was used in the greatest quantities. The primary cause of failure was heater burnouts. Examination showed failure was caused by two factors: 1. The use of molybdenum tungsten alloy as heater base wire, and 2. Sintering of the heater coating, caused by tube processing. By using pure tungsten, and adjusting processing schedules to avoid sintering, heater failures have been virtually eliminated. The second cause of failure in order of magnitude was tip cracks. The remedy was found in using heavy-wall tubing for the exhaust tubulation during the bulb exhaustion process.

[2]Life-test rating is defined as average tube life divided by the length of the test period. For quantity lots used, this is the sum of tube operating hours, divided by the product of the number of tubes times the test period in hours.

*(Concluded on page 35)*

## RELIABLE TUBES

*(Continued from page 34)*

The 5654, which is the reliable counterpart of the 6AK5, is practically free from these types of failures. The improvements made in this tube have also been applied to the others.

Since very few defective tubes are found which qualify for weighted values as provided in the tube rating system, the figure of merit is very nearly the actual average tube life which can be expected before failure, expressed in hours. The last computation of the figure of merit for the 5654 tube was 1600. At that time, the number of failures were very close to 2.5% of the total number of tubes in use, and included tubes with more than 1,000 hours service. This is evidenced by the fact that the figure of merit is well beyond 1,000. The failures within the first 1,000 hours were somewhat less than 2.5%.

The average life of the original 6AK5 was about 900 hours, not computed by the figure of merit formula. These two figures are not directly comparable, but an idea of the magnitude of the improvement may be obtained when it is realized that by the end of 1,000 hours all the 6AK5's were replaced, but only 2.5% of the 5654's would have been replaced at the end of 1,600 hours. Obviously, by using the 5654 a saving is realized in replacement cost alone, even though the price of the 5654 is four times that of the 6AK5.

### Conclusion:

The benefits to the airline industry of the reliable electron tube program are manifold. Increased reliability of electron tubes means greater reliability of the equipment and systems of which they are a part. This, in turn, directly affects airline operation since communication, navigation, and traffic control of aircraft are necessarily dependent upon electronic equipment. Increase in traffic handling at congested centers can be accomplished only by an increase in the number of electronic equipments and their reliability.

Industry-wide savings in the first year of the reliable tube program are estimated at $100,000 in tube replacement alone. Reductions in maintenance costs and mechanics' time in handling and servicing equipments and records account for an additional $150,000, giving a total of a quarter-million dollars saved the first year. With increased use of the reliable tube, greater savings can be expected. These savings and the greater reliability of airborne navigation and communications equipment has more than justified the reliable tube program already.




STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

Of *FM* AND TELEVISION, published monthly at Great Barrington, Massachusetts, for October 17, 1950

State of Massachusetts
County of Berkshire, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Milton B. Sleeper, who having been duly sworn according to law, deposes and says that he is the owner, publisher, and editor of the *FM* AND TELEVISION Magazine and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Milton B. Sleeper, Great Barrington, Massachusetts; Editor, Milton B. Sleeper, Great Barrington, Massachusetts; Managing Editor, none; Business Manager, Charles Fowler, South Egremont, Massachusetts.

2. That the owner is: Milton B. Sleeper db/a FM Company, Great Barrington, Massachusetts.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

*(Signed)* MILTON B. SLEEPER, *Owner*

Sworn to and subscribed before me this Seventeenth day of October, 1950.

[Seal] LILLIAN BENDROSS. *Notary Public*

Commission expires July 1, 1954.

## WHAT'S NEW THIS MONTH

*(Continued from page 11)*

At one point, Mr. Goldman did mention picture size, but he disposed of that by saying that big color pictures only await the development of the tri-color tube. He might have mentioned that no one knows how the tri-color tube will work with CBS transmission, but he didn't.

While Mr. Goldman argued the urgency of adopting CBS standards, and the ease with which manufacturers could build CBS color sets if they wanted to, we wondered if he would explain that such receivers would be limited to pictures of peep-show size not only in color but in black-and-white as well — pictures of a size already rejected by the public. Of course he didn't. We thought he should have, because he represented an agency charged with representing public interest. But, as we heard Mr. Goldman, he was pleading the case of the FCC vs. the radio industry. His concern with public interest was only as a subsidiary issue.

Judge Rosenman told the Court that the set manufacturers don't want color. They just want to keep on making black-and-white sets. He stated it as a fact. If he had been testifying under oath, that would have been struck out of the records as hearsay, or personal opinion. Probably he didn't know that the whole history of radio merchandising is one of keenest competition to be first with added features of performance. Or that the industry nearly wrecked itself by desperate efforts to shift quickly from audio to television set production.

Altogether, his arguments seemed to us vague and unconvincing, as if, while he tried to remember what he had been told to say, he hoped the Court would be impressed by the fact that he had once been an adviser to President Roosevelt. Thinking thus, we hoped that his advice was confined to subjects with which he was more familiar than the problems of color television.

We couldn't help but wonder how Commissioner Jones would have felt about these proceedings. Would he consider it ethical for lawyers employed by the FCC and CBS to withhold information from the Court merely because it was in conflict with the arguments they were employed to sustain? Would he hold that there is one book of ethics for engineers, and another for lawyers? Or, to paraphrase a statement from his 80-page castigation of expert witnesses, would he say that there is grave doubt that any lawyer can be relied upon to present the complete facts concerning any system if, by so doing, he might prejudice the interests of his clients?

# *Travis Offers Joy To Broadcasters*

AL TRAVIS, the recording supply maggot* doing business for some months now as BROADCAST ENGINEERS' SPECIALTY CO. (BESCO) states in part (and bless him for sparing us the rest), quote:

"ANYBODY can print a price list, but it takes exceptional foresight to propagandize the nation just before the aluminum-coaters stick out their hot mitts for more dough.

"Prices *had* to rise. The ever-increasing demand for single-face discs finally brought manufacturers to where, in order to fill orders, they needed such half-rejects disproportionately to good discs. Meantime, the cost of every thing and person in the coating shack had been going up, so the money bags had been grossing too little avoirdupois."

Al says the NEW prices of popular items typified below offer percentage savings as good as or better than before. (He says he got so rich on your past orders that he decided to soak up some of the chisel himself.)

16" "PRO" Double-Face Discs Each....$1.49

12" "PRO" Double-Face Discs Each.....85

Red Oxide Plastic Base Magnetic Tape, 1,250 ft.....2.95

Sapphire Resharp Service.....1.49
(one week plus travel time)

Al claims that any station or studio can steal this stuff at these prices by simply sending a check or a reasonable facsimile of a D & B rating. He guarantees the stuff, promises shipment in 24 to 48 hours and, tight as he is, he PREPAYS.

In addition to the trifles mentioned above, Al says he offers lots of other horrors which are concisely described in his literature. Even if BESCO moichandise is only mildly sensational, both customers and prospects say that Al's mail gives joy to otherwise nostalgic days. It may even help keep a bored engineer awake all morning. Clip the coupon and LIVE!

BROADCAST ENGINEERS' SPECIALTY CO.
101-38, 121 St., Richmond Hill 19, N. Y.
Dear Al:

We don't wanna buy nuttin' now, but we DO buy recording supplies, so please mail the dope.

Company .....

Address .....

.....

Name .....

* Magnets in short supply account recent cobalt cut.

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## for January to December, 1950



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## DESIGN PRACTICE



## TELEVISION

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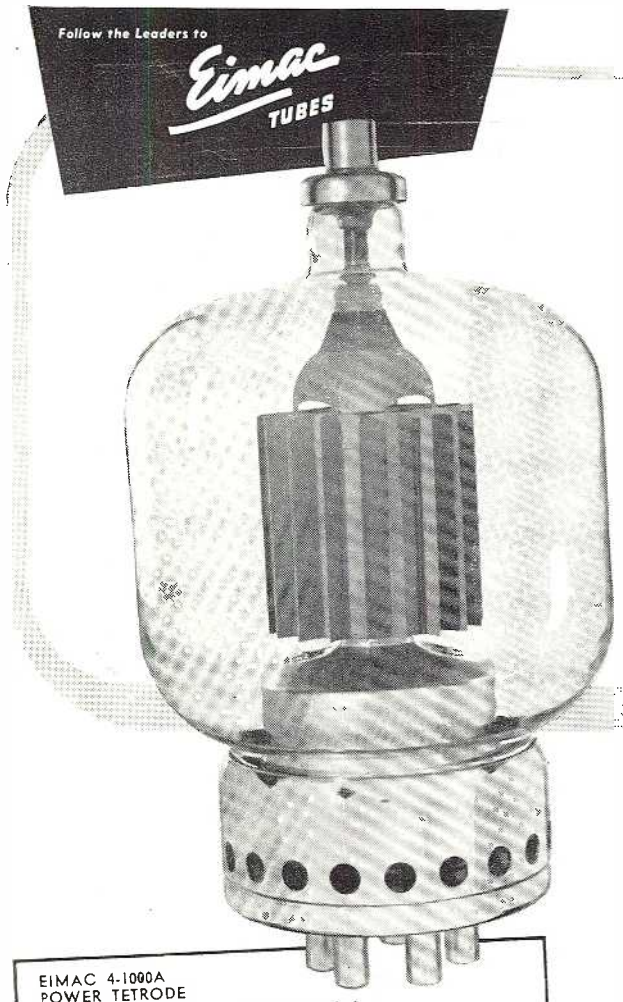



Eimac

# 4-1000A

## POWER TETRODE

EIMAC 4-1000A
POWER TETRODE

General Characteristics

| | |
|---|---|
| **ELECTRICAL** | |
| Filament: Thoriated Tungsten | |
| Voltage | 7.5 Volts |
| Current | 21 Amperes |
| Grid-Screen Amplification Factor (avg.) | 7 |
| Direct Interelectrode Capacitances (avg.) | |
| Grid-Plate (without shielding, base grounded) | 0.24 uufd |
| Input | 27.2 uufd |
| Output | 7.6 uufd |
| **AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR** | |
| TYPICAL OPERATION | |
| Class-$AB_1$ (Sinusoidal wave, two tubes) | |
| D-C Plate Voltage | 5000 Volts |
| D-C Screen Voltage | 1000 Volts |
| Max-Signal D-C Plate Current | 1.00 Amps. |
| Effective Load, Plate-to-Plate | 10,000 Ohms |
| Driving Power | 0 Watts |
| Max-Signal Peak A-F Grid Voltage (per tube) | 125 Volts |
| Max-Signal Plate Power Output | 3100 Watts |
| **PLATE MODULATED RADIO FREQUENCY AMPLIFIER** | |
| Class-C Telephony—Carrier Conditions | |
| TYPICAL OPERATION | |
| (Freqencies below 30 Mc., one tube) | |
| D-C Plate Voltage | 5500 Volts |
| D-C Screen Voltage | 500 Volts |
| D-C Plate Current | 600 Ma. |
| Driving Power | 9 Watts |
| Plate Power Output | 2630 Watts |
| **RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR** | |
| Class-C Telegraphy | |
| TYPICAL OPERATION, per tube | |
| (Frequencies below 30 Mc.) | |
| D-C Plate Voltage | 6000 Volts |
| D-C Screen Voltage | 500 Volts |
| D-C Plate Current | 15 Watts |
| Driving Power (approx.) | .7 Amps. |
| Useful Power Output | 3400 Watts |

## High-Power Amplifier Oscillator, Modulator

Eimac tetrode type 4-1000A is the electronic workhorse of modern communication systems. It is rated at 1000 watts of plate dissipation and is capable of efficient operation well into the vhf region. Like other Eimac tetrodes, the 4-1000A is readily 100% plate modulated.

At lower frequencies power gains of over 200 can be expected. Below 30 Mc. in normal operation 15 watts drive is sufficient to obtain output power in excess of 3000 watts per tube.

At 110 Mc. in FM broadcast service a pair of these heavy duty tubes will deliver over 5000 watts of useful power output.

In the adjacent column are highlighted typical operation data in more specific applications. Complete characteristics are compiled in a new data sheet . . . available by writing direct.

A 4-1000A is the economical vacuum-tube component for modern transmitters. Initial cost is low . . . tube life is long, consequently replacements are not only infrequent but also inexpensive. Consider it for your applications . . . Price $132.00.

**EITEL-McCULLOUGH, Inc.**
San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California 271

***Just off the press . . .***

***NEW, COMPLETE 4-1000A DATA...FREE***

# Linear Standard Units...

## THE ULTIMATE IN QUALITY...

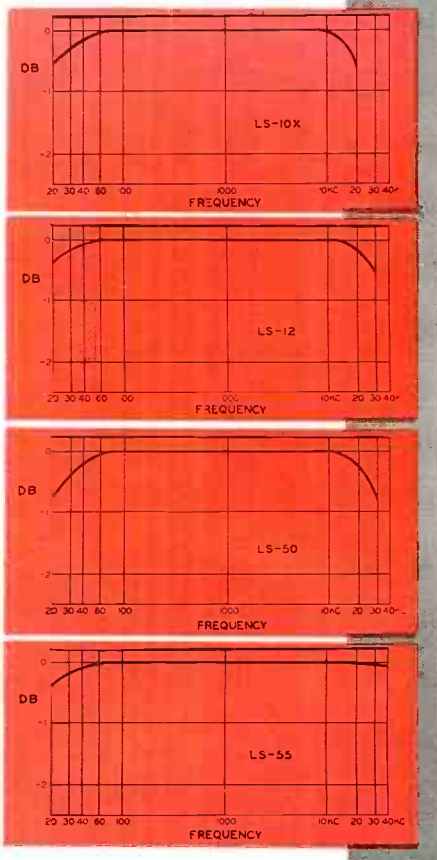
**UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability.**

*UTC Linear Standard Transformers feature . . .*

- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse coupling.
- **Reversible Mounting** . . . permits above chassis or sub-chassis wiring.
- **Alloy Shields** . . . maximum shielding from inductive pickup.
- **Hiperm-Alloy** . . . a stable, high permeability nickel-iron core material.
- **Semi-Toroidal Multiple Coil Structure** . . . minimum distributed capacity and leakage reactance.
- **Precision Winding** . . . accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **High Fidelity** . . . UTC Linear Standard Transformers are the *only* audio units with a *guaranteed* uniform response of ± 1 DB from 20-20,000 cycles.

## TYPICAL LS LOW LEVEL TRANSFORMERS

| Type No. | Application | Primary Impedance | Secondary Impedance | ±1 db from | Max. Level | Relative hum-pickup reduction | Max. Unbalanced DC in prim'y | List Price |
|---|---|---|---|---|---|---|---|---|
| LS-10 | Low impedance mike, pickup, or multiple line to grid | 50, 125, 200, 250, 333, 500/600 ohms | 60,000 ohms in two sections | 20-20,000 | +15 DB | —74 DB | 5 MA | $25.00 |
| LS-10X | As Above | As above | 50,000 ohms | 20-20,000 | +14 DB | —92 DB | 5 MA | 32.00 |
| LS-12 | Low impedance mike, pickup, or multiple line to push pull grids | 50, 125, 200, 250, 333, 500/600 ohms | 120,000 ohms overall, in two sections | 20-20,000 | +15 DB | —74 DB | 5 MA | 28.00 |
| LS-12X | As above | As above | 80,000 ohms overall, in two sections | 20-20,000 | +14 DB | —92 DB | 5 MA | 35.00 |
| LS-26 | Bridging line to single or push pull grids | 5,000 ohms | 60,000 ohms in two sections | 15-20,000 | +20 DB | —74 DB | 0 MA | 25.00 |
| LS-19 | Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary | 15,000 ohms | 95,000 ohms; 1.25:1 each side | 20-20,000 | +17 DB | —50 DB | 0 MA | 24.00 |
| LS-21 | Single plate to push pull grids. Split primary and secondary | 15,000 ohms | 135,000 ohms; turn ratio 3:1 overall | 20-20,000 | +14 DB | —74 DB | 0 MA | 24.00 |
| LS-22 | Push pull plates to push pull grids. Split primary and secondary | 30,000 ohms plate to plate | 80,000 ohms; turn ratio 1.6:1 overall | 20-20,000 | +26 DB | —50 DB | .25 MA | 31.00 |
| LS-30 | Mixing, low impedance mike, pickup, or multiple line to multiple line | 50, 125, 200, 250, 333, 500/600 ohms | 50, 125, 200, 250, 333, 500/600 ohms | 20-20,000 | +17 DB | —74 DB | 5 MA | 25.00 |
| LS-30X | As above | As above | As above | 20-20,000 | +15 DB | —92 DB | 3 MA | 32.00 |
| LS-27 | Single plate to multiple line | 15,000 ohms | 50, 125, 200, 250, 333, 500/600 ohms | 30-12,000 cycles | +20 DB | —74 DB | 8 MA | 24.00 |
| LS-50 | Single plate to multiple line | 15,000 ohms | 50, 125, 200, 250, 333, 500/600 ohms | 20-20,000 | +17 DB | —74 DB | 0 MA | 24.00 |
| LS-51 | Push pull low level plates to multiple line | 30,000 ohms plate to plate | 50, 125, 200, 250, 333, 500/600 ohms | 20-20,000 | +20 DB | —74 DB | 1 MA | 24.00 |
| LS-141 | Three sets of balanced windings for hybrid service, centertapped | 500/600 ohms | 500/600 ohms | 30-12,000 | +10 DB | —74 DB | 0 MA | 28.00 |




## TYPICAL LS OUTPUT TRANSFORMERS

| Type No. | Primary will match following typical tubes | Primary Impedance | Secondary Impedance | ±1 db from | Max. Level | List Price |
|---|---|---|---|---|---|---|
| LS-52 | Push pull 245, 250, 6V6, 42 or 2A5 A prime | 8,000 ohms | 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 | 25-20,000 | 15 watts | $28.00 |
| LS-55 | Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's | 5,000 ohms plate to plate and 3,000 ohms plate to plate | 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 | 25-20,000 | 20 watts | 28.00 |
| LS-57 | Same as above | 5,000 ohms plate to plate and 3,000 ohms plate to plate | 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 | 25-20,000 | 20 watts | 20.00 |
| LS-58 | Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's | 2,500 ohms plate to plate and 1,500 ohms plate to plate | 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 | 25-20,000 | 40 watts | 50.00 |
| LS-6L1 | Push pull 6L6's self bias | 9,000 ohms plate to plate | 500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2 | 25-20,000 | 30 watts | 42.00 |


United Transformer Co.

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# RCA SUPER Carfone 2-way radio system

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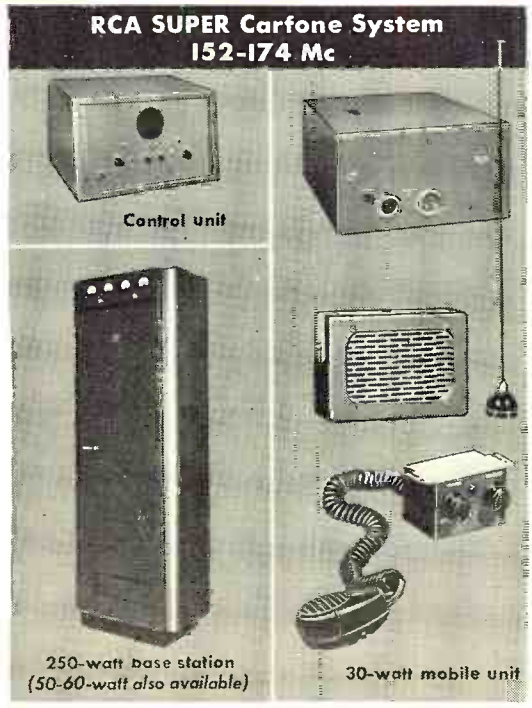
- Causes no interference to neighboring systems
- Pierces poor radio locations
- Clear reception through interference
- Improved message intelligibility

Now reliable communication in congested metropolitan areas is *a practical reality*—with the RCA SUPER Carfone System.

For example, radio vehicles can operate to within a few feet of adjacent-channel stations without receiving interference. Mobile units have the power to "override" the dead spots—communicate from inside the radio shadows of tall buildings and high hills. In the open country, a SUPER Carfone can increase your coverage *as much as 20%*. And that's not all!

SUPER Carfone Systems are engineered to do away with interference to other services, such as television, air navigation, and neighboring communication systems. Mobile units save substantially on tubes and battery... because they operate at low current on standby. Dynamic balancing reduces mechanical vibration—adds materially to equipment endurance.

Let us put complete information in your hands at once. Write Dept. 38L RCA Engineering Products, Camden, N. J.—*today!*

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