Price 35 Cents June '51

FM-TV RADIO COMMUNICATION

★ ★ Edited by ★ ★
Milton B. Sleeper

1945 THE ORIGINAL DESIGN OF THE WALKIE-TALKIE

SUBMINIATURIZED PRC-10 DETAILED IN THIS ISSUE 1951

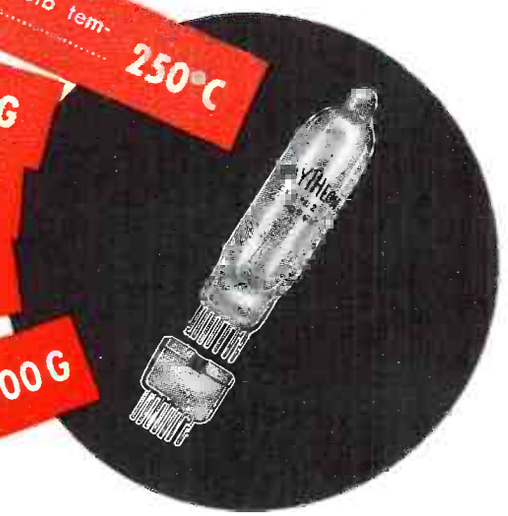
11th Year of Service to Management and Engineering

NEW AND HIGHER RATINGS FOR

RAYTHEON CK5702/CK605CX

SUBMINIATURE TUBES

1. 500 hour life for maximum bulb temperature of ..... 250°C
2. Shock ratings similar to the "W" Military Ruggedized tube types 450G
3. Fatigue tested the same as Military Ruggedized tubes 2.5G for 96 hrs.
4. Long Life Reliability Rating 5000 hrs.
5. Centrifuge acceleration ratings for any position 1000G



This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	TYPICAL OPERATING CONDITIONS Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk=200
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk=220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk=500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
CK5829	Similar to 6AL5	0.300x0.400	1.5	6.3	150			117ac	5.0 per section			
CK5995	Half Wave Rectifier	0.400	1.75	6.3	300				45	Inverse peak 850 volts		
FILAMENT TYPES												
1AD4	Shielded RF Pentode	0.300xD.400	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg=2meg
CK571AX	10 ma. filament Electrometer Tube, Ig = $2x10^{-13}$ amps. max.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		−3.0
CK573AX	Triode, High-Freq. Osc.	0.300x0.400	1.5	1.25	200	2000		90.0	11.0			−4.0
CK574AX	Shielded Pentode RF Amplifier	0.290x0.390	1.25	0.625	20	160		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	−6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	Shielded RF Pentode	0.300x0.400	1.515	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current $5x10^{-13}$ amps.	0.285x0.400	1.25	0.625	20	1.5†		12.0	0.22			−3.0
CK5785	High voltage rectifier	0.300x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
VOLTAGE REGULATORS												
CK5783	Voltage reference tube—like 5651	0.400	1.625	Operating voltage 87. Operating current range 1.5 to 3.5 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ® RK ®

†Voltage Gain Ratio.

→ **These four Raytheon Subminiature Types comprise *fifteen* of the total of sixteen tubes in the AN/PRC-10.**

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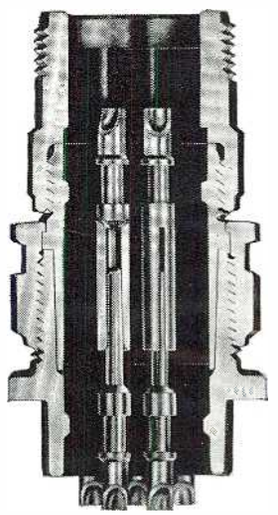

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CONTACTS
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FM-TV RADIO COMMUNICATION

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

VOL. 11 JUNE, 1951 NO. 6

INDUSTRY NEWS

FM BROADCASTING

TELEVISION

APPARATUS DESIGN

COMMUNICATION

AUDIO SECTION

SPECIAL DEPARTMENTS

MILTON B. SLEEPER, *Editor and Publisher*

ROY F. ALLISON, *Associate Editor*
CHARLES FOWLER, *Business Manager*
LILLIAN BENDROSS, *Circulation Manager*
SOPHIE FORTY, *Production Manager*
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CPA AUDIT

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

THE RTMA figures for March set production show activity in the TV, FM, and AM categories at high level.

First-quarter shipments of TV sets were 45% above the 1950 average. However, there will be a sharp drop in the April figure, since substantial cut-backs were put into effect at that time. This reduction was anticipated last year but, as events have developed, it did not come as a result of an expected shortage of components and materials, but from lack of public demand.

There seems to be no reason for blaming this situation on the delay in reaching a decision concerning color television, nor has the Supreme Court's finding in favor of the FCC action in adopting the CBS system settled the matter as far as the industry is concerned.

Radio manufacturers do not expect set owners to buy adapters to get monochrome reception of CBS color, or that any large number will want auxiliary circuits and color wheels to get color programs transmitted in off hours. About all that can be expected from the CBS system is some practical field-testing of color reception, concerning which too little is known now. By the time CBS programs have contributed the necessary home experience with color, it can be expected that a compatible system, acceptable to the FCC, will be available.

AM sets took a spurt that made March output the third highest month since the war, and the highest since October, 1947. This increase was spread across home, portable, and auto models.

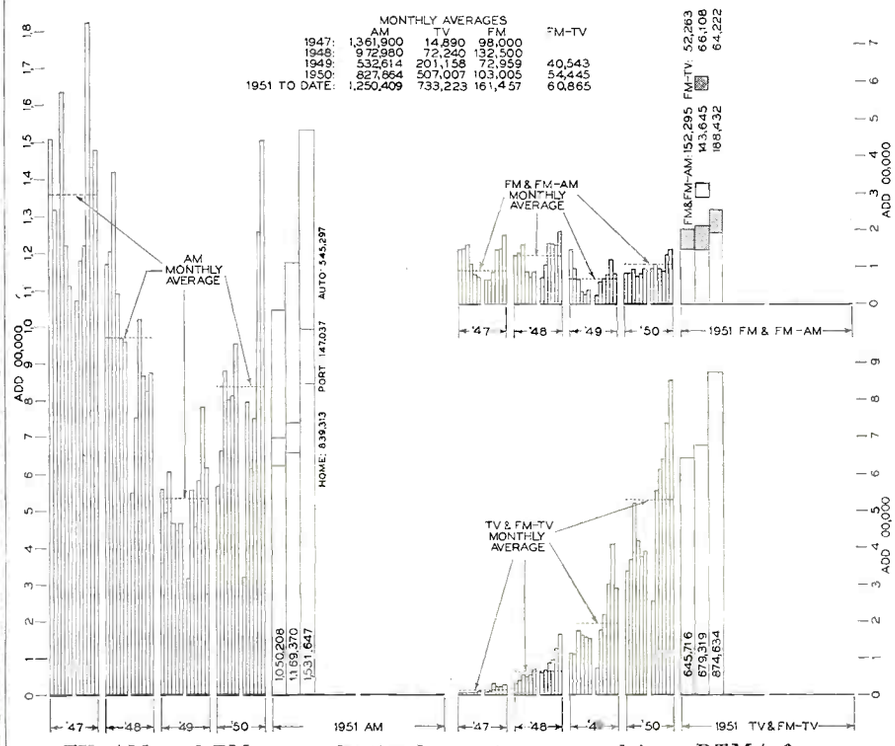
FM sets rose to a postwar record, in March, exceeding the 1950 average by 85%.

Monthly average figures for the first three months of 1951 are up over 1950 averages by the following amounts:

TV '51 monthly average, 45% above '50
AM " " 51% "
FM " " 57% "

Picture-tube sales in March to receiver manufacturers amounted to 608,396 units, valued at $16,064,425. This was slightly under February. Rectangular tubes 16 and 17 ins. in size accounted for 75% of March production. RTMA figures did not show replacement sales.

Receiving tubes reached an all-time high of 44,413,146 in March, over 4 million above the previous record set last October. First-quarter total of 118,277,243 was comprised of 79,880,821 for new audio and TV sets; 7,967,898 for other new equipment: 25,477,655 for replacements; 4,274,559 for export; and 676,310 for Government agencies.



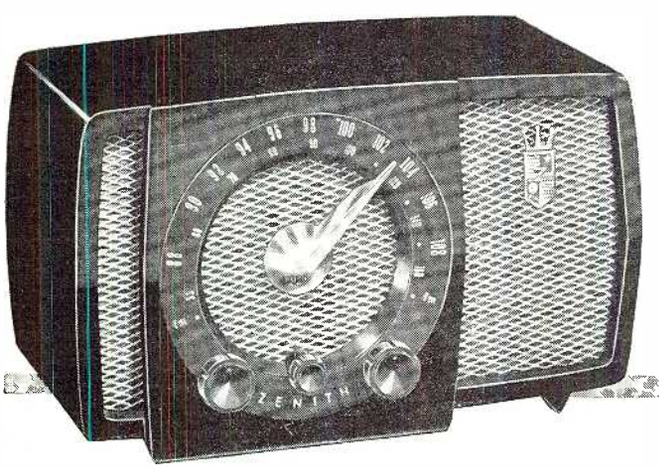
TV, AM, and FM set production barometer, prepared from RTMA figures

ZENITH ANNOUNCES

2 Super-Sensitive FM-AM Radios

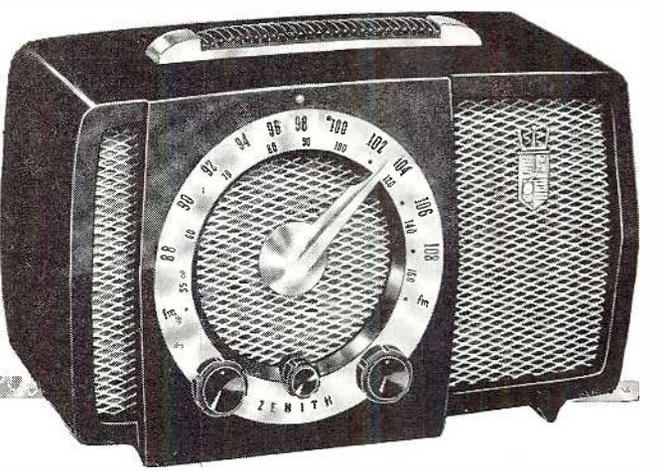
with Performance Superiority that makes Sales!

Again Zenith lengthens its lead over the FM-AM field—with new and better versions of the Zeniths that were already the industry's two best sellers. With Zenith's unrivaled Super-Sensitive FM, they bring in a wealth of entertainment, static-free and real as only genuine FM can be. Their newly designed cabinets are the style highlights of the radio year. Of course, both have Zenith's famous Long Distance AM, big Zenith-built Alnico speakers and other Zenith advantages.



New Super-Medallion

Genuine Super-Sensitive Zenith FM plus Zenith Long Distance AM — automatic volume control — built-in Wavemagnet* and Light-Line Antenna — cabinet of beautiful maroon plastic with Roman Gold mesh grille and tuning indicator.



New Super-Triumph

The same Super-Sensitive FM and Long Distance AM as the Super-Medallion, plus new broad-range tone control—jewel-like on/off indicator—maroon plastic cabinet with "Flexo-Grip" carrying handle—Roman Gold embossed dial.

Zenith is No. 1 for '51!

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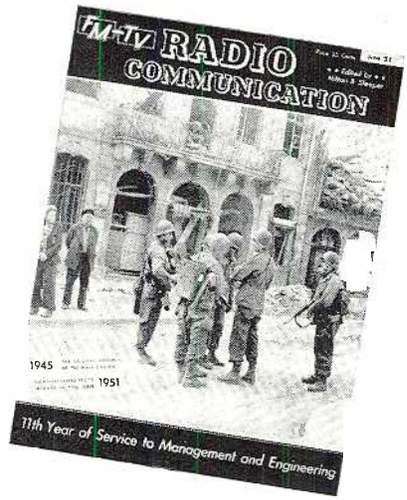
LONG DISTANCE RADIO and TELEVISION
THE ROYALTY OF RADIO AND TELEVISION

THIS MONTH'S COVER

This month, our cover picture was selected from the years-ago file, because it recalls one of the greatest communication achievements of World War 2 — the famous FM Walkie-Talkie. The occasion for this look backward is the publication in this issue of design details on the subminiaturized PRC-10, also employing FM, but reduced to one-half the weight of its 50-lb. predecessor. Possibilities of subminiature design, exemplified in the PRC-10, deserve the particular attention of every engineer concerned with the design of communication equipment.



SPOT NEWS NOTES

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

Color TV Decision:

On May 28, the Supreme Court of the United States voted 8 to 0 to affirm the ruling of the lower court, which sustained the FCC's adoption of the CBS system. "We sustain the Commission's power to reject this [RCA's] position and hold valid the challenged order, buttressed as it is by the District Court's approval. . . . Whether the Commission should have reopened its proceedings to permit RCA to offer proof of new discoveries for its system was a question within the discretion of the Commission which we find was not abused."

However, it was a dubious victory for the five Commissioners who favored the CBS system. Even the Supreme Court said: "There is no doubt but that a compatible color television system would be desirable. . . . The fact that adjustments are required before a CBS color broadcast can be received in black and white on existing sets makes this system incompatible with the millions of television receivers now in the hands of the public."

Decrying the FCC's haste in establishing standards for color transmission, Mr. Justice Frankfurter commented in a dubitante: "One need not have the insight of a great scientific investigator, nor the rashness of the untutored to be confident that the prognostications now made in regard to the feasibility of a compatible color television system will be falsified in the very near future."

Dr. W. R. G. Baker:

Discussing the TV color decision: "If a compatible system is achieved and should be ultimately adopted, the CBS system will have been, in fact, an interim system, approved by the FCC in order to insure color during this transition period to those who desire to make the necessary investment in this type of receiver."

New York Audio Fair:

Will be held at Hotel New Yorker, New York City, November 1 to 3, inclusive, under the sponsorship of the Audio Engineering Society. Prospects are that it will be even bigger and more interesting than the highly successful 1950 show.

Educational Television:

With Commissioner Hennock leaving the FCC, the drive which she sponsored for what could only be Government operation of educational TV stations will probably subside. This may come as a blow to registered lobbyist Stuart Hayden, who has been carrying much of the work load in this dubious project.

Vacant Frequency Space:

Jeremiah Courtney, in his page in this issue, brings to light the availability of a 10-mc. band from 460 to 470 mc., now assigned to but not used by the citizens radio service. With 450-mc. mobile radio proving so successful, that spectrum space should not be allowed to go unused and unassigned.

FM-AM Tests by BBC:

Wireless World of London reports that: "Tests have now been going on long enough for conclusions to be reached, but as yet no official statement has been issued. However, the best-informed technical opinion inclines strongly to the view that the decision will be emphatically in favor of frequency modulation.

(Continued on page 7)

SPOT NEWS NOTES

(Continued from page 6)

. . . the BBC announcement on the system of modulation may possibly not be made until the Report is debated in Parliament."

Juke Boxes in Jeopardy:

Some fifty members of Washington Transit Riders Association won a round in their battle against transitcasting. No one seems to know who has been financing the high-power legal talent that has helped to make such an issue of this minority opinion. As matters stand now, the U. S. Court of Appeals has reversed the finding of the U. S. District Court which ruled in favor of transitcasting a year ago. Ben Strouse, vice president of transitcast station WWDC-FM Washington, has announced that the case will be appealed to the Supreme Court. Meanwhile, transitcasting will be continued, as the final decision may not be reached before 1952.

Contending that Congress has given the Capitol Transit Company a virtual monopoly of mass transportation in the District of Columbia, the Court of Appeals ruled that: "If Transit obliged its passengers to read what it liked or get off the car, invasion of their freedom would be obvious. Transit obliges them to hear what it likes or get off the car. Freedom of attention, which forced listening destroys, is a part of liberty essential to individuals and to society. The Supreme Court has said that the constitutional guarantee of liberty 'embraces not only the right of a person to be free from physical restraint, but the right to be free in the enjoyment of all his faculties.' One who is subjected to forced listening is not free in the enjoyment of all his faculties." Well, there's another by-product of Government control and regulation which, in itself, threatens to abridge the constitutional rights of men to engage in business.

High-Temperature Wires:

Revised standards for Ceroc 200 and Ceroc T magnet wires, in sizes 16 to 44 have been issued by Sprague Electric Company, North Adams, Mass. Using ceramic-silicone and ceramic-Teflon insulation, Ceroc 200 can be continuously run at 200° C., and Ceroc T at 250°.

Hard to Believe:

Commissioner George Sterling, discussing the first application for radio by the petroleum industry, in 1928: "Because of the novel question presented, a hearing on the matter was held in November of that year and, believe it or not, a decision was rendered just one month later

(Continued on page 8)

SPOT NEWS NOTES

(Continued from page 7)

in simple, direct language of one paragraph."

1,500-Mile Pipe Line Relay:

Federal Telephone & Radio Corporation will install a PTM system, operating on 2,000 mc., for the Michigan-Wisconsin Pipe Line Company. It will run from the Hugoton Field in Texas to Fond du Lac, Wisc., and Detroit, Mich. Multiplex facilities will handle dispatching, administrative and supervisory services, and mobile radio communication.

Advanced Training Course:

Norden Instruments, Inc., Hartford, Conn., will operate a school of instruction for engineers and physicists at Avon Old Farms. Arthur H. Jones, director of field engineering, will be in charge of this training project.

Broadcast Bureau Appointments:

Organization of the newest FCC Bureau, of which Curtis B. Plummer has been named Chief, is now rounded out by the appointment of Joseph M. Kittner as Assistant Chief; James E. Barr, Chief of the Aural Facilities Division; Cyril M. Braum, Chief of the Television Facilities Division; Dwight D. Doty, Chief of the Renewal and Transfer Division; Frederick W. Ford, Chief of the Hearing Division; and Paul Dobin, Chief of the Rules and Standards Division.

Casualty was Harry (Head Horseman) Plotkin who, in his zeal to win arguments, forgot that his salary came from the taxpayers. He has joined the law firm of Arnold, Fortas & Porter.

Parts Show Sets Record:

Most successful Chicago Show drew an attendance of 8,498, comprised of 2,439 distributors, 1,798 reps, 4,107 member-exhibitors' personnel, and 154 members of the press. There were 164 exhibits in the main Hall, and 126 displays in the upper rooms.

Disaster Systems Licensed:

First license for this new service was issued on May 29 to Santa Cruz, Calif., for 1 fixed station, 10 portable units, and 4 mobile units. Call is KMAA2. The second went to Maricopa County Civil Defense, Phoenix, Ariz., KOAA2, for 1 fixed station, 19 portable units, and 28 mobile units. Operation is on 1,750 to 1,800 kc.

Dr. Henry G. Booker:

Professor of Engineering at Cornell University and chairman of the US Navy Advisory Board on Antennas has been

(Concluded on page 9)

Special Services Directory

SPOT NEWS NOTES

(Continued from page 8)

elected a director of LaPointe-Plascamold Corporation, Windsor Locks, Conn.

Terrific, Colossal, Stupendous:

That's what Warehouse Sales calls their offerings of new TV sets in postcard listings that range from $119 for a 12½-in. model to $239 for one with a 20-in. tube. That figures out about $10 per inch, which may be high or low, depending upon the way you look at it.

Radio Amateur's Handbook:

The 28th edition of the Old Reliable is out now in a new revision of 768 pages. Price is $2.50 in the USA. Copies can be ordered from the American Radio Relay League, West Hartford, Conn.

Success Assured:

The new Lowell Institute FM station at Boston, announced in our April issue, will receive a $300,000 grant from the Ford Foundation, thus providing the necessary financial support for this ambitious live-talent project.

Dr. Harry F. Olson:

Director of RCA's acoustical research laboratory at Princeton has been elected president of the Acoustical Society of America for 1952.

No Bed of Roses:

AM stations are beset by loss of coverage due to night interference and reduced revenue resulting from rate cuts; FM is troubled by lack of sets and opposition to transitcasting and functional music; TV is faced with delays in ending the freeze, color cross-up, and highly organized opposition from the theatre operators. Right now, it's all so bad that any further change will have to be for the better.

New Plant Facilities:

Lenkurt Electric Company has just completed a factory addition of 19,000 square feet, and is already laying the foundation for another building almost twice as large. New area will be used for VHF radio link development, production of hermetically-sealed transformers and filters, and for expanded engineering and office space.

FM Sets for Schools:

Although sets have been offered as meeting the specifications of the U. S. Office of Education, the fact is that no such specifications have ever been issued by that office, nor has any manufacturer's design been approved for use in the public schools. No consideration should be given to such claims.

Radio TOWERS

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

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SPECIFY *Genuine* WINCHARGER TOWERS for POSITIVE RESULTS

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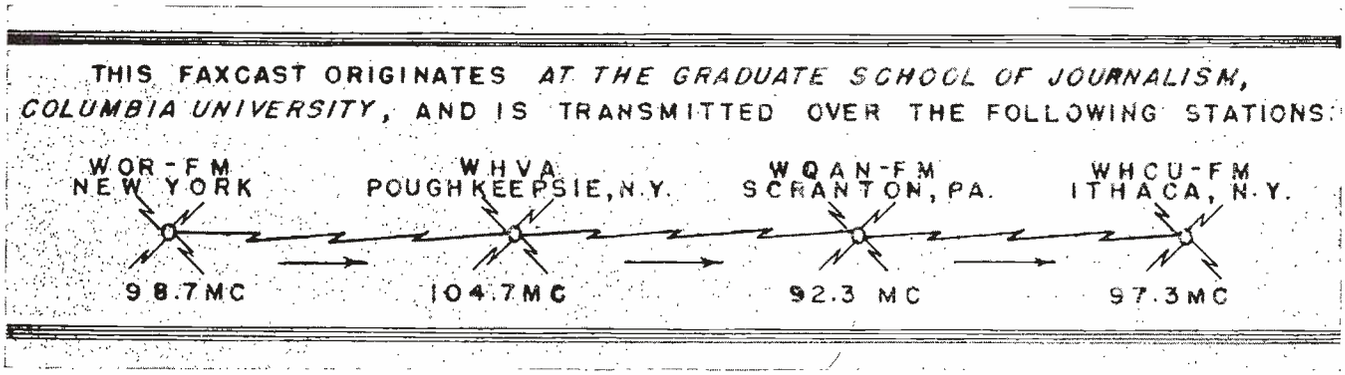


FIG. 2. REPRODUCTION OF ACTUAL FACSIMILE STATION IDENTIFICATION AS RECEIVED FROM ONE OF THE STATIONS IN THE RURAL RADIO NETWORK

MULTIPLEXED FM BROADCASTING

IDEAS FOR MULTIPLEX AUDIO OR FACSIMILE OPERATION THAT OPEN NEW SOURCES OF REVENUE FOR FM BROADCAST STATIONS — *By* JOHN V. L. HOGAN*

IN its initial stages, FM broadcasting was considered as a directly competitive system to AM, offering advantages in freedom from interference, superior audio quality, and greater primary service range. Subsequent work by research and development engineers has disclosed that the characteristics which afforded the advantages just enumerated make possible additional, special services which cannot be provided on AM.

This is due to the fact that control signals, or even a second audio program can be transmitted by an FM station without any interference with its primary modulation up to 15,000 cycles. Thus, with two multiplexed channels available, the following combinations are available to FM broadcasters:

1. Channel A can be used for regular programs and commercial announcements, and channel B for the same program but different commercials, or no commercials at all.

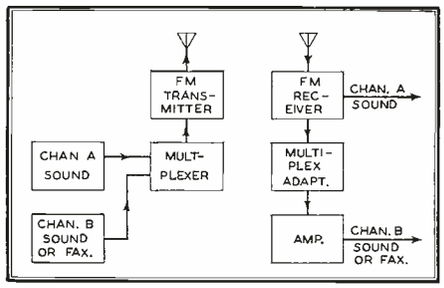
2. The two channels can be used to carry entirely different entertainment programs, or for a mobile communication service on channel B.

3. Channel A can be used for regular programs, and channel B for facsimile news transmission.

Multiplex Operation:

It is now possible for any FM broadcaster to purchase and install at his transmitter a relatively simple piece of equipment, about the size of a single amplifier panel, which in effect gives his station two completely independent channels. The normal FM channel can be used in the regular way to transmit aural programs with complete freedom from interference between that transmission and audio or facsimile modulation on the second channel.

The result is much as though the broadcaster were assigned an additional transmitting frequency. However, the added B channel does not require any additional space in the radio spectrum. Neither does it call for a second transmitter and tower, nor an increase in operating personnel or costs. The only additional expenses are those of installing a multiplex amplifier, and of preparing and



SHOWING ADDED UNITS REQUIRED FOR MULTIPLEX FM BROADCAST TRANSMISSION AND RECEPTION

selling the programs that are to be transmitted over channel B.

Any FM receiver can be modified to receive the B channel programs by merely adding a single-tube adapter-amplifier such as is shown in Fig. 1. This unit is cheap and small, and its installation in the receiver is simple. The set can be arranged to receive channel B only, or either channel A or channel B. Of course, if the user of the receiving set wants to reproduce the programs going over both channels at the same time, he will need a second audio amplifier and a second loudspeaker or a facsimile recorder.

Uses of Multiplexing:

How would the use of this multiplex system affect the operation of an FM station engaged in transit radio, for instance?[1] The only changes necessary would be installation of the multiplexer panel at the transmitter and an adapter amplifier in each bus receiver, so that it would respond to channel B signals instead of those of channel A. The supersonic control circuit and relay could be removed, and this source of possible failure eliminated, for with multiplex operation the relative volume of music and commercials on channel B can be controlled from the studio without changing the levels on channel A.

The station can transmit the same music and the same commercials on both channels, or it can use the same music for both and insert different commercials in the transit program. Or, by using a somewhat more elaborate studio setup, two entirely different programs can be broadcast, one designed to please regular home listeners and the other planned to be most effective as heard in the buses or trolleys. The advantages of such a new facility for the FM station are quite apparent.

The same flexibility of operation furnished by multiplexing obviates the need for program or announcement compromises between a home service and either storecasting or functional music. Multiplex operation unties the hands of the FM broadcaster who is interested in any of these three supplementary aural services, by letting him plan two programs in such a way as to give optimum performance to each group of listeners.

Facsimile Service:

Furthermore, through the use of multiplex, facsimile transmission can be handled in a more efficient and effective

* President, Hogan Laboratories, Inc., 155 Perry Street, New York 14; and Consultant, stations WQXR and WQXR-FM.

[1] The decision made recently by the U. S. Circuit Court of Appeals, declaring transit radio unconstitutional, is being appealed to the Supreme Court.

manner than is possible with ordinary simplex operation. Although provisions have been made in the FCC's Rules and Regulations for simplex transmission of facsimile, its use is generally limited to experimental or test work. There are at least two reasons for this: 1) It can only be broadcast when the station is carrying no sound program, and 2) the FCC allows only one hour of simplex facsimile between 7:00 A. M. and midnight.

On the other hand, as a result of a recent amendment of FCC Rules and Standards,[2] facsimile may be multiplexed with sound programs without any time limitations, provided there is no degradation of the aural program below 15 kc. This advantage, plus the practicality of simultaneous transmission of facsimile and aural programs open new opportunities to FM broadcasters who are interested in developing facsimile service.

Network Multiplexing:

A recent development is the practical demonstration, by full-scale field tests, of the feasibility of networking multiplexed sound and facsimile programs.

This was proved out in cooperation with Major Armstrong who made his Alpine FM station available for feeding the first experimental programs into the Rural Radio Network. Subsequently, WOR-FM became the starting point for a four-station FM multiplex network extending from New York City to Ithaca, by way of the RRN stations at Poughkeepsie and Scranton. The facsimile station identification reproduced in Fig. 2 shows the network plan.

In a recent demonstration, the network was operated to deliver some eighty pages of facsimile daily to those attending the observation of Farm and Home Week at Cornell University in Ithaca. Fig. 3 shows the exhibit presented at the University by the network during that week.

Shorter daily programs are being continued, and it is hoped that the present facility will be extended to furnish facsimile news, weather and crop reports, agricultural information, and similar data over all the stations of the Rural Radio Network from facsimile editorial offices at Columbia or Cornell.

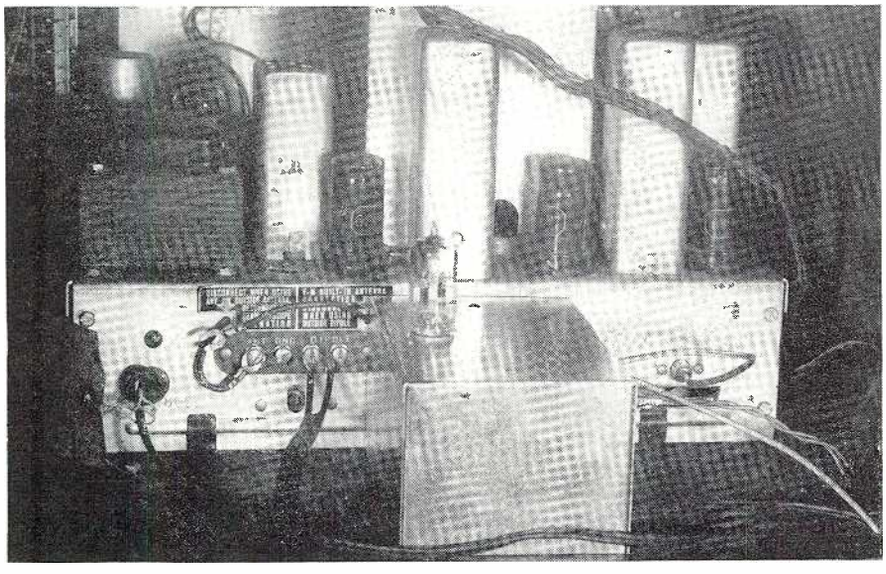


FIG. 1. ONE-TUBE MULTIPLEX ADAPTER CAN BE ADDED READILY TO ANY STANDARD FM BROADCAST SET

Future Possibilities:

Consider what could be done by using a multiplexed FM radio relay network for handling two sound programs. One can easily visualize a new and entirely independent broadcast system, perhaps even national in scope, which could relay audio programs from one FM station to another. These programs would be transmitted on channel B and would be available to all stations in the chain. However, if for any reason one station did not want to broadcast the channel B network program on its A channel, it could merely relay it on channel B and carry on with its own local origination. Hence, there would be no necessity for breaking the chain.

FIG. 3. THIS DISPLAY WAS USED TO DEMONSTRATE MULTIPLEX FACSIMILE AT CORNELL UNIVERSITY

FM ASSIGNMENTS

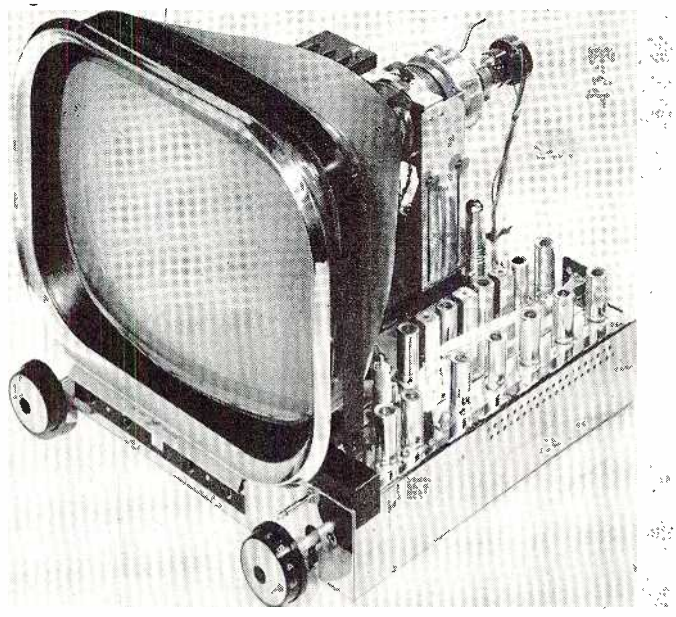
One of these days, it will be in order to review the frequencies assigned to FM broadcast stations, with a view to reducing co-channel and adjacent-channel interference. When frequencies were assigned after the shift to 88 to 108 mc., there was only limited information available on propagation characteristics, and still less about the problems of receiver design.

A basic error in judgment made at that time was the policy of grouping all assignments in any area, so that local FM stations would come in at one section of the dial. Also, co-channel and adjacent frequencies were assigned on assumptions of relatively limited transmitting range. Listening experience, even with well-designed receivers, shows that co-channel and adjacent-channel stations should have been planned with considerably greater geographical separation than is now the case.

With the peculiar changes that take place through the year, and to a lesser extent from day to day, listeners who must depend for their FM programs on stations 30 to 40 miles or more distant sometimes find their reception blanked out by co-channel or adjacent-channel stations far away.

While this interference on FM is not common, the performance of FM broadcasting is so nearly perfect that even a little trouble seems annoying, in contrast to AM which is so full of interference that people take it for granted, and just switch off their sets.

[2]For further information on this amendment, see RADIO COMMUNICATION, May, 1951, page 11.



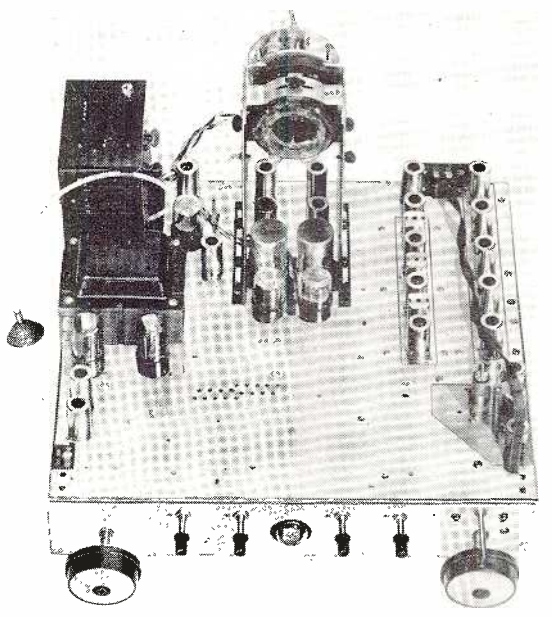


FIG. 1. THIS RADIO CRAFTSMEN MODEL OPERATES WITH AN EXTERNAL AMPLIFIER. FIG. 2. A 5-WATT AMPLIFIER IS BUILT INTO THIS CHASSIS

TV FOR CUSTOM INSTALLATIONS

A CHASSIS DESIGN INTENDED TO MEET THE CRITICAL REQUIREMENTS OF THOSE PEOPLE WHO PREFER CUSTOM INSTALLATIONS — *By* EDWARD MILLER*

THE rapidly increasing interest in high-fidelity custom installations has given rise to the need for a television chassis which can meet the same standards as the audio components in such systems. People who have become discriminating in their listening habits are equally critical of television performance, both as to picture and audio quality.

* Chief Engineer, 4401 N. Ravenswood Avenue, Chicago 40, Ill.

The Craftsmen model 101 and 200 chassis have been designed specifically to meet the requirements of that market. Fig. 1 shows the model 101 for use with an external amplifier, while Fig. 2 illustrates the model 200 chassis which includes a 5-watt amplifier. This choice is provided because, in some cases, it is convenient to use the TV chassis with an existing audio system, while in other installations it is necessary to make the TV receiver completely independent, or to locate it separately.

Co-Channel Sound:

An examination of the block diagram of Fig. 3 will reveal that a co-channel sound system has been employed in both models. It was felt necessary to use this type rather than an intercarrier system in order to meet the precise requirements of high-fidelity equipment where ex-

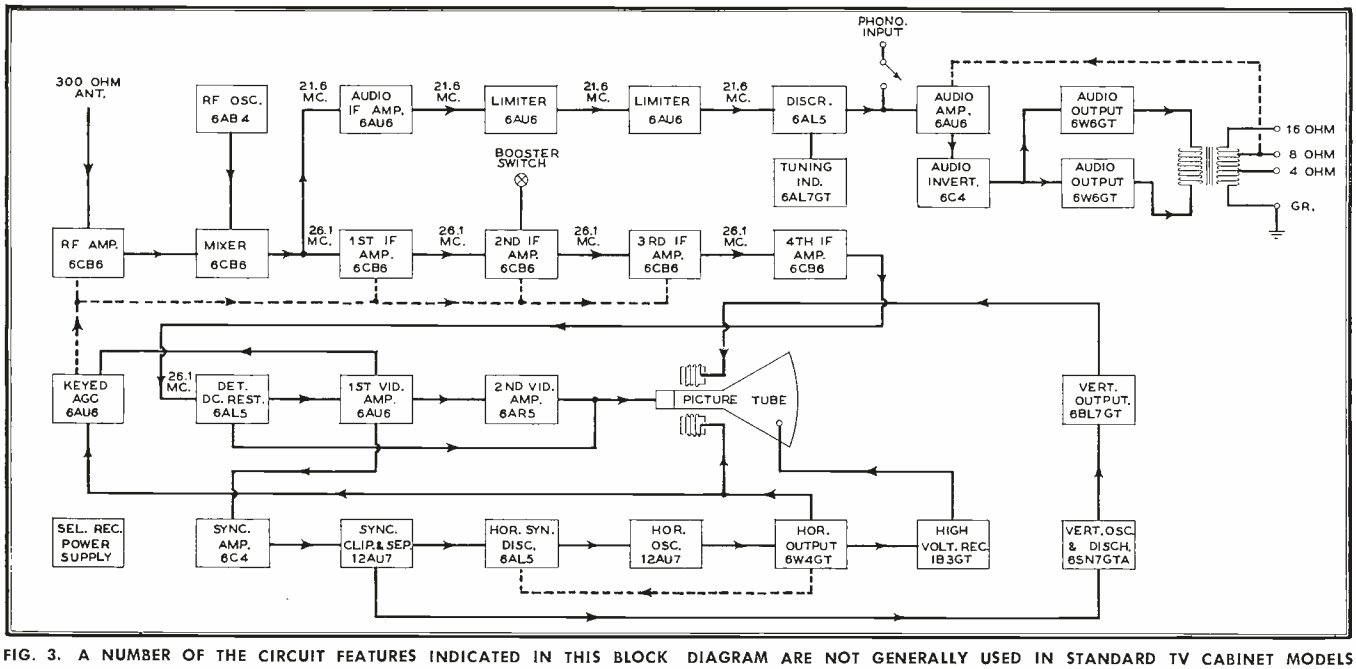


FIG. 3. A NUMBER OF THE CIRCUIT FEATURES INDICATED IN THIS BLOCK DIAGRAM ARE NOT GENERALLY USED IN STANDARD TV CABINET MODELS

tremely low noise level and a minimum of distortion are demanded.

Despite the many advantages obtained from the use of intercarrier circuits, even the most carefully executed designs fail to meet the exacting standards of custom installations. During periods when the video carrier level approaches zero, such as intervals of camera switching or adjustment, the downward modulation of the sound carrier causes a buzz in intercarrier systems which cannot be entirely removed even with the best FM detector systems.

A second advantage of co-channel sound is the more exact tuning which is possible with the aid of a double-shadow indicator tube. Many people fail to tune their sets accurately when they depend only on their eyes and ears. Thus a tuning indicator is an important aid to getting the clearest pictures with the least noise.

As can be seen in the block diagram, double limiters cascaded with a Foster-Seeley discriminator are used for FM detection. Such devices provide a minimum of interference and distortion. The entire IF channel, Fig. 4, is constructed as a separate unit so that it can be adjusted precisely before it is mounted on the chassis, thus assuring uniformly high performance.

Audio Output:

Model 200 provides 5 watts of audio output at 2% distortion from 6W6's in push-pull, ample for residence installations where the television set is used independently of the radio-phonograph system. Model 101 has a low-impedance output designed to feed an external amplifier capable of frequency response up to 20 to 20,000 cycles.

Large Screen Operation:

Consistent with the high-fidelity audio system is the provision of a high-definition, large-screen picture system. Because of the trend towards larger tubes, the chassis is designed to handle tubes up to 24 ins.

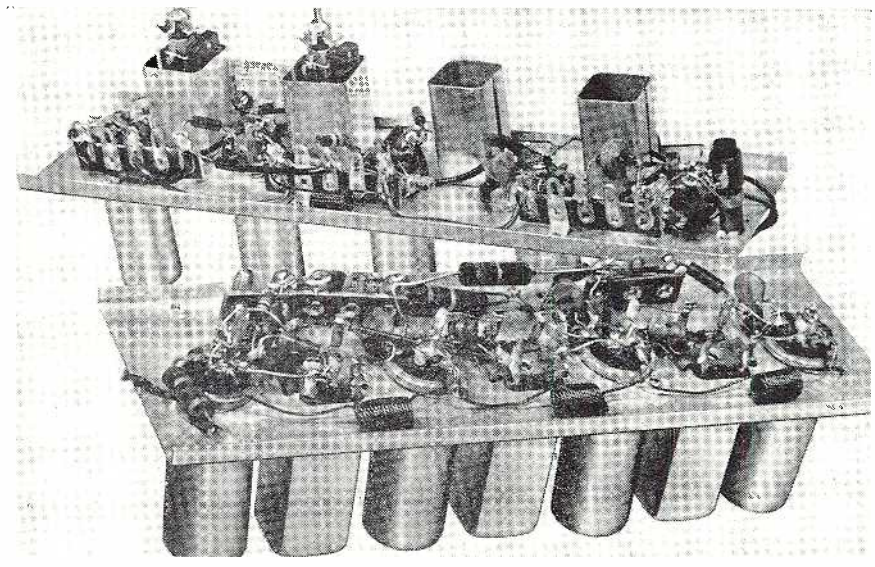


FIG. 4. BOTH THE AUDIO IF AND THE VIDEO IF CHANNELS ARE ASSEMBLED AS SEPARATE UNITS

An anode voltage of 16 kv. and 70° horizontal deflection is delivered from a new design of horizontal output transformer driven by a 6BQ6GT. This transformer, Fig. 5, features a split winding with consequent reduction in leakage inductance, increased efficiency, and more conservative operation of the output tube. Other factors given special consideration in the design of this transformer and its mounting include the reduction of heating and the 15.75-kc. sound-radiation whistle.

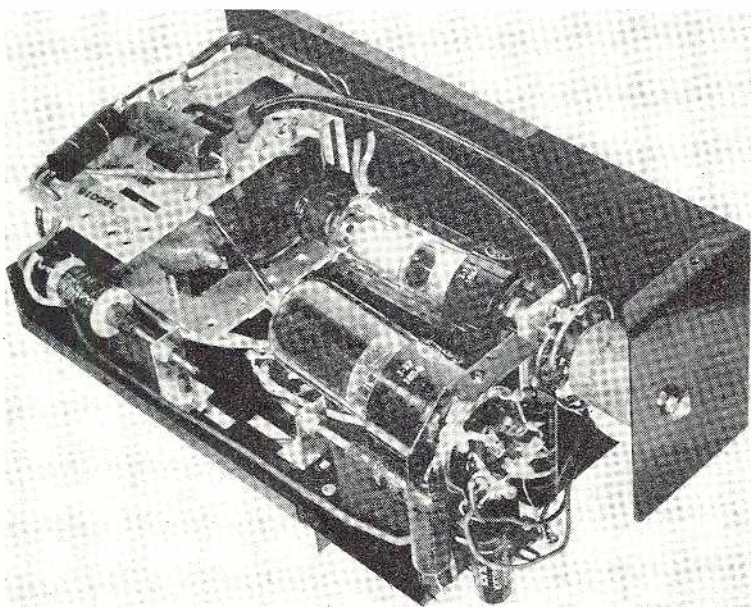


FIG. 5. A NEW SPLIT-WINDING TRANSFORMER, DRIVEN BY A 6BQ6GT TUBE DELIVERS 16,000 VOLTS

Besides providing the increase in brightness necessary for the screen of a 24-in. picture tube, the 16 kv. anode voltage provides a considerable improvement in the focusing of highlights in the picture. This is especially important in producing clear pictures under daytime lighting conditions and, of course, it applies to any size tube.

In addition to the improvement afforded through use of higher anode voltage, a new design of deflection yoke with a distributed coil winding is employed to obtain uniform sharpness over the entire face of the tube. Neck shadow problems, sometimes troublesome with 70° deflection tubes such as the 24AP4, have been reduced through the use of a ferrite core in the yoke, allowing the overall tube length to be shortened and thus moving the center of deflection forward on the picture tube.

Fig. 4 shows the video IF channel which, like the sound IF circuits, is assembled on a separate panel, and mounted as a unit on the chassis. Because picture definition is determined largely by the passband of the video IF channel and video amplifiers, these circuits have been designed to handle the full 4-mc. band width.

Two Types of RF Tuners:

Consumer choice still is divided between the turret-type tuner for simplified channel selection, and the continuous-coverage tuner with a frequency range which includes the 88 to 108 mc. FM band. So that custom set builders can furnish either method of adjustment, either tuner illustrated in Fig. 6 is available on both TV chassis. These tuners deliver comparable electrical performance, and are of highly dependable mechanical design. The turret-type tuner features easily re-

(Concluded on page 36)

SUBMINIATURIZATION TECHNIQUES

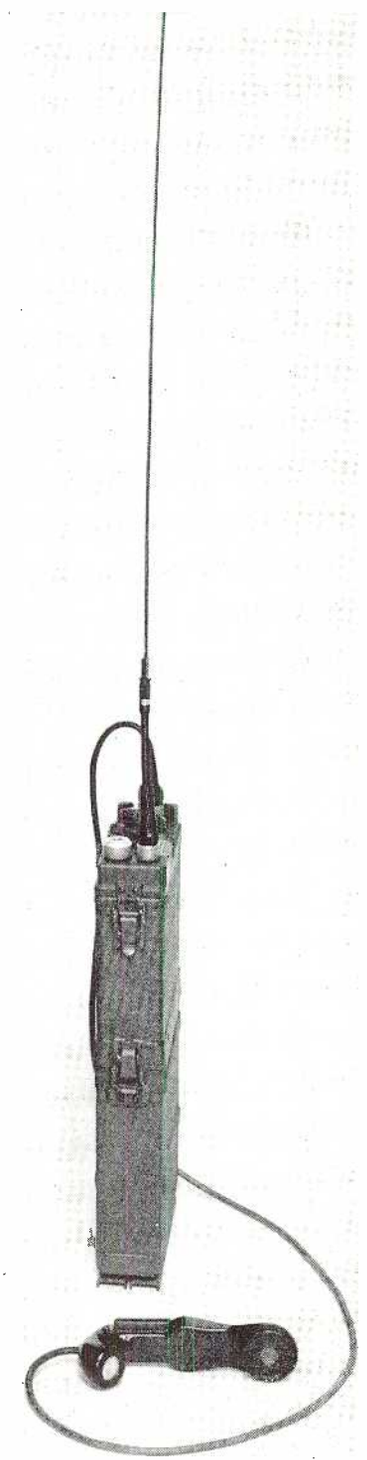
SMALL SIZE AND LOW CURRENT DRAIN OF PRC-10 INDICATE WIDER USE OF SUBMINIATURE TUBES FOR COMMERCIAL EQUIPMENT — *By* MILTON B. SLEEPER

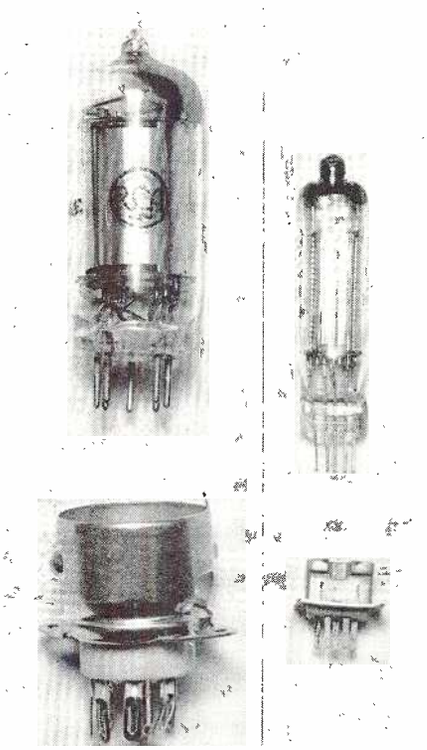
THE design of commercial communication equipment will be greatly affected in the not-too-distant future by current military progress in subminiature design. For the most part, details of the latest developments have been withheld from publication. Great interest attaches, therefore, to the release of information on the new AN/PRC-10 unit, designed by the RCA Laboratories as a successor to the renowned World War 2 Walkie-Talkie, illustrated on the front cover of this issue. Figs. 1 and 2 show their comparative size.

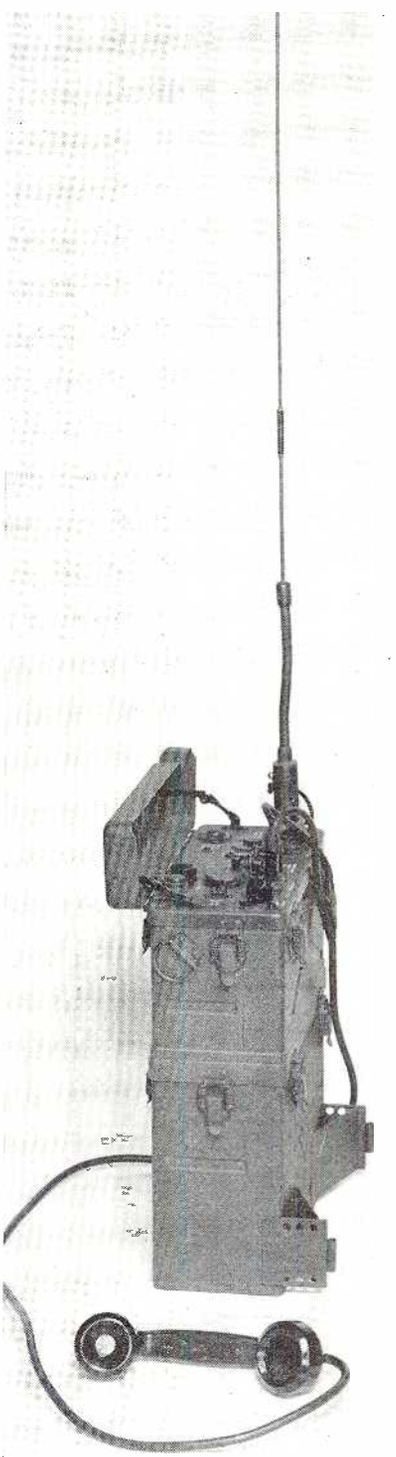
The basic element of the trend toward smaller physical dimensions and lighter weight is the subminiature tube. There may not be complete agreement on this point, but certainly most of the impetus to research and development in subminiature tubes resulted from the need for tubes capable of withstanding high G's, which is another way of describing severe mechanical shock. Small size seems to have been a secondary consideration, and something of a by-product.

Postwar, the availability of subminiature tubes of commercial types made possible the development of pocket-size hearing aids using vacuum-tube amplifiers. They proved so successful that they have taken most of the production of these tubes, other than those for military use.

Fig. 3 shows the miniature and subminiature tubes and sockets in their actual size. Because of the extreme precision required in the manufacture of subminiature tubes, in order to attain uniform characteristics, it might appear that they would be delicate, and short-lived. The contrary is true. If a sub-







FIGS. 1 AND 2. WEIGHT OF PRC-10, LEFT, IS HALF THAT OF THE ORIGINAL WALKIE-TALKIE DESIGN. FIG. 3. ACTUAL SIZE OF THE STANDARD MINIATURE AND SUBMINIATURE TUBES AND THEIR SOCKETS

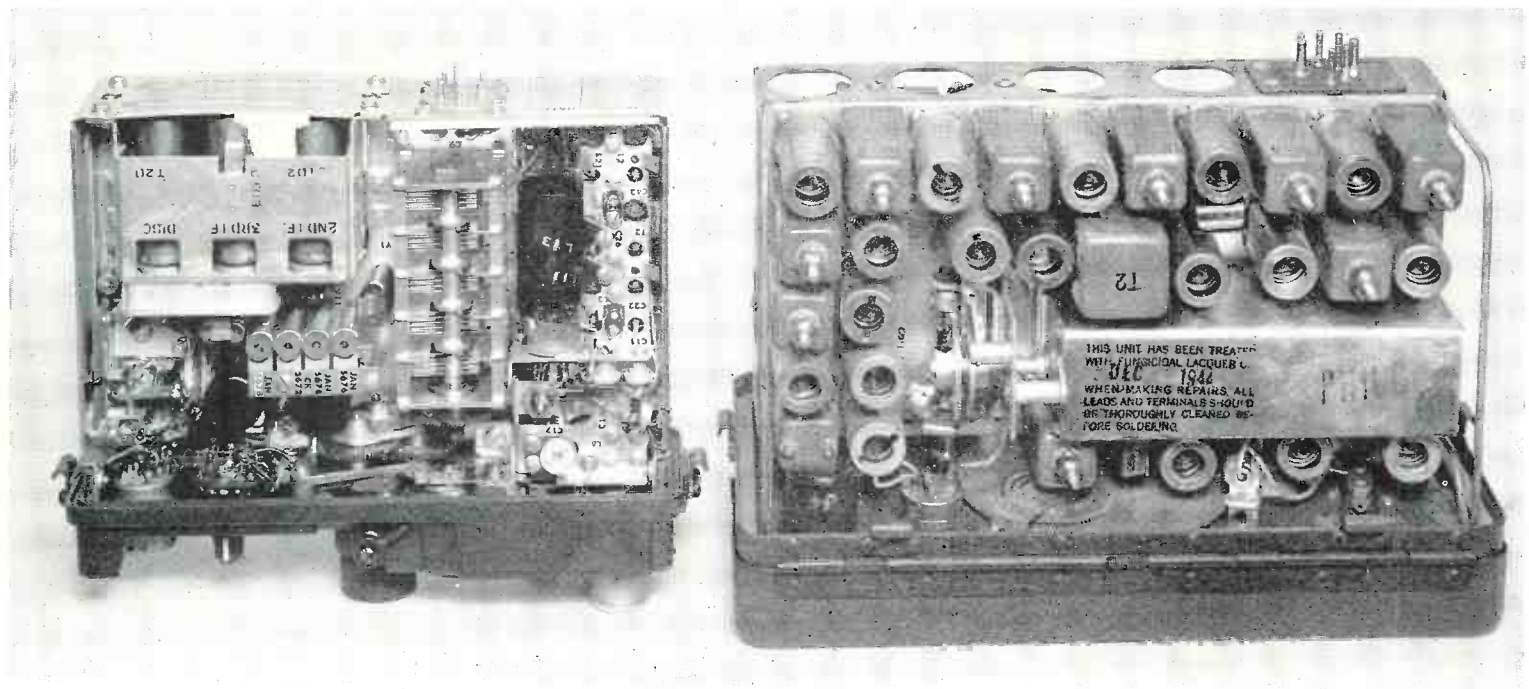


FIG. 4. SHOWING EXTRA SPACE REQUIRED BY THE MINIATURE TUBES AND SEPARATE TRANSFORMERS

miniature tube is dropped, or even thrown against the wall, it will not be damaged. This is due in part to manufacturing techniques employed in assembly, and to the fact that the tube elements are so light in weight as to be unaffected by severe shock. Moreover, their operating life is substantially greater than that of larger, equivalent tube types. These factors, as will be explained, are exerting a great influence not only on the mechanical design of communication equipment, but on the fundamental philosophy of design and maintenance.

An Historical Note:

Back in 1927, the writer was asked to

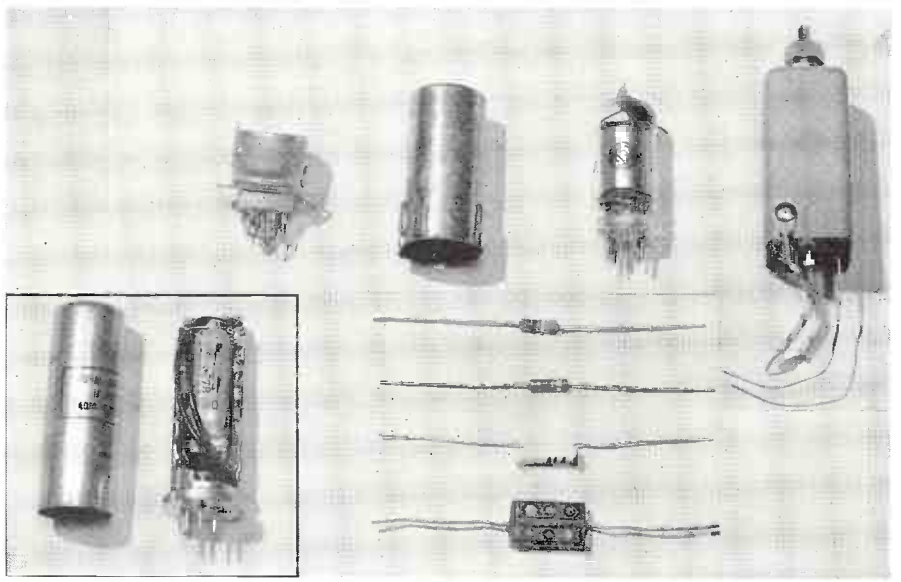
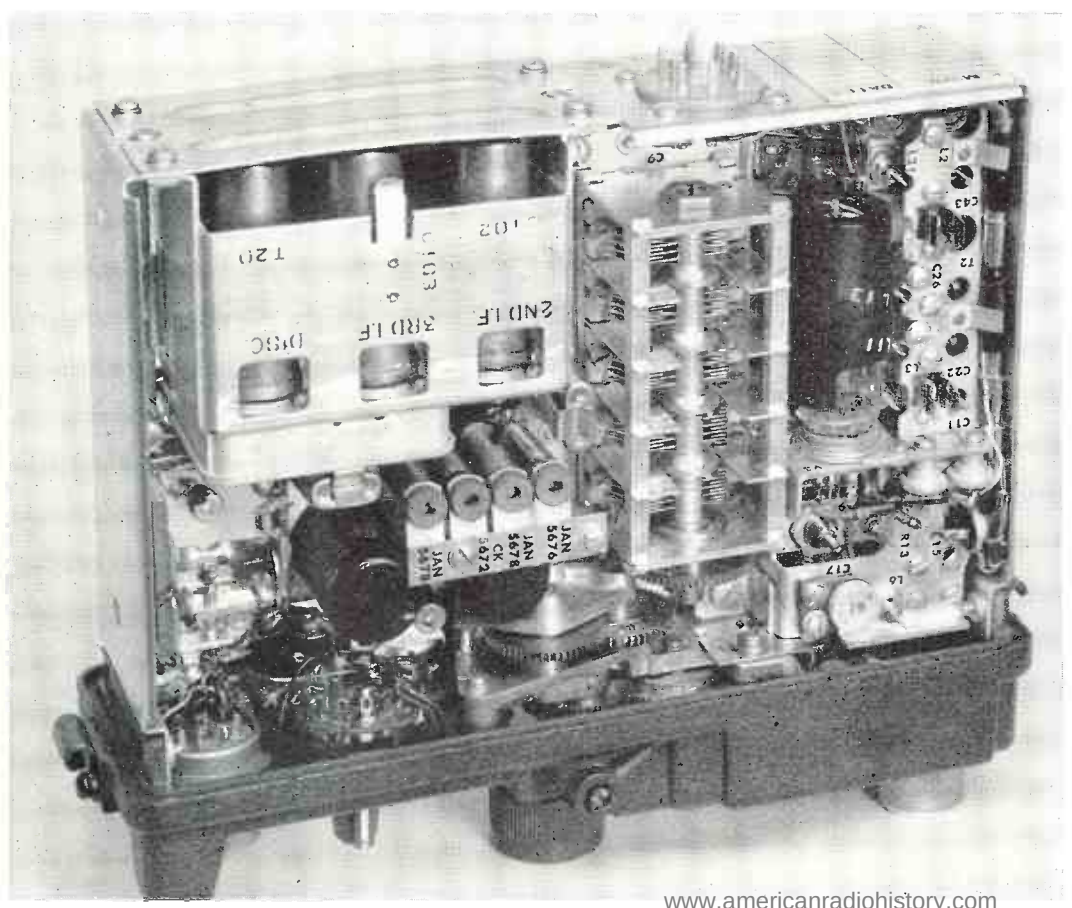


FIG. 5. PLUG-IN IF CIRCUIT REPLACES ALL THE 7 COMPONENTS ILLUSTRATED. FIG. 6. COMPONENTS ARE COMPACT BUT NOT CROWDED



undertake a receiver development project which offered possibilities of wide acceptance. The limiting design factor was the large size of the vacuum tubes then in use. The Western Electric peanut tube was being manufactured at that time, but it was not sold for commercial use in the United States.

The only answer was to interest a tube manufacturer in undertaking the design and production of a new tube type. It appeared that Raytheon might be prevailed upon to do so. A series of conferences were held with Lawrence Marshall, then president of the Company, and he, in turn, discussed it with his tube engineers. Finally, however, the conclusion was reached that the whole idea was impractical because very small envelopes would not provide sufficient heat radiation.

This episode probably had no connection with Raytheon's subsequent development of subminiature tubes. However, the problem of heat dissipation was solved and this company did eventually go into large-scale production on tubes

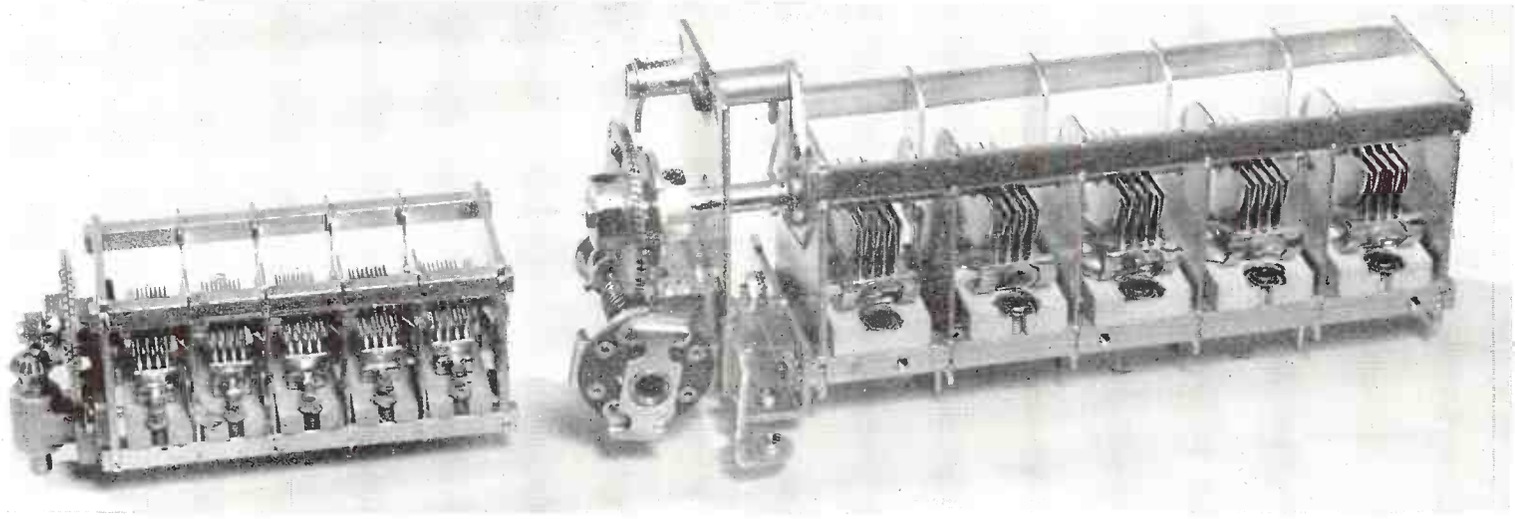


FIG. 7. REDESIGN OF 5-GANG TUNING CONDENSER MADE POSSIBLE ANOTHER SUBSTANTIAL SAVING OF SPACE, AS COMPARED TO THE ORIGINAL

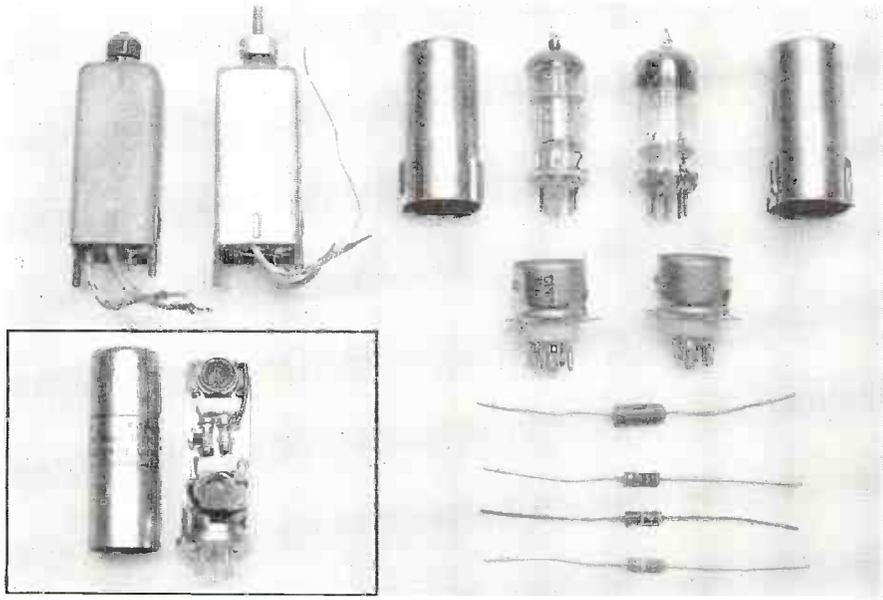


FIG. 8. PLUG-IN CRYSTAL-DIODE DISCRIMINATOR IS THE EQUIVALENT OF 11 SEPARATE COMPONENTS

complete IF stage is 2 ins. long by ¾ in. in diameter! Consider that the small box in the upper left hand corner of the PRC-10, Fig. 4, contains 5 IF stages and the discriminator. More details of this box can be seen in Figs. 6 and 9.

In contrast to the original discriminator, Fig. 8, which was made up of 2 tubes, 2 shielded coils, an external condenser, and 3 resistors, the new design is made up as the single unit shown at the lower left hand corner of the illustration. Here, germanium diodes replace the vacuum tubes.

The subminiature tubes make additional weight and space reduction possible in the battery section, also, because of their lower current consumption. This can be seen in Figs. 1, 2, and 13. In both designs, the lower part of the case is occupied by batteries.

even smaller than those contemplated in 1927. Incidentally, Raytheon has supplied all the tubes used in hearing aids other than a small number of one or two types. Now, under pressure of military necessity, several manufacturers are setting up plants to produce subminiature tubes, and by the end of the present emergency the supply will be sufficient to permit their use not only in commercial communication equipment but in audio and TV broadcast receivers.

Size and Weight Factors:

Figs. 4 and 13 present direct comparisons of size between the original Walkie-Talkie, which weighed 50 lbs., and the 25-lb. PRC-10, while Fig. 7 shows the ganged tuning condensers in the two equipments. In the old type, the most conspicuous components are the tubes and transformer cans, but these parts can hardly be seen in the new design.

Figs. 5 and 8 explain this difference. An IF stage, Fig. 5, formerly comprising a tube, shielded transformer, and an externally-mounted condenser and 3 resistors, has been shrunk to the single assembly shown in the lower left hand corner. The shield which contains the

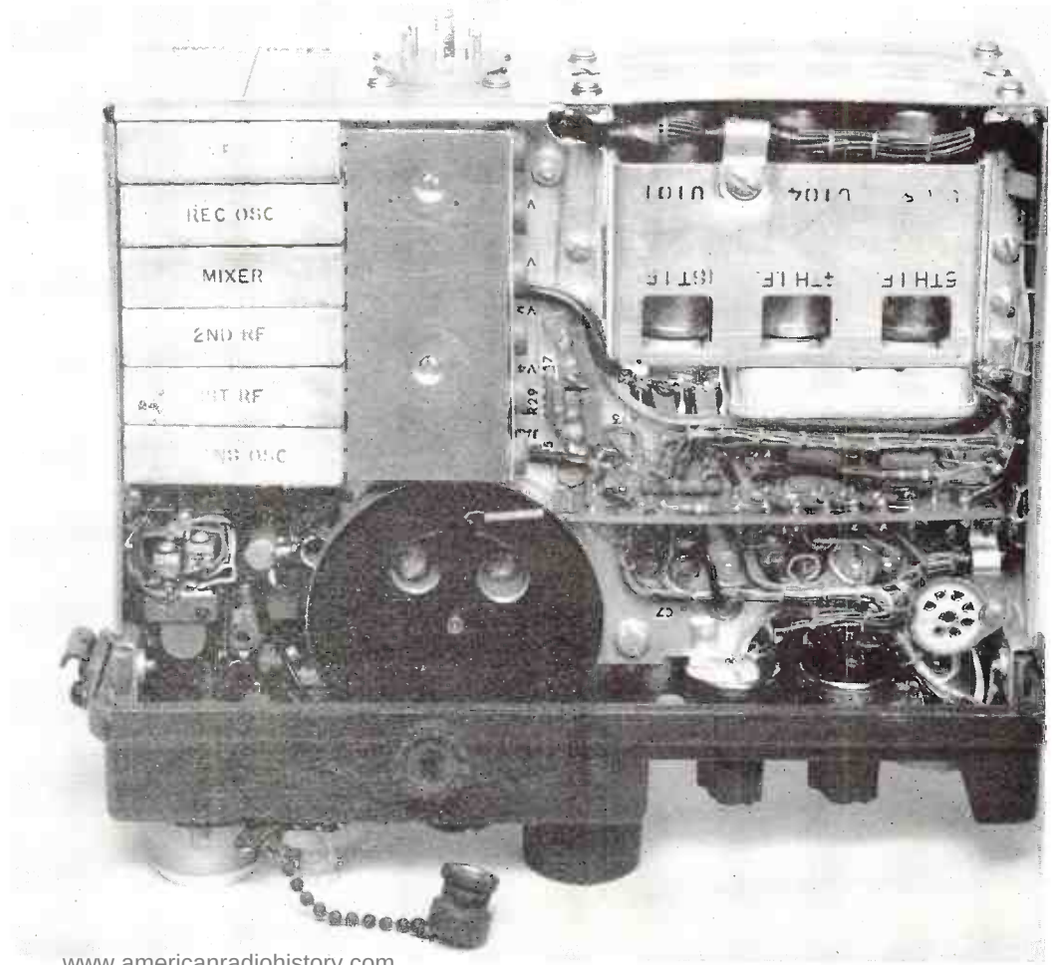


FIG. 9. OPPOSITE SIDE OF PRC-10 CHASSIS

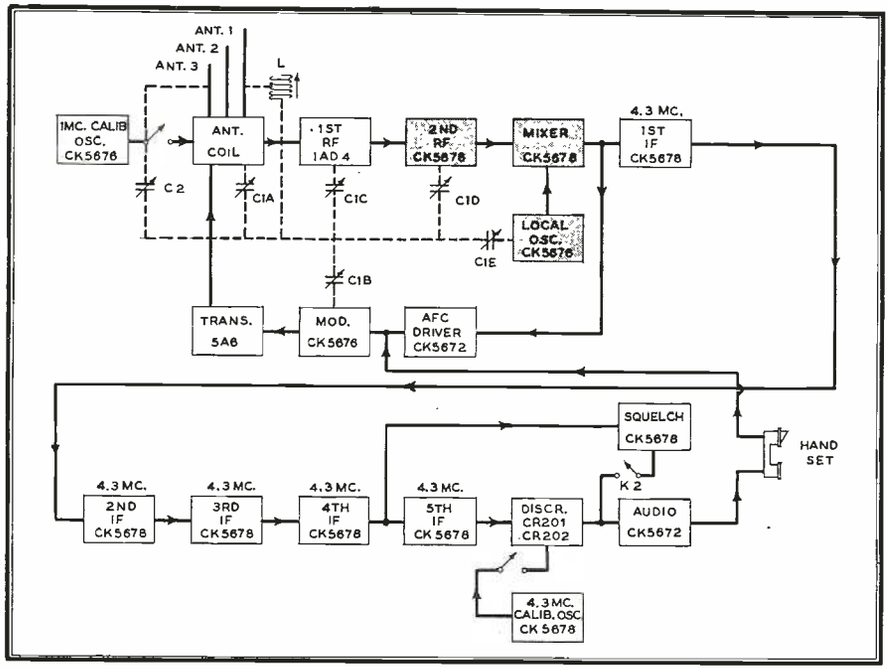


FIG. 10. SHADED BLOCKS REPRESENT THE TUBES USED FOR BOTH TRANSMITTING AND RECEIVING

The PRC-10 case containing the radio-circuits is 9½ ins. high, 10½ ins. wide, and 3 ins. thick, and weighs only 9 lbs. Considering that this volume contains 16 vacuum tubes and both transmitter and receiver circuits, it is easy to imagine a subminiaturized broadcast receiver, complete except for the audio amplifier, not much larger than a cigarette box, and a TV receiver which could be tucked into the empty space of a cabinet just large enough to hold the picture tube!

Simplified Service Procedure:

Subminiature tubes have made it possible to realize the serviceman's dream of repairing equipment by merely replacing plug-in circuit elements. In the case of military equipment, and particularly items which take as much abuse in the field as the Walkie-Talkie, ease of repair is a major consideration. Most of the field service has been eliminated on the PRC-10, for the IF alignment and most of the tuning adjustments are made on the tube-and-circuit assemblies at the factory, before the plug-in units are sealed. This eliminates many of the causes of failure, but if circuit troubles develop, or if a tube burns out, repair is effected by merely pulling out the old assembly, and plugging in a new one.

In military equipment, of course, cost is a secondary consideration. However, it should prove economically feasible to follow the same practice in designs for commercial or home use. The cost of plug-in assemblies should be low compared to the labor involved in repairing and realigning defective circuits.

Description of the PRC-10:

The PRC-10 employs frequency modulation, operating on a continuously adjustable frequency range in the VHF band, with an output of approximately 1 watt. The receiver has a sensitivity of .5 microvolt with 2.5 milliwatts output, 15 kc. deviation, at a 10-db signal-to-noise ratio.

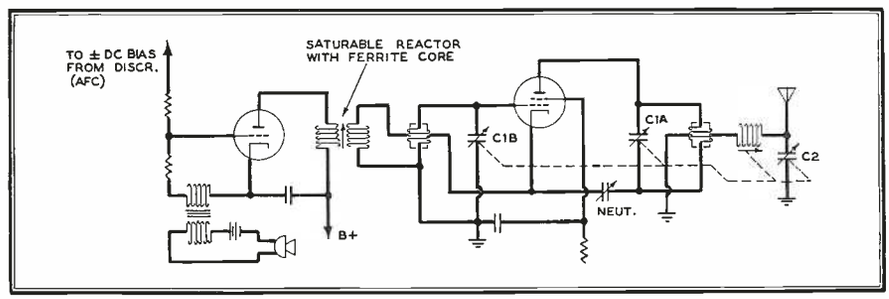


FIG. 11. DETAIL SHOWING THE METHOD OF MODULATION EMPLOYED, AND THE OUTPUT CIRCUIT

As shown in the block diagram, Fig. 10, provisions are made for using 1) a short

FIG. 12. THE CHASSIS SLIDES OUT OF THE UPPER SECTION OF THE CASE.

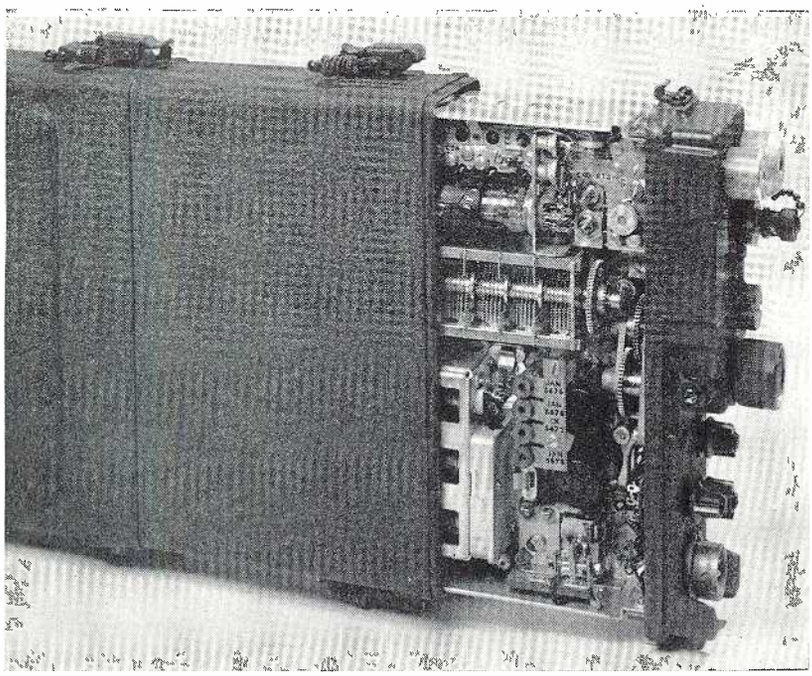


FIG. 13. THIS SHOWS THE CONTROLS PROVIDED ON THE TWO MODELS

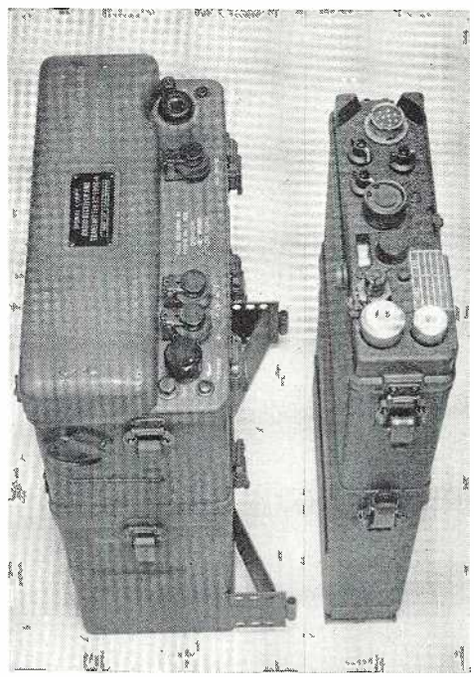


FIG. 14. BECAUSE MANY CIRCUIT ELEMENTS ARE MADE UP AS INDEPENDENT SUB-ASSEMBLIES, IT IS NOT NECESSARY TO FOLLOW THE CUSTOMARY PRACTICE OF ADDING EACH PART DIRECTLY TO THE CHASSIS, AND WIRING IT IN AS THE CHASSIS MOVES DOWN THE LINE. SPOT WELDING AND RESISTANCE SOLDERING CAN BE EMPLOYED ADVANTAGEOUSLY SINCE THE PARTS ARE VERY SMALL AND CAN BE HELD BY SIMPLE FIXTURES. FOR OPERATIONS REQUIRING THE USE OF A SOLDERING IRON, A VERY SMALL TIP IS EMPLOYED TO LOCALIZE THE HEAT. THIS CAN BE SEEN IN THE ILLUSTRATION ABOVE

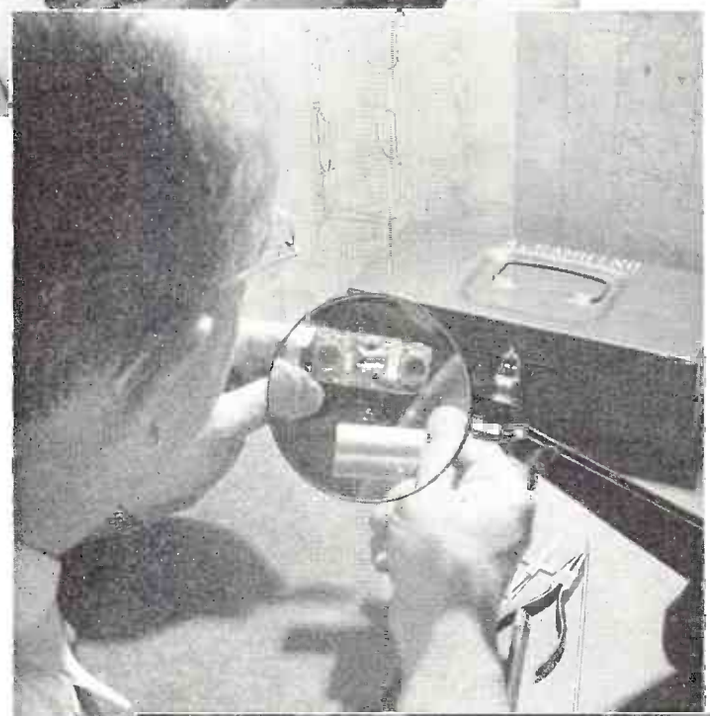


FIG. 15. INSPECTION IS SIMPLIFIED GREATLY BECAUSE A WHOLE CIRCUIT CAN BE CHECKED WITHOUT THE NECESSITY OF DELAYING THE PROGRESS OF A CHASSIS WHICH HAS BEEN INSPECTED AT PREVIOUS STAGES OF ASSEMBLY

FIG. 16. EACH PLUG-IN CIRCUIT AND ITS ASSOCIATED TUBE CAN BE ALIGNED INDIVIDUALLY. IN THIS WAY, WHEN THE FINISHED CHASSIS REACHES THE ALIGNING BOOTH, MOST OF THE WORK OF ALIGNMENT HAS BEEN DONE. THIS REDUCES REWORKING AFTER FINAL TEST TO THE VERY MINIMUM. IF A SECTION IS FOUND TO BE DEFECTIVE, IT IS ONLY NECESSARY TO PULL IT OUT AND PLUG IN ANOTHER

squelch controls; and a ten-prong connector for the handset or remote control cable.

Fig. 10 presents the complete block diagram.[1] Tubes represented by the shaded blocks are used for both transmitting and receiving; and are turned on continuously while the equipment is in use.

For transmitting, the type 5672 driver and modulator tubes and the 5A6 transmitter output tube are also used. The 1st RF tube is not used because sufficient capacity coupling is obtained straight through the RF stage.

(Continued on page 28)

[1] This diagram is entirely different from that which appeared on page 98 of *Electronics* for May, 1951. The latter is incorrect.

antenna of flexible steel that folds into very small space, 2) a long, 7-section telescoping whip, or 3) a semi-permanent antenna mounted on an elevated support and connected by a cable. Two PRC-10's can be connected together and set up on high ground to serve for unattended relay operation, repeating messages in both directions. This is a new feature that adds greatly to the usefulness of the units.

The arrangement of the controls can be seen in Figs. 12 and 13. These include a switch which controls the power, cuts in the audio jack for remote operation, or turns on the calibration oscillators and dial lights; tuning control and lock; pointer adjustment; volume and

JEREMIAH COURTNEY'S MOBILE RADIO NEWS AND FORECASTS

THE preview of 450-mc. mobile operation arranged by Link Radio in Chicago and observed by the writer was the first demonstration of mobile equipment operating in regular commercial service in that band.

Since each of the mobile radio services (land transportation, public safety, industrial, and common carrier) has a very substantial stake in the form of twenty 100 kc. channels at 450 to 460 mc., the results of the 450-mc. tests are presumably of interest to all mobile radio users. They are reported below for that reason, and this explanation is advanced only to make it clear that the writer is not abdicating the policy of leaving technical matters to qualified engineers.

Very Impressive Results:

The initial results of 450-mc. operation can be unquestionably characterized from a lay point of view as excellent. Reception over a 15-mile radius in the highly industrialized region that is Chicago was uniformly good. Not only could the messages be heard distinctly, but they came in without the background noise or scratchiness that frequently characterizes mobile reception on 25 to 50 mc. and, to a lesser degree, reception on 152 to 162 mc. It is the writer's impression, therefore, that the use of 450 mc. will continue the general improvement in reception that has accompanied the movement of the mobile services to successively higher frequencies.

The equipment demonstrated was that licensed to the Yellow Cab Company of Chicago. The group observing the performance of the taxi system included Charles Higginbotham, Land Transportation Engineer from the Washington office of the FCC; Jack Struben, Emergency Road Service Manager of the Chicago Motor Club; Arthur V. Haneline, Emergency Road Service Manager of the Cleveland Automobile Club; two Yellow Cab Company road supervisors; and V. Lee Cook, Link regional manager for the area.

The Chicago Yellow Cab Company is one of the largest cab companies in the United States. It is the first to obtain a developmental license for regular taxi operations in the 450-mc. band. The company is using the initial installations in its road supervisors' cars, and intends to expand the system based upon the experience thus obtained. The authorized power of the Yellow Cab Company base station, operating on 452.02 mc., is 200 watts. The mobile units, operating on 452.55 mc., have 20 watts output. Mobile antenna on the cars are only 6 ins. high, which should reduce breakage.

The dispatching offices of the Yellow Cab Company at 57 E. 21st Street, one of the remote control points for the system, were first inspected. Then the group went out in two of the road supervisors' cars in order to determine the mobile coverage of the system. Each car went out for a distance of 15 miles from the base station. At various times, both cars were at one of the railroad stations two stories below street level, and at other times underneath the El structures which still mar(k) the Chicago landscape. This transportation center of the country, incidentally, boasts one of the highest noise levels in all the U.S.A. At no time and under no circumstances, however, was the clear reception of the system in the mobile units affected. At the time of the visit, the installation had been in operation only about a week, but had already brought Yellow many returns in controlling the movement of cabs and their safe performance through the use of the radio-equipped supervisors' cars.

The Yellow Cab's use of the 450-mc. band points up the possibilities for other concerns. There are presently about two dozen cab companies authorized within the Chicago area to use the four pairs of lower-frequency channels that are available for taxi dispatching throughout the Country. There is absolutely no space in the 152-mc. band to accommodate the large number of units that are operated in Chicago by Yellow (1,595) and Checker (1,000). As a result the two largest cab companies in Chicago operating more than two-thirds of the taxicabs in our second largest city, have been effectually denied the use of radio for taxi dispatching. The opening up of the 450-mc. band will permit these companies to use radio, and without destroying the equipment investment of their own competitors.

Citizens Radio a Mistake?

The fine performance of the first commercial operation in the 450 to 460-mc. band suggests that the Commission may have made a mistake in assigning the entire adjacent 10-mc. band (460-470 mc.) to citizens radio use. The thought behind that assignment was, of course, a very laudable one: radio for every citizen who wanted it. (And two cars in every garage). The attainment of this fine theoretical goal appears in more than slight jeopardy, however, because equipment costs in this band are comparable to those in the lower mobile bands. All of which means that the interested citizen will have to lay on the line something like $2,000 for a base station and $600 per mobile unit. How many citizens will be interested in private radio communication at that price remains to be seen. One thing is sure! The number will certainly be much smaller than the number of business concerns who would find radio use economically justified if they had some semblance of protection from the indiscriminate citizens radio use now provided for in that band.

At this point, it appears that the Commission's gesture of the dedication of a 10 mc. band to John Q. Public was of dubious substantive merit, has been rendered more token than real by the economics of the situation, and that the usefulness of this valuable band can only be salvaged if it is turned over for specified business uses, of which there are many still denied in congested metropolitan areas where 450-mc. equipment seems to operate so ideally.

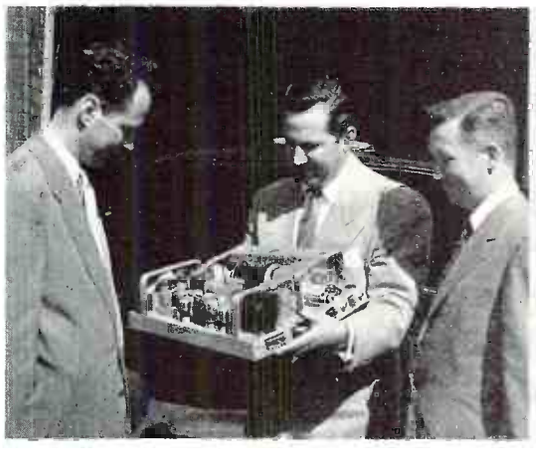
Miscellaneous FCC Actions:

Withdrawing its notices of proposed rule making, previously released, the Commission has amended its rules governing issuance and renewal of commercial operator licenses. Requirement that an operator must show two years' satisfactory service under a license being renewed or take an examination has been waived for the duration of the present emergency. A new class of radio operator license, "Temporary Limited Radio-Telegraph Second-Class Operator License (TLT)" has been established on a temporary basis, good on ships only. Amendments were made effective immediately because of a serious shortage of radio operators for sea duty.

License term of all Experimental Class 2 (Maritime) stations of the petroleum industry operating on maritime mobile frequencies in the 2 to 3-mc. band, which normally would expire on May 1, 1951,

(Concluded on page 26)

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



1. SUCCESS OF 450 MC. AT CHICAGO IS ATTRACTING WIDE ATTENTION. 2. LIVE TALENT BUILDS FM AUDIENCES. 3. CONTROL POINT FOR C-D SQUADS

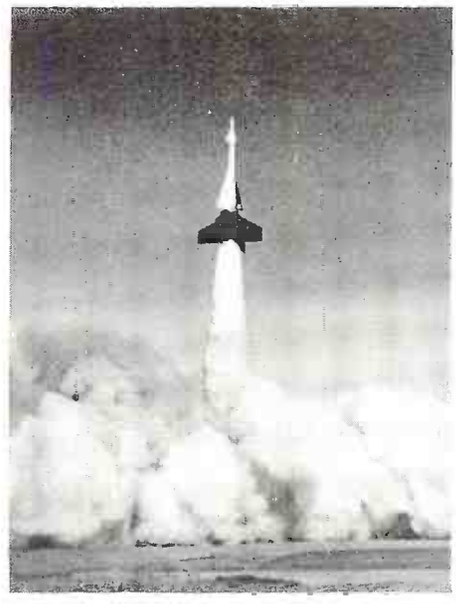
NEWS PICTURES

1. Among those who have been getting first hand information on the performance of Checker Cab's 450-mc. installation at Chicago are, left to right: Charles Higginbotham, FCC Land Transportation Engineer; V. Lee Cook, regional manager for Link Radio; and Jeremiah Courtney, legal counsel specializing in radio communication matters.

2. FM station WPJB Providence has been doing a consistently fine job of live-talent programming. This ensemble of six harps and two pianos, presented by the Rhode Island Federation of Music Clubs, was a special FM treat.

3. Here is the communication control point for the civil defense organization which covers the 15 buildings occupying 12 acres at Rockefeller Center, New York. First-aid and fire-fighting squads are equipped with Motorola Handie-Talkie and pack sets over which they can receive instructions and transmit reports to the control station. There were nearly 1,000 members trained in various phases of civil defense activities.

4. One of the new guided missiles which can be directed at enemy aircraft from the ground, even though they are hidden from sight by fog or clouds. Bell Laboratories developed and Western Electric is building the radar and control equipment by which the missile is guided to its target.



4. GUIDED MISSLE OPERATES BY RADAR CONTROL

5. A special ceremony marked the delivery of the 1,000th Raytheon commercial radar equipment, for installation on the super-liner S. S. United States. Left to right are: Raytheon president Charles F. Adams, Jr.; Vice Admiral Edward L. Cochrane, chairman of the Federal Maritime Board; William S. Newell, board chairman of the Bath Iron Works; and John M. Franklin, president of the United States Lines.

6. Radio is proving much faster and more certain than the line telephone for calling members of volunteer fire departments. G. E. equipment for police at Oberlin, Ohio, uses selective calling so that the 27 firemen can be called at their homes, but they do not get the police calls.

7. Bell Laboratories and Western Electric have joined forces to produce new radar-operated fire-control equipment for 90 and 120-mm. anti-aircraft batteries. Here is one of the first units to be delivered.

5. PLAQUE MARKS 1,000TH RADAR INSTALLATION. 6. FM TELEPHONE SUMMONS VOLUNTEER FIREMEN. 7. NEW RADAR CONTROL FOR ANTI-AIRCRAFT BATTERIES

THE GROWTH OF MCC SERVICES

AN ACCOUNT OF THE PROGRESS OF RADIO DISPATCH SYSTEMS AND THE FCC'S PURPOSE IN AUTHORIZING THE MCC SERVICE — *By* NORMAN E. JORGENSEN*

DISPATCH service using mobile radiotelephone has become a full-fledged business in its own right. The small group of pioneers who have entered into this new form of enterprise provide businessmen with a quick, efficient message service direct to their automobiles or fleet of automobiles. Their struggle for recognition by the FCC and survival in the face of competition from the telephone systems has been a hard test of their determination.

Services Rendered:

Many business and professional men spend a considerable portion of their working days traveling by automobile. A considerable number of companies, particularly those in service and distribution activities, operate vehicles which, once sent on their daily rounds, are lost to contact until they return at the close of the day. These and a host of other potential users of two-way radiotelephone systems are not eligible for their own radio licenses. Even if some of these potential users were eligible under FCC Rules, the cost of operating individual two-way radio systems would be prohibitively high. The operators of radio dispatch systems, however, are able to bring down the cost to individual subscribers by providing service to large numbers of cars and trucks.

The telephone companies also provide mobile radiotelephone service, tied in with the land lines of the Bell Telephone System. Thus, a person driving along Wilshire Boulevard in Hollywood can call New York quite simply and easily. However, while the call is being placed and completed, the radio frequency used is occupied for an undetermined and almost unlimited period. Costs, too, are almost unlimited. On the other hand, the local dispatch services, identified by the FCC as miscellaneous common carriers, do not operate over land telephone lines, but rather render an exclusively relay, dispatch-type message service. Despite this difference in operation, the two types of service are highly competitive.

In some instances, established telephone-answering organizations have supplemented that service with radio communication in order to extend their usefulness. Thus, if a patient or a doctor's secretary wants to get a message to a doctor in his car, it is only necessary to call the radio dispatch station by conventional land line telephone, and give the message to be relayed. A trained dispatcher then calls the doctor's car by radio, repeats the message, and takes an answer if one is required. If the doctor should be out of his car, the call is repeated until he answers. This procedure is repeated in a similar manner for any other type of subscriber. Typical installations for handling such activities are shown in Figs. 1 and 2.

The uses to which this new radio service can be put are endless, limited only by the ingenuity of the businessman to apply its unique characteristics to reduce operating costs.

Systems Now Operating:

There are at the present time, about 200 base stations in almost as many communities throughout the United States, licensed either on a regular or experimental basis to serve approximately 10,000 mobile units. There are applications pending before the Federal Communications Commission for the establishment of an additional 75 base stations to serve about 3,000 associated mobile units. Service is available in many localities such as New York City, Chicago, Los Angeles, St. Paul, Miami and even smaller towns like Sheffield, Illinois, and Peru, Indiana. There is service in at least one town in every state except North and South Dakota, Tennessee, Vermont and Wyoming. Almost daily, new applications to establish such service are filed with the Commission. The Territory of Hawaii has one licensee, and there is an application pending to bring this service to San Juan, Puerto Rico.

FIG. 1. TYPICAL SETUP FOR RELAYING LAND-LINE MESSAGES TO AND FROM MOBILE UNITS

History of the Service:

Section 303 (g) of the Communications Act of 1934, as amended, charges the FCC with the responsibility to "Study new uses for radio, provide for experimental uses of frequencies, and generally encourage the larger and more effective

*Krieger & Jorgensen, 1707 H St., N. W., Washington 6, D. C.

FIG. 3. MCC ADVERTISING TO SPECIAL GROUPS

use of radio in the public interest." The Commission was aware of the tremendous developments in radio during World War I and the probability of even greater impact from World War II. Near the end of the last conflict, the Commission decided to re-examine the allocations of frequencies to all types of radio use in the entire usable spectrum. On August 15, 1944 the FCC ordered public hearings which were designed to explore the needs for specific frequencies or bands of frequencies for all radio services.

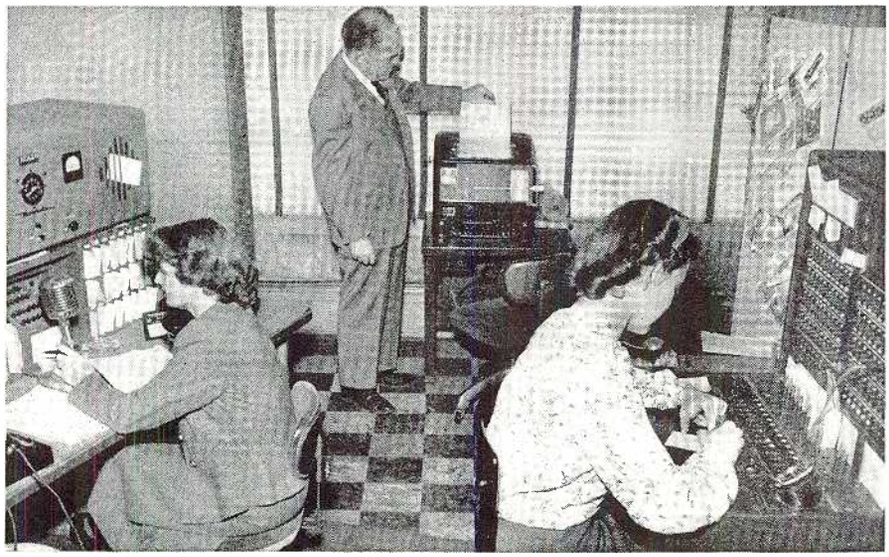


FIG. 2 THIS MCC EMPLOYS THE FACILITIES OF LAND-LINE AND RADIO TELEPHONE, AND TELETYPE

At this proceeding, which lasted 25 days, witnesses appeared for the American Telephone and Telegraph Company and various independent telephone companies, pressing for frequencies to establish a common carrier mobile radio service which had never before been authorized. They listed utilities, burglar and fire alarm companies, express companies, truckers, ambulances, doctors, taxicabs, buses, refrigeration companies, armored car services, and fuel oil distributors as examples of potential subscribers.

The seed of a possible competing service apparently was planted at this early date. FCC Chairman James Lawrence Fly was concerned about the monopoly elements in the telephone companies' position, and this concern must have prompted his question to a telephone witness: "Are you contemplating in your calculations a single unified service? . . . I mean the absence of competing carriers. Absence of duplication?" The answer was that, within any single specific area, unified control was contemplated, so that all mobile service would be interconnected with the land lines of the Bell System or the other telephone companies.

First Frequency Allocations:

As a result of consideration of the first phase of the allocation hearing, on January 15, 1945 the Commission made an initial basic decision to allocate frequencies on an overall basis for the purpose of providing two-way radio mobile service. The Commission, in its report, said:

"1. There is no practicable substitute for the use of radio to accomplish this purpose.

"2. Two-way radio communications with mobile units, such as intercity or interstate buses and trucks, should contribute greatly to highway safety.

"3. The proposed service should benefit a large number of people as shown by the scope and extent of the bus, truck, and taxicab industries, without considering the various other portions of the general public (doctors, salesmen, etc.) who may receive benefit from this service when established.

"4. Although the details of the operation of the proposed new service have not been definitized, it appears that it can be established on a practical working basis as soon as materials and manpower are available."

On February 28, 1945, further hearings were commenced. During the general mobile portion of these proceedings, by far the most important and common objection to the FCC's proposed allocation for a common carrier general mobile radio service was the inadequate number of radio channels which were to be allocated. The telephone companies again were the only ones appearing in support of the service. As a result of this further hearing, the Commission proposed to increase the number of channels for possible allocation from 7 to 24 channels, to be located in the 152 to 162-mc. portion of the radio spectrum. The Commission disposed of the matter with the following statement of policy:

"The remaining questions raised with respect to the proposed allocation for the general mobile service are disposed of as follows:

"To the extent possible, it will be the Commission's policy to encourage experimentation on the part of all interested users of the general mobile radio service so that the most informed judgment possible may be exercised with respect to the best use to be made of the frequencies presently allocated on an experimental basis for this service."

On August 14, 1945, a further statement was issued by the FCC, setting forth the overall policies that were to guide it in issuing experimental licenses in the general mobile two-way radio service. It was the plan of the Commission to explore, in a later hearing, the results of such experimentation before finalizing the allocation of frequencies to any service on a permanent basis. In that Commission statement, the miscellaneous common carriers were still not specifically recognized, for the simple reason that they did not yet exist.

It was not until May 7, 1946, that the small communication business idea began to germinate. On that date the Commission issued another statement regarding radio service to mobile units. Here the Commission mentioned the large number of individual users who probably had a use for mobile radio but could not afford to maintain their own systems, listing "pick-up and delivery trucks, doctors' and nurses' vehicles, armored cars, railway express trucks, oil trucks, highway buses and trucks, taxicabs, boats in adjacent rivers and harbors, aircraft, etc.; and a one-way signalling service to indicate to the vehicle operator that he should call his home, office, etc." At that time the 24 frequencies for the urban mobile service were specifically identified in the 152 to 162-mc. band. The FCC again made it clear that it did not have

FIG. 4. MANY DOCTORS NOW USE MCC SERVICES

sufficient data upon which to make a final determination in the allocation of frequencies. It was undecided as to whether this service should be rendered by common carriers, non-common carriers or a mixture of both. But still nothing explicit was said of the miscellaneous or "limited" common carrier. Quite obviously the MCC operator still had not become an identifiable entity.

However, on September 30, 1946, in a public notice issued by the FCC, 152.03 mc. and 157.29 mc. were designated for use by experimenters other than regular established communication companies. Thus, though the MCC pioneers had never appeared before the FCC and their position had never been articulated, there was reserved for them, unobtrusively, a part of the public domain which they could exploit at a profit, within the Government's concept of the public interest.

MCC Pioneers:

The MCC frequencies remained fallow for about a year before the first experimenters took action. By this time, taxicabs were experimenting on a single pair of frequencies. The mutual interference on their channels created a bedlam in the large metropolitan areas. In an effort to alleviate this condition, Radio Dispatch, Inc., on March 7, 1947, filed an application with the FCC to establish a mobile dispatch type of radio service in Seattle, Washington. On May 12, 1947, Solomon Schiller, engaged in operating a telephone-answering business in Brooklyn, applied to the FCC for a license to provide radio service to his subscribers. On May 29, 1947, J. J. Freke-Hayes, also engaged in the telephone-answering business in New York City, filed his application. On July 14, 1947, Robert C. Crabb, a communications engineer, and Walter Mumphrey, a taxicab operator, applied from Los Angeles and New Orleans, respectively. The following month, Ward Rogers, another telephone answering service operator, filed to establish radio service in Chicago. These represent only a cross-section of the pioneers in this field. It is to be noted that each applicant's background provided the kind of experience that enabled him to appreciate the possibilities of an improvement in our methods of communications. Also it looked like a sound business venture.

Separate Allocations:

In May, 1947, the Commission decided to allocate the 152 to 162-mc. band separately from the rest of the spectrum, and initiated a special proceeding to consider this part of the spectrum alone.

It was in this further hearing that the miscellaneous common carriers made their first appearance in a formal proceeding before the FCC. As related above, between March 7, 1947, and the late Fall of that year, a small force of miscellaneous common carriers had entered the business. In response to the Commission's notice of further hearing on the allocation of frequencies for mobile purposes to be held on December 8, 1947, Robert Crabb of Los Angeles, U-Dryvit Auto Rental Company of Boston, Transportation Communication Service of High Point, North Carolina, and J. J. Freke-Hayes of New York City requested to be heard. These early operators were very effective in presenting a clear picture of the distinctive type of radio relay dispatch service they rendered. The high degree of frequency utilization of the MCC operation, when posed against the less-efficient use by the telephone companies, and the need for some competition for the telephone companies were graphically related in their testimony. Moreover, it became clear that the people most interested in MCC business were radio engineers, telephone answering services, taxicab operators, and service organizations with large fleets of cars and trucks — all businessmen with a particular appreciation of the need for, and value of maintaining communication with moving vehicles.

Proposed FCC Rules:

Following the hearings of December, 1947, the FCC issued proposed rules governing the mobile services on June 11, 1948. Between those dates, a large number of MCC operators had entered the business — a business which, so far as its basic and most necessary commodity was concerned, the radio frequency, still wore on FCC experimental tag. But in these rules the MCC operator had at last been recognized, at least as far as regulation was concerned.

Part 6 of the FCC Rules and Regulations was then drafted to govern their proposed service. These rules allocated four pairs of frequencies to the service, but limited the allocation of those channels to alternate pairs in any one community until such time as radio equipment would be improved so that they could operate efficiently on all four pairs in any one community.[1]

The Commission invited comments on the proposed rules, and stated that either further hearings or oral argument would be held thereon before final adoption.

The oral argument on the proposed rules was held in October of 1948. It was forcefully urged that competition among the MCC operators, as well as the competition engendered between MCC operators and the telephone companies would be in the public interest, and the proposal to provide for four operators in a community was sound.

[1]Because radio equipment has now been improved, the FCC has adopted a proposal to commence using all four pairs of channels.

Final Rules Adopted:

In a final decision released by the FCC on May 3, 1949, the MCC operators were given regularly assigned frequencies, and Part 6 of the FCC Rules and Regulations was made effective on July 1, 1949. Thus, the miscellaneous common carriers, finally recognized by the FCC, were ready to move forward with assured steps under the title of Domestic Public Land Mobile Radio Service.

In recognizing the need for this new common carrier service, the Commission adopted the thesis that competition was desirable, and stated in its decision that it had "taken particular care to provide a family of frequencies within which the development of common carrier mobile radio systems by enterprises other than existing telephone companies may take place." Moreover, because the Commission did not want to put the small MCC operator in the position of being obliged to compete with the telephone companies for frequencies, it wisely set aside frequencies for the MCC operator alone. In the event there was competition for the frequencies in any one community, the MCC operator would compete for frequencies only with those who were members of his own class. In short, the Commission's favorable recognition of the MCC operators developed because they provide competition to the telephone interests as well as among themselves; and they furnish mobile radio dispatch services to a large number of potential users who would not otherwise have access to such service.

Frequencies Now Available:

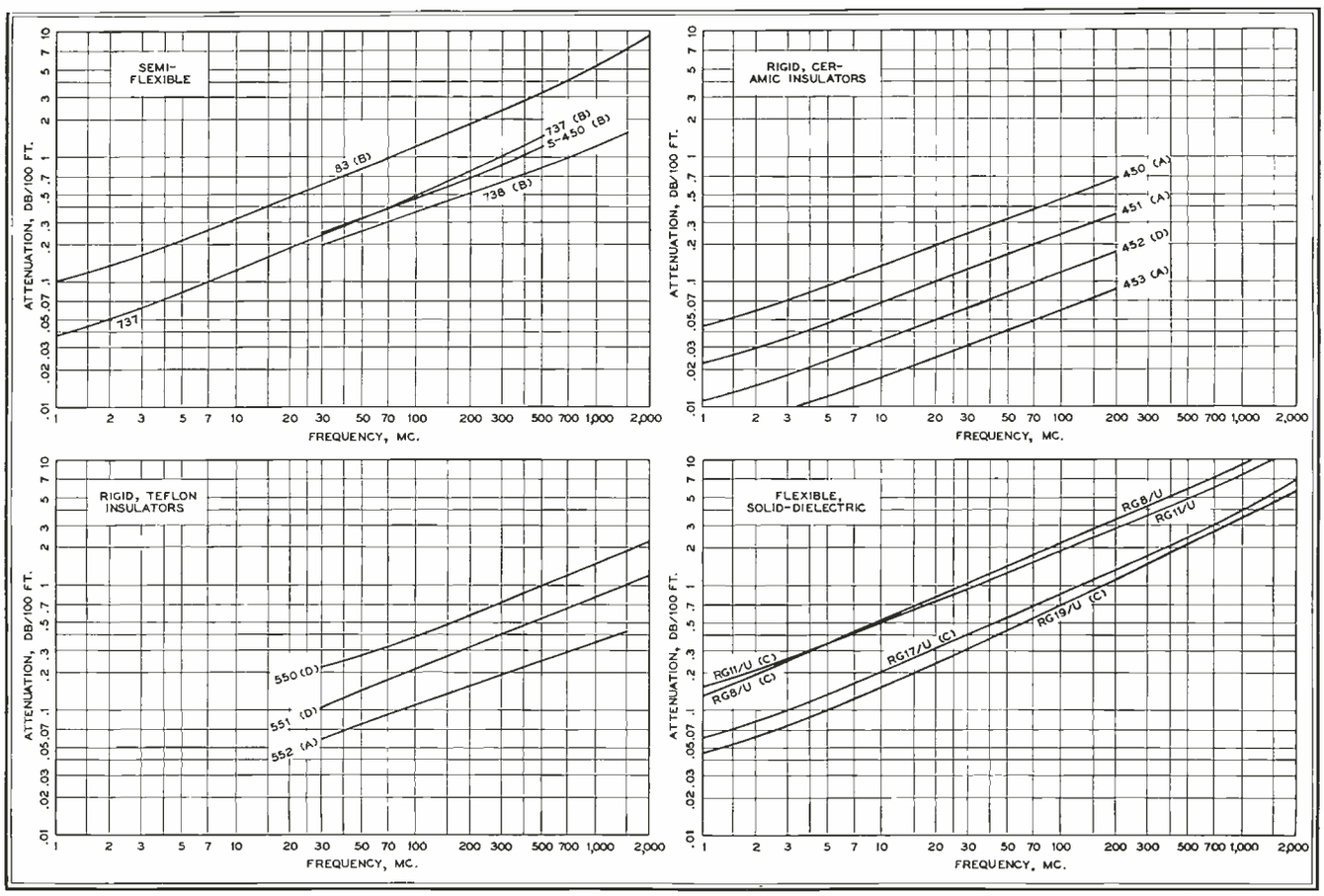
The telephone companies are assigned frequencies in both the 30 to 40-mc. band and the 152 to 162-mc. band. These are set forth in Section 6.401 of Part 6 of the FCC Rules. Four pairs of channels are available for assignment to the MCC operators. They are:

Base Station Frequencies	Associated Mobile Frequencies
152.03 Mc.	158.49 Mc.
152.09	158.55
152.15	158.61
152.21	158.67

It is very important to note that these frequencies are not shared with any other radio service, nor are they to be shared by the MCC operators themselves within any particular community. A pair of frequencies, consisting of one land station and one mobile frequency, is assigned to a single MCC operator on an exclusive, interference-free basis with-

[2]There is also the frequency 43.58 mc. which has been set aside for interference-free service for a one-way paging service. This provides service to those subscribers who do not need two-way communications but who will call a pre-arranged number when signalled.

(Continued on page 38)



NOTES ON ATTENUATION CURVES: (A) LOSS CALCULATED ACCURATELY, AND FURTHER DERATED 10%. (B) LOSS CALCULATED ACCURATELY. (C) MANUFACTURER'S MEASURED VALUE OR THEORETICAL MINIMUM VALUE, WHICHEVER IS GREATER. (D) MEASURED VALUE

SELECTION OF COAXIAL LINES

INFORMATION ON 15 STANDARD TYPES OF COAXIAL LINES, AND DATA ON ATTENUATION AT FREQUENCIES UP TO 2,000 MC. — *By* C. RUSSELL COX*

SOME 15 different types of coaxial cables are most commonly used for communication and broadcast transmitter installations. These can be broken down into four varieties, namely, semi-flexible, rigid with ceramic insulators, rigid with Teflon insulators, and flexible solid-dielectric construction.

Application Factors:

While carrying capacity and attenuation are primary considerations in specifications for coaxial cable, other factors such as flexibility or rigidity, continuous length, and weight, together with price per foot, may indicate advantages that are not disclosed by performance ratings alone.

Therefore, detailed information is presented here on each of the types plotted in the attenuation curves above, for comparison purposes.

Semi-Flexible Types:

NUMBER 83, 3/8 in. diameter: Soft-tempered copper tubing, manufactured in 100 ft. coils. Can be factory-spliced in lengths up to 2,000 ft. Weight .16 lb. per ft.

Impedance is 70 ohms, with a maximum power rating of 300 watts. Used for communication transmitters or receivers, and sampling lines for directional antenna installations.

NUMBER 737, 7/8 in. diameter: Soft-tempered copper tubing, manufactured in 100-ft. coils: Can be factory-spliced in lengths up to 2,000 ft. Weight .5 lb. per ft.

Impedance is 64 ohms (nominally called 70 ohms) with a maximum power rating of 2,500 watts. Used for communication and broadcast transmitters of 1,000 watts or less, and for 5,000-watt directional antenna systems.

NUMBER S-450, 7/8 in. diameter: Soft-tempered copper tubing, manufactured in 100-ft. coils. Can be factory-spliced to 2,000 ft. lengths. Mechanically similar to type 737, although the inner conductor is larger.

Impedance is 49 ohms, but it is electrically similar to the rigid type 450 cable which has an impedance of 51.5 ohms. Used for communication and broadcast transmitters up to 1,000 watts where a 7/8-in. semi-flexible cable of approximately 50 ohms is required.

NUMBER 738, 7/8 in. diameter: Soft-tempered copper tubing, manufactured in 100-ft. coils. Can be factory-spliced to specified lengths up to 2,000 ft.

Impedance is 51.5 ohms. This cable has Teflon insulation for low-loss performance particularly in the 1,000-mc. point-to-point services, or at lower frequencies if very low loss is required, or at 2,000 mc. if a VSWR of 2 or less can be tolerated. It should not be used on 1,200 to 1,700 mc. without consulting the manufacturer.

Rigid Cable, Ceramic Insulators:

NUMBER 450, 7/8 in. diameter: Hard-tempered copper, supplied in straight 20-ft. lengths. Weight, .58 lb. per ft.

Impedance is 51.5 ohms. Commonly used for 250- or 1,000-watt FM and AM broadcast stations, and 5,000-watt direc-

*Vice President, Andrew Corporation, 363 E. 75th Street, Chicago, Ill.

tional AM systems where the power is divided among several transmission lines. Hangers, elbows, terminals, adapters, and other fittings are available.

NUMBER 451, 1⅝ in. diameter: Hard-tempered copper supplied in straight 20-ft. lengths. Weight, 1.25 lbs. per ft.

Impedance is 51.5 ohms. Generally used for 5,000-watt FM and AM broadcast stations. Power rating is 7,300 watts on FM and 10,000 watts on AM. Hangers, elbows, terminals, adapters, and other fittings are available.

NUMBER 452, 3⅛ in. diameter. Hard-tempered copper, supplied in straight 20-ft. lengths. Weight, 2.7 lbs. per ft.

Impedance is 51.5 ohms. Used in FM stations of less than 10 kw. where the line is unusually long, and in 50-kw. FM stations where the total power is carried by two lines. Power rating is 20 kw. FM or 30 kw. Hangers, elbows, terminals, adapters, and other fittings are available.

NUMBER 453, 6⅛ ins. diameter: Hard-tempered copper, supplied in straight 20-ft. lengths. Weight 6.8 lbs. per ft.

Impedance is 51.5 ohms. Used at 50-kw. FM and AM stations, and installations of lower power where the line is unusually long. Power rating is 91 kw. FM or 100 kw. AM. Hangers, elbows, terminals, adapters, and other fittings are available.

Rigid Cable, Teflon Insulation:

NUMBER 550, ⅞ in. diameter: Hard-tempered copper, supplied in straight 20-ft. lengths.

Impedance is 51.5 ohms. Intended primarily for use on frequencies of 450 to 475 mc., 890 to 960 mc., and 1,750 to 2,110 mc. In the latter band, the VSWR in the line, with a perfect termination, averages about 1.07. Can be joined to RG-8/U or RG-17/U solid-dielectric cable. Hangers, elbows, terminals, adapters, and other fittings are available.

NUMBER 551, 1⅝ in. diameter: Hard-tempered copper, supplied in straight 20-ft. lengths.

Impedance is 51.5 ohms. Different insulator spacings are used, according to the frequency band specified. Accordingly 551 is for VHF television, No. 551-2 is for 890 to 960 mc.; 551-5 for 1,750 to 1,990 mc.; and 551-3 for 1,990 to 2,110 mc. Can be joined to RG-17/U solid dielectric cable. Hangers, elbows, terminals, adapters, and other fittings are available.

NUMBER 552, 3⅛ in. diameter: Hard-tempered copper, supplied in straight 20-ft. lengths.

Impedance is 51.5 ohms. No. 552-1 is intended for VHF television, while 552-2 is primarily for 890 to 960 mc. Because of the waveguide effect in this cable, it should not be used at frequencies above 1,200 mc. Can be joined to 551 cable. Hangers, elbows, terminals, and other fittings are available.

Flexible, Solid-Dielectric Cables:

NUMBER RG-8/U, .405 in. outside diameter: A general-purpose cable with stabilized polyethylene dielectric, and a protective covering of vinyl. Supplied in continuous lengths up to 1,000 ft. Weight, .12 lb. per ft. Impedance is 52 ohms.

NUMBER RG-11/U, .405 in. outside diameter: For use with communication and video equipment. Dielectric is stabilized polyethylene; outside covering is vinyl. Supplied in continuous lengths up to 1,000 ft. Weight, .109 lb. per ft. Impedance is 75 ohms.

NUMBER RG-17/U, .87 in. outside diameter. A low-attenuation line for higher-power transmission. Dielectric is stabilized polyethylene; outside covering is vinyl. Supplied in continuous lengths up to 1,000 ft. Weight, .49 lb. per ft. Impedance is 52 ohms.

NUMBER RG-19/U, 1.12 in. outside diameter. A large, low attenuation line for higher-power transmission. Dielectric is stabilized polyethylene; outside covering is vinyl. Supplied in continuous lengths up to 1,000 ft. Weight, .74 lb. per ft. Impedance is 52 ohms.

MOBILE RADIO NEWS

(Continued from page 20)

have been extended to August 1, 1951. The Commission also extended to November 1, 1951, the license term of all Experimental Class 2 VHF specialized operational radiotelephone maritime stations, which normally would expire May 1, 1951. Actions suggest finalization of marine rules may be expected prior to August 1.

Finding that current national emergency made it desirable to expedite the determination of the eventual status of the radiolocation service used in connection with geophysical proepecting for petroleum, the Commission conducted a hearing in early June on subject. Particularly in issue was question whether continued use of 1,750 to 1,800-kc. band, now employed in Gulf of Mexico, would interfere with disaster communication service. In the latter connection, Commission has defined, in its public release of May 15, 1951, what constitutes an acceptable communication plan within the meaning of Section 20.13 of the FCC Rules governing the disaster communications service. All applications for authorization in this new service are required to be accompanied by plan (unless a previously approved plan has been placed on file for area) showing purpose of station, manner of use, local authority

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, some 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
Special Attention: Desk No. 9
4900 Euclid Ave., Cleveland, 3, Ohio

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.

MOBILE RADIO NEWS

(Continued from page 26)

in charge of use, composition of disaster organization, points of communication, and method of coordination with existing stations.

Parts 9, 10, 11, 12, 16, 19 and 20 of FCC rules have been individually amended to reflect new antenna requirements incorporated in the recently-adopted Part 17 Rules relating to antennas and antenna supporting structures.

Commissioner George E. Sterling in his recent speech before the Petroleum Industry Electrical Association at Dallas, performed a noteworthy job of research in tracing the history of the development and expansion in the use of radio by the petroleum industry from earliest inception down to the present date, with more than a slight look ahead, too. Time was when the broadcasters got all the top-level speeches, and most if not all of the Commissioners' time. But not any more with two FCC Commissioners (Sterling and Webster) giving close and continuing attention to mobile matters. Huge growth in this field and tremendous equipment investments involved, as in microwave relay installations, more than justify present close top-level attention to mobile and point-to-point radio developments.

SUBMINIATURIZATION

(Continued from page 19)

Following the 5678 mixer, the AFC driver applies the output of a discriminator to the modulator, varying the DC bias on the modulator. This variation controls the 5A6 electron-coupled transmitting oscillator by means of a saturable inductance, as the current in the modulator tube is varied. This detail is shown in Fig. 11.

AFC driver signals are obtained as follows: Some of the transmitter signal, by-passed by the 1st RF stage, is amplified by the 2nd RF stage. In the mixer, it is mixed with the local oscillator signal to produce a given IF signal. The center frequency of the germanium-diode discriminator is tuned precisely to the IF frequency. The closer the applied frequency is to the IF frequency, therefore, the smaller the voltage developed in the AFC discriminator. Thus the transmitter frequency, is tied to the local oscillator frequency, less the given IF frequency, making the transmitter and receiving frequencies always the same. This is very important for network operation on 2-way communication.

For receiving, a conventional FM limiter-discriminator circuit is employed. There are two tuned RF stages, and five IF stages connected as grid limiters, pro-

(Concluded on page 29)

SUBMINIATURIZATION

(Continued from page 28)

viding noise limiting if the signal strength is great enough. One audio stage is used after the discriminator.

The 5678 squelch tube operates a relay to short the discriminator output when the squelch circuit is switched on, and no signals are being received. When squelch control signals bias off the squelch tube, the relay opens and removes the short on the audio input.

The 5676 and 5678 crystal-controlled oscillators work together to supply reference points at 1-mc. intervals throughout the RF band. They are used by tuning the oscillator and adjusting the fiducial marker to the nearest calibration point on the dial.

Assembly Techniques:

Because so many of the parts involved in the assemblies comprising the PRC-10 are very small and compactly arranged, the production methods are considerably different from those employed for conventional equipment. It is particularly important to limit the heat, during soldering operations, to the points of connection. Therefore, resistance-type soldering is employed extensively. Where soldering irons are used, as in Fig. 14, the tips are hardly ⅛ in. in diameter. Magnifying glasses are widely used for both assembly and inspection, and scrupulous care is required to eliminate dust, metal chips, and bits of excess solder.

While subminiaturization has required a certain amount of retraining, and the introduction of new assembly methods, definite advantages have been achieved. By breaking down the circuits into subassemblies, and designing many of them as plug-in units, they can be put through final test and inspection individually, as in Fig. 16. This is in contrast to assembly and test methods employed where the complete chassis moves the total length of an assembly line. If, after assembly is completed, a defect is found, the defective part is not repaired or adjusted. Instead, the whole unit is removed, and a perfect one substituted.

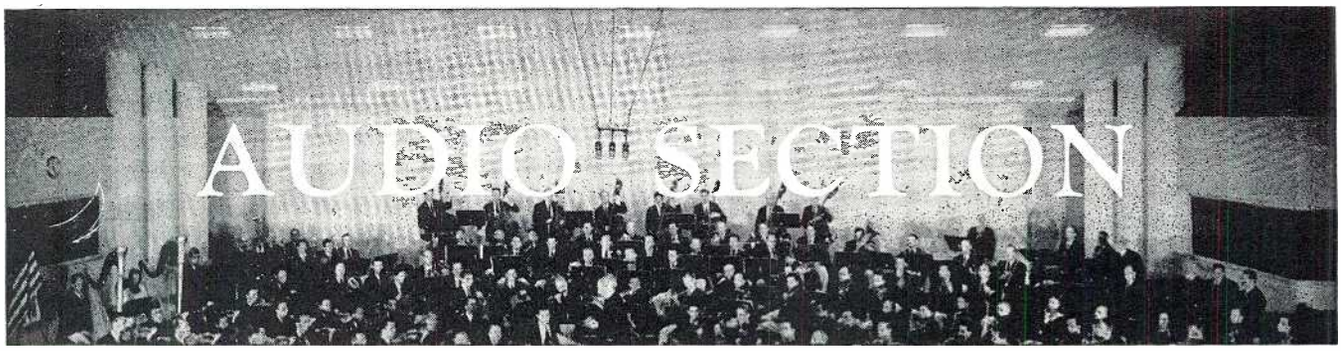
Production of the PRC-10:

This discussion of the PRC-10 would not be complete without reference to the remarkable speed with which RCA put this equipment into production after the first Signal Corps contract was awarded. Starting at that point with an approved model, an RCA team set up what was considered a nearly-impossible schedule of 55 weeks to finalize production drawings, bring in materials, complete tools, fixtures, assembly and test procedures, and to start these units coming off the production lines. Subsequently, the schedule was revised and tightened to 44 weeks. Actually, the first finished sets were delivered in 37 weeks, or 4 months sooner than the original promise to the Signal Corps.

HIGH-FIDELITY

You might think that men who make a business of radio would want to turn to some other kind of activity in their spare time. However, judging from the number of subscriptions to HIGH-FIDELITY that has come from this group, and the number of enthusiastic letters received from them about the new Magazine, they account for a considerable segment of the audio-phile fraternity. On the other hand, many executives of radio manufacturing companies expressed surprise to learn that there are enough people interested in fine audio reproduction of radio and phonograph music to justify the initial circulation of 20,000 copies of HIGH-FIDELITY.

All of which goes to show that both the broadcasters and the equipment manufacturers have been too greatly occupied with other matters to discover the huge market for high-quality audio equipment, and the fast-growing number of people interested in better audio.



DESIGN OF A SPEECH-STRETCHER

A METHOD OF REDUCING SPEECH SOUND RATE, WITHOUT SERIOUS ALTERATION OF ESSENTIAL SPEECH CHARACTERISTICS — *By* COL. G. T. GOULD, JR.*

THE purpose of the Speech Stretcher is to perform a function for the ear which is analogous to what the slow-motion camera does for the eyes. Through the use of the slow-motion camera, the eye is able to follow in detail motions that take place under otherwise rapidly moving conditions. The slow-motion technique essentially involves stretching in the time domain, without otherwise altering the basic character of the activities as originally photographed. If an equally satisfactory method of stretching speech in the time domain could be found, it appears reasonable that there would be valuable applications for the process.

By establishing a suitable ratio between the filming and projecting speeds, the slow-motion movie can be obtained. The method is extremely simple. Unfortunately, sound recordings offer no similarly simple method of time stretching. Varying the speed of a recording also varies the sound frequency components, and therefore alters the basic nature of the sound. The device described in this paper permits time stretching by a factor of two, without altering the invariant speech characteristics.

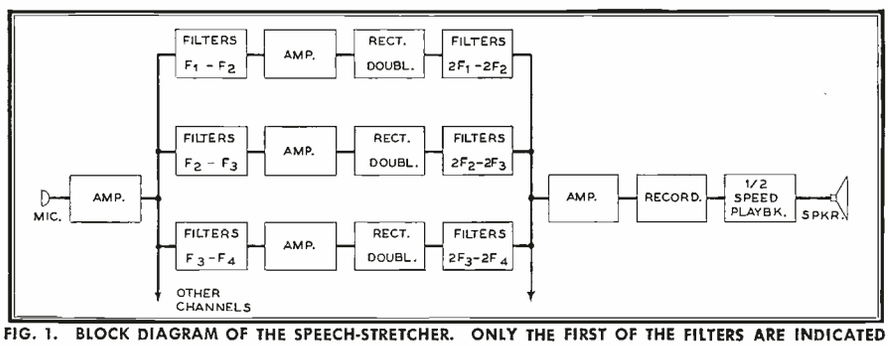


FIG. 1. BLOCK DIAGRAM OF THE SPEECH-STRETCHER. ONLY THE FIRST OF THE FILTERS ARE INDICATED

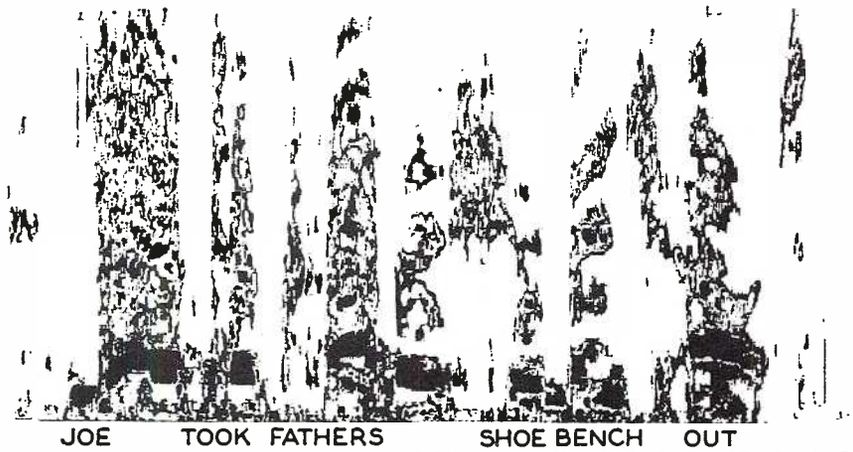


FIG. 2. SPECTOGRAPH OF A SIMPLE SENTENCE FROM NORMAL SPEECH, PRESENTED AT NORMAL RATE

Method of Operation:

Based on a fundamental stretching process suggested by M. Joos, the writer and a colleague, Lt. F. L. Hafer, designed and constructed a speech-stretching device. A block diagram of the system is shown in Fig. 1.

The input speech signal, after suitable amplication by a high-quality amplifier, is fed into a series of spectrum filters having contiguous pass bands. These filters serve to subdivide the input signal according to frequency content. The separate circuit paths from the input to the output filters are referred to in this paper as "channels."

The output of each of the spectrum filters is amplified and then fed into a rectifier-doubler circuit, which has the function of doubling the frequency components of the original signal as passed by the respective spectrum filter. Since the doubler is a nonlinear circuit, a filter follows the doubler in order to eliminate, to the maximum practicable extent. the unwanted components. The pass band of the output filters is twice that of the input filters. Signals from the various output filters are mixed, amplified, and then recorded. Ideally, the recorded signal differs from the original only in the sense that its frequency components are doubled. By using a half-speed playback, the original frequencies are reproduced, but the time is stretched by a factor of two. Actually, the concept of doubling all of the frequency components, and then regaining the original frequencies by a half-speed playback, is somewhat of an oversimplification of the process, as a pitch alteration does take place. However, the concept is useful in trying to get a general idea of what takes

* Engineering Division, Directorate of Research and Development, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio. This paper was published originally in the *Technical Data Digest*, issued by the Central Air Documents Office.

place. One variation of the system described above can be obtained by using a recorded half-speed input. The output can then be listened to directly if desired. The principal advantage of this method is that a given frequency range can be covered with fewer channels. For

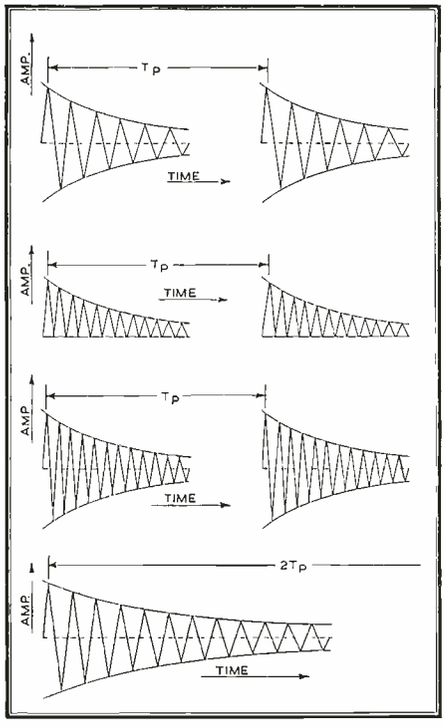


FIG. 3. PERIODIC, EXPONENTIALLY DECAYING SINE WAVE. FIG. 4. OUTPUT OF THE RECTIFIER-DOUBLER. FIG. 5. SIGNAL FROM FILTER OUTPUT. FIG. 6. THE RECORDING SIGNAL AT HALF-SPEED

a given application, one or the other of the two methods might have particular advantages.

Nature of the Process:

From a technical point of view, the question as to exactly what it is desired to accomplish in the stretching process is not without difficulty. If a single sine-wave input is used, say at 1000 cycles, then on the final playback we should expect to hear 1000 cycles, but for twice as long. For example, if we used the 1000 cycle input for one minute, then on the playback we would expect to hear 1000 cycles for two minutes. If an amplitude-modulated sine wave, with frequency components $fc \pm fm$, is used in the input, then at the output of the rectifier doubler the components $2fc \pm fm$ and $2fc \pm 2fm$ are to be expected in the range of interest. For low modulation frequencies, comparable in magnitude to the speech sound rate, it is evident that it is not practicable to filter out one set of these components and retain the other set. For stretching this type of wave it appears evident that retention of $2fc \pm fm$ is desired. Otherwise, at the output of the playback unit we would end up with exactly the same components with which we started.

The preceding illustrations help to give some feeling for what should take place in terms of steady-state phenomena, but neither the pure tone nor the simple amplitude-modulated wave are adequate for speech representation. In the case of speech, the simplest way of describing what is wanted is in terms of the spectogram. Fig. 2 illustrates the spectrogram of a normal speech sample. Frequency is represented on the vertical axis, and increases in the upward direction. Time is represented on the horizontal axis, and increases to the right. Energy level is a function of the color intensity, running from light gray to black.

An ideal speech stretcher would alter the spectrogram by merely changing the scale in the time dimension. That is, Fig. 2 could also represent stretched speech if each unit on the time scale is doubled. This means that frequency compression or expansion is not desired, and that the frequency-energy distribution should not be altered.

The phenomena of stretching may also be considered in terms of oscillograph patterns. For simplicity, consider that

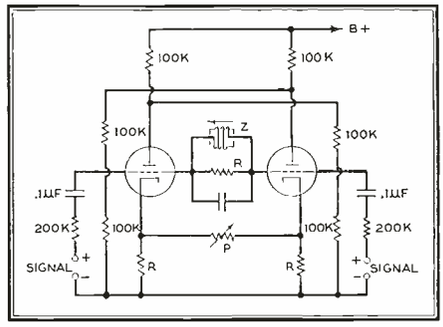


FIG. 7. SCHEMATIC DIAGRAM EMPLOYED FOR EACH OF THE 32 INDIVIDUALLY-TUNED AUDIO FILTERS

the nature of the signal to be stretched is a periodic, exponentially decaying sine wave such as that shown in Fig. 3. Simplifying the nature of the signal does not alter the validity of the arguments as to what takes place. After the signal is passed through the rectifier-doubler circuits, the negative peaks are inverted and the signal should appear as shown in Fig. 4. The output filters should reject all but the double frequency component under the envelope, and the signal would then appear as shown in Fig. 5.

When the signal is reproduced on a half-speed playback, the original frequency under the envelope is regained, but the envelope is stretched. Thus, the speech stretcher may be thought of as an envelope stretcheer. One other significant change in the final signal is evident. The fundamental period of the signal is doubled, and in terms of auditory perception this means that the pitch is halved. More will be said about this pitch change in a later section.

Equipment Employed:

The speech stretcher that was built contains 32 channels, but there is nothing magical about this particular number. At the outset, there were no definite rules which would indicate the optimum number and frequency ranges of the channels to be used. In this particular case it was decided to cover an over-all frequency range from 75 to 7000 cps, using a constant bandwidth in the range from 100 to 1000 cps, and a logarithmic variation from 1000 to 7000 cps (this arrangement roughly simulates the response of the human ear). By choosing a bandwidth of 100 cycles for channels below 1000 cycles, in no case will the contribution which any one channel is required to make to the articulation index exceed five per cent. Based on this type of reasoning, the arrangement shown below was obtained.

FREQUENCY RANGE OF CHANNELS

Channel	Freq. Range	Channel	Freq. Range
1	* 75 - 125	17	1802 - 1978
2	* 125 - 200	18	1978 - 2168
3	200 - 300	19	2168 - 2374
4	300 - 400	20	2374 - 2597
5	400 - 500	21	2597 - 2840
6	500 - 600	22	2840 - 3103
7	600 - 700	23	3103 - 3388
8	700 - 800	24	3388 - 3697
9	800 - 900	25	3697 - 4037
10	900 - 1000	26	4037 - 4399
11	1000 - 1108	27	4399 - 4793
12	1108 - 1225	28	4793 - 5220
13	1225 - 1352	29	5220 - 5683
14	1352 - 1490	30	5683 - 6183
15	1490 - 1640	31	6183 - 6683
16	1640 - 1802	32	6683 - 7183

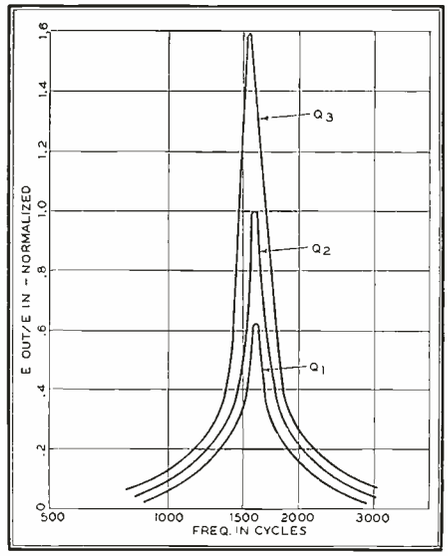
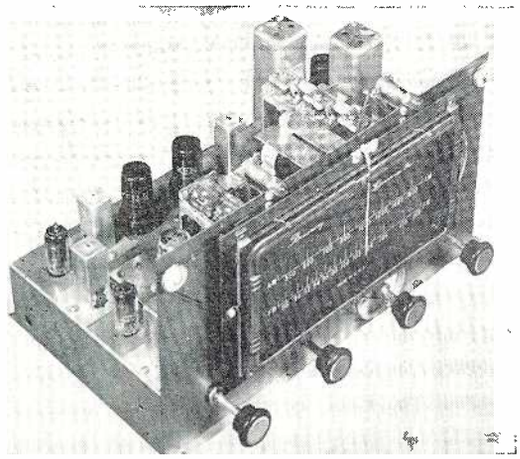


FIG. 8. EFFECT OF ADJUSTING THE Q-CONTROL

Circuits used are of conventional design, with the exception of the filters. To facilitate laboratory investigation, it was desirable to employ filters that could be variably tuned. The circuit used is shown in Fig. 7 and was devised on the basis of a suggestion by Mr. C. P. Smith of the AMC's Cambridge Research Laboratories. A response which is essentially

* Variation from 100 cycles bandwidth is here a matter of practical consideration due to the tuned circuits that were available for filter use.

BROWNING FM AND FM-AM TUNERS ARE



RJ-12B FM-AM TUNER

The number of custom radio-phonograph installations is increasing at a truly phenomenal rate. In recent years, this activity has spread from a few metropolitan areas to the point where it is national in scope. This is best illustrated by the accompanying list of distributors, now handling BROWNING FM and FM-AM tuners.

Professional custom set builders have come to standardize on BROWNING tuners because:

First of all, they deliver maximum performance on *both* FM and AM. Behind the current models is a continuing program of engineering refinement and improvement that was started in 1940. The latest feature to be added is the Selective AFC control, now available on all three.

In addition, these tuners are designed specifically to meet the requirements of custom set builders. Consider, for example, the convenient terminals for connecting associated equipment, and the single switch to cut in FM, AM, or TV reception, or a record player.

Finally, there is a choice of three distinct BROWNING models, to meet various space limitations, different types of installations, and the preferences of individual customers. However, all models have the same basic radio circuits, and all give the same outstanding performance.

Model RV-10A is a straight FM tuner, with a drift-compensated Armstrong circuit employing a 2-stage noise limiter to give 20 db quieting on signals of 10 microvolts.

Model RJ-12B illustrated here, is a very compact FM-AM tuner, with a separate power supply unit. Separate RF and IF circuits are used on FM and AM, with triple-tuned IF transformers. On FM, the drift-compensated Armstrong circuit provides 20 db quieting on 10 microvolt signals.

Model RJ-20A is a single-chassis tuner similar to the RJ-12B, but with variable IF bandwidth on AM, and a built-in preamplifier with controls to give up to 20 db bass and treble boost.

One of these three models will meet the requirements of any installation, no matter how simple it is to be, or how complicated. See, hear, and order them from your nearest distributor. For detailed data sheets, write BROWNING LABORATORIES, Inc., 700 Main Street, Winchester, Mass.

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

WHERE TO BUY BROWNING HIGH-SENSITIVITY FM and FM-AM TUNERS

Partial list of distributors who will be pleased to supply you with BROWNING tuners best suited to your particular requirements

Alaska

Anchorage
Alaska Radio Supply
P. O. Box 84

Alabama

Birmingham
Ack Radio Supply Co.
223 N. 22nd St.
Clary Co., Inc.
2024 Fourth Ave., N.

Arizona

Tucson
Elliott Electronics
418 N. Fourth Ave.
Branch: Phoenix

Arkansas

Fort Smith
Wise Radio Supply
1001 Towson Ave.

Little Rock
Southern Radio Supply
1419 Main St.
Branch: Dallas, Tex.

Texarkana
Lavender Radio Sup.
522 E. 4th St.

California

Burbank
Valley Elect. Sup. Co.
1302 N. Magnolia Bvd.

Eureka
Comm. Radio & Electr.
317 W. 7th St.

Fresno
Arbuckle Radio
2330 Kern
De Jarnatt Wholesale
223 Fulton St.
Branch: Stockton

Long Beach
Dean Co., Fred S.
969 American Ave.
Scott Radio Supply Co.
266 Alamitos Ave.

Los Angeles
Henry Radio
11240 W. Olympic Bvd.
Kierulff & Co.
820 W. Olympic Bvd.
Branches: Fresno, San Diego
Radio Products Sales
1501 S. Hill St.
Radio Specialties Co.
1956 S. Figueroa St.
Univ. Radio Supply
1729 S. Los Angeles St.

Oakland
Brill Co., W. D.
198 10th St.
Electric Supply Co.
149 12th St.
Wenger Co., E. C.
1450 Harrison St.
Branches: Sacramento, Fresno, San Francisco

Pasadena
Dow Radio, Inc.
1759 E. Colorado St.
Branch: Chicago

Sacramento
Kemp Co., E. M.
1115 "R" St.
Branch: Reno, Nev.
Radio Telev. Prod. Co.
1519 19th St.
Sacramento Elec. Sup.
1219 S St.

San Bernardino
Bagley Co., George H.
1216 "D" St.
Branch: San Bernadino

San Diego
Coast Electric Co.
744 G St.
629 8th Ave.

San Francisco
Assoc. Radio Dist.
1251 Folsom St.
Brown Co., C. C.
61 9th St.
Branch: Sacramento
Cox Distributing Co.
2598 Lombard St.
Graybar Elec. Co.
1750 Alameda St.
Kaemper and Barrett
1850 Mission St.
Branch: Berkeley
Leo J. Meyberg Co.
70 Tenth St.
Branches: Fresno, Los Angeles
Pacific Wholesale
116 Ninth St.
G. M. Popkey Co.
458 Brannan St.
Branches: Duluth, Minn., Marinette, Wis.
S. F. Radio & Supply
1282 Market St.
San Francisco Radio
1280-84 Market St.
Zack Radio Supply Co.
1426 Market St.

San Jose
Frank Quement, Inc.
161 W. San Fernando St.

Santa Barbara
Channel Radio Supply
434 State St.

Stockton
Dunlap Whsle. Rad. Co.
27 N. Grant St.

Colorado

Denver
Sound Service
446 Broadway

Pueblo
L. B. Walker Co.
218 W. 8th St.
Branch: Denver

Connecticut

Hartford
Hatry & Young, Inc.
203 Ann St.
Branches: Bridgeport, Stamford, Waterbury
Moses Radio Elec. Co.
54 Flower St.

New Britain
United Radio Supply
53 E. Main St.

New Haven
Brown Co., Thomas H.
15-25 Whiting St.

Waterbury
Bond Radio Supply Co.
439 W. Main St.

District of Columbia

Washington
Elect. Wholesalers
2010 14th St., N. W.
Kenyon Radio Sup. Co.
2020 14th St., N. W.
Sun Radio & Service
938 F St., N. W.

Florida

Miami
Walder Radio & Appl.
1809 N. E. 2nd Ave.

Pensacola
Grice Radio & Elect.
358-360 E. Wright St.

St. Petersburg
Cooper Radio Co.
648 Second Ave., S.

Sarasota
Morley Radio Electric
944 Main St.

Tampa
Kinkade Radio Supply
402-04 W. Fortune St.
Thurow Distributors
134-36 S. Tampa St.

Georgia

Atlanta
Specialty Distrib. Co.
425 Peachtree St., N. E.
Branches: Savannah, Albany, Macon, Chattanooga, Tenn.

Idaho

Boise
Craddock's Radio Sup.
1522 State St.

Illinois

Chicago
Allied Radio Corp.
833 W. Jackson Bvd.
Concord Radio Corp.
901 W. Jackson Bvd.
Newark Electric Co.
323 W. Madison St.
Walker-Jimieson, Inc.
311 S. Western Bvd.

Mt. Carmel
Wabash Radio Distrib.
702 Plum St.

Rockford
Mid-West Associated
506 Walnut St.

Indiana

Angola
Lakeland Radio Sup.
525 S. West St.

Fort Wayne
Pembleton Labs.
236 E. Columbia St.

STANDARD FOR CUSTOM INSTALLATIONS

Indianapolis
Van Sickle Radio Sup.
102 S. Penn. St.
Lafayette
Lafayette Radio Sup.
412 Brown St.
Terre Haute
Archer & Evinger
1348 Wabash Ave.

Iowa

Des Moines
Gifford & Brown, Inc.
1216-18 W. Grand Ave.
Branches: Cedar Rapids, Waterloo, Ft. Dodge

Kansas

Wichita
Amateur Radio Equip.
1215 E. Douglas St.

Kentucky

Lexington
Radio Equipment Co.
480 Skain St.
Louisville
Burks & Company
911 W. Broadway
Universal Radio Sup.
533 S. 7th St.
Owensboro
Central Electronics
600 N. Third St.

Louisiana

New Orleans
Columbia Radio & Sup.
3940 3rd St.
Shuler Supply Co.
415 Dryades St.
Southern Radio Sup.
1900 Tulane Ave.
Walther Bros. Co.
714-20 Howard Ave.

Maryland

Baltimore
Henry O. Berman Co.
12 E. Lombard St.
Wholesale Radio Parts
311 W. Baltimore St.
Hagerstown
Zimmerman Whlslrs.
114 E. Washington St.

Massachusetts

Boston
Demambro Radio Sup.
1111 Commonwealth
Branches: Lawrence, Providence, R. I.
Hatry & Young
42-44 Cornhill
Branches: Lawrence, Springfield, New London, Conn.
Herman Co., Inc.
885 Boylston St.
Mayer Co., A. W.
895 Boylston St.
Radio Shack Corp.
167 Washington St.
Radio Wire Television
110 Federal St.
Brockton
Ware Radio Supply Co.
913 Centre St.
Cambridge
Electrical Sup. Corp.
1739 Mass. Ave.
New Bedford
Beckman Co.
11-35 Commercial St.
Pittsfield
Pittsfield Radio Co.
41 West St.
Springfield
Cushing, T. Frank
349 Worthington St.
Springfield Radio Co.
405 Dwight St.
Branch: Holyoke
Springfield Sound Co.
147 Dwight st.
Worcester
Demambro Radio Sup.
729 Main St.
Radio Maintenance
19-25 Central St.

Michigan

Ann Arbor
Purchase Radio & Cam.
605 Church St.
Wedemeyer Elect. Sup.
213-17 N. Fourth Ave.
Branch: Lansing
Battle Creek
Electronic Sup. Corp.
185 W. Michigan Ave.
Branch: Kalamazoo
Detroit
Duffy & Co., Inc.
2040 Grand River Ave.
K. L. A. Laboratories
7422 Woodward Ave.
Radio Specialties Co.
456 Charlotte St.

Minnesota

Minneapolis
Bonn Co., Lew
1211 LaSalle Ave.
Branches: Duluth, St. Paul
Northwest R. & E. Sup.
52 S. 12th St.
Branch: St. Paul
Stark's, Inc.
71 S. 12th St.
Branches: Duluth, La Crosse, Wis.

Mississippi

Jackson
Cabell Electric Co.
422 S. Farish St.

Missouri

Butler
Henry Radio Shop
211 N. Main St.
Branch: West Los Angeles, Cal.
Cape Girardeau
Suedekum & Sons
620 Good Hope Ave.
Joplin
Brotherson Co.
515 N. Byers Ave.
Kansas City
Burstein-Applebee Co.
1012-14 McGee St.
St. Louis
Ashe Radio Co.
1123-25 Pine St.
Van Sickle Radio Co.
1113 Pine St.
Springfield
Reed Radio Supply
833 Boonville Ave.

Montana

Billings
Electronic Supply Co.
214 11th St., W.
Missoula
Northwest Distributors
50 S. Higgins

Nebraska

Lincoln
Hicks Radio Co.
1420-22 O St.
Omaha
Radio Equipment Co.
2822 Farnam St.

Nevada

Reno
Saviers Elec. Prod.
640 Sierra St.
Branch: Las Vegas

New Hampshire

Concord
Evans Radio
10 Hills Ave.
Dover
American Radio Corp.
510 Central Ave.
Manchester
Radio Service Lab.
670 Chestnut St.
Branches: Portland, Bangor, Maine

New Jersey

Jersey City
Nidisco-Jersey City
713 Newark Ave.
Newark
Continental Sales Co.
195 Central Ave.
Electronic Marketers
415 Halsey St.
Lippman & Co.
246 Central Ave.
Radio Wire Television
24 Central Ave.
Phillipsburg
Williams, Carl B.
154 S. Main St.
Trenton
Allen & Hurley
25 S. Warren St.

New York

Albany
Ft. Orange Radio Dist.
904 Broadway
Taylor Co.
465 Central Ave.
Amsterdam
Adirondack Radio Sup.
32 Guy Park Ave.
Brooklyn
Benray Distrib. Co.
485 Coney Island Ave.
Peerless Electronics
76 Willoughby St.
Buffalo
Dymac, Inc.
2329-31 Main St.
Genesee Radio & Parts
205 E. Genesee St.
Radio Equipment Corp.
147-51 Genesee St.
Hempstead, L. I.
Davis Electronics
204 Main St.
Standard Parts Corp.
277 N. Franklin St.
Ithaca
Stallman of Ithaca
127-31 S. Tioga St.
Jamaica, L. I.
Norman Radio Distrib.
94-29 Merrick Rd.
Peerless Radio Distrib.
92-32 Merrick Rd.
Branch: New York
Mt. Vernon
Davis Radio Distrib.
66-70 E. Third St.
New York
Arrow Electronics
82 Cortlandt St.
Dalis, Inc., H. L.
175 Varick St.
Federated Purchaser
66-68 Day St.
Branch: L. Angeles, Cal.
Easton, Allentown, Pa.
Fischer Distrib. Co.
118 Duane St.
Harrison Radio Corp.
12 West Broadway
Branch: Jamaica, L. I.
Harvey Radio Co., Inc.
103 W. 43rd St.
Leonard Radio, Inc.
69 Cortlandt St.
Milo Radio & Elect.
200 Greenwich St.
Newark Electric Co.
242 W. 55th St.
Radio Wire Telev.
100 6th Ave.
Stan-Burn R. & E. Co.
1697 Broadway
Branch: Brooklyn
Sun Radio & Elect.
122-24 Duane St.
Terminal Radio Corp.
85 Cortlandt St.
Rochester
Hunter Electronics
233 East Ave.
Rochester Radio Sup.
118 St. Paul St.
Branch: Syracuse
Schenectady
Schwartz & Son
710-12 Broadway
Syracuse
Broome Distrib. Co.
100 Tully St.
Branch: Binghamton
Troy
Trojan Radio Co., Inc.
420 River St.
White Plains
West. Elect. Supply
420 Mamaroneck Ave.

North Carolina

Asheville
Freck Radio & Supply
38-40 Biltmore Ave.
Charlotte
Shaw Distributing Co.
205 W. 1st St.
Raleigh
Car. Radio Equipment
105 E. Martin St.
Winston-Salem
Dalton-Hege Rad. Sup.
342 Brookstown Ave.

Ohio

Akron
Olson Radio Warehse.
73 E. Mill St.
Sun Radio Co.
110 E. Market St.
Canton
Burroughs Radio Co.
711 2nd St., N. W.
Branch: Mansfield
Cincinnati
Schuster Electric Co.
317-21 E. 8th St.
Steinberg's, Inc.
633 and 637 Walnut St.
United Radio, Inc.
1314 Vine St.
Cleveland
Northern Ohio Labs.
2073 W. 85th St.
Olson Radio Warehouse
2020 Euclid Ave.
Pioneer Radio Supply
2115 Prospect Ave.
Progress Radio Supply
415 Huron Rd.
Winteradio, Inc.
1468 W. 25th St.
Columbus
Hughes-Peters, Inc.
111-17 E. Long St.
Branches: Dayton, Cincinnati
Thompson Radio Sup.
182 E. Long St.
Dayton
Srepco, Inc.
135 E. 2nd St.
Branch: Springfield
Elyria
El-A-Co.
121 Lodi St.
Toledo
H. & W. Auto Acc.
26 N. 11th St.
Warren Radio Co.
1320 Madison Ave.
Branches: Lima, Akron, Peoria, Ill.
Ft. Wayne, Ind.
Youngstown
Ross Radio Co.
325 W. Federal St.
Zanesville
Thompson Radio Sup.
135 S. Sixth St.

Oklahoma

Oklahoma City
Electronic Supply
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Tulsa
Radio, Inc.
1000 S. Main St.

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Portland
Central Distributors
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Portland Radio Supply
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Pennsylvania

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59-63 E. Broad St.
Erie
Duncombe Co.
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Warren Radio Co.
12th & State Sts.
Philadelphia
A. C. Radio Supply Co.
1539 W. Passyunk Ave.
Branch: Chester
Almo Radio Co.
509 Arch St.
Consolidated Radio Co.
612 Arch St.
Herbach & Rademan
1204 Arch St.
Neuber, Herbert K.
1207 Race St.
Radio Electric Serv.
701 Arch St.
Branches: Philadelphia, Allentown, Easton, Pa., Camden, N. J., Wilmington, Del.
Pittsburgh
Cameradio Co.
963 Liberty Ave.
Branch: Wheeling, W. V.
Tydings Co.
632 Grant St.
Reading
Barbey Co., Inc.
55-57 Penn St.
Branch: Lancaster
Scranton
Pursell, Fred P.
548-50 Wyoming Ave.

Rhode Island

Providence
Dandreta & Co.
129 Regent Ave.
Edwards Co., W. H.
94 Broadway

South Carolina

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Dixie Radio Supply
1715-17 Main St.
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Tennessee

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Radio Electric Supply
210 Cherokee St.
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Austin
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Milwaukee
Electro-Pliance Distr.
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For Complete Technical Data on These FM and FM-AM Tuners, Address:

BROWNING LABORATORIES, Inc.

700 Main Street, Winchester, Massachusetts

the same as that of an ordinary tuned parallel-resonant circuit is obtained, but the "Q" can be controlled by varying the variable resistor "P." The effect of varying the "Q" control can be seen in Fig. 8. Channel crossovers were adjusted at the 3 db points.

Experimental Results:

When identical samples of stretched and unstretched speech are heard, there are two particularly outstanding features. First, a pronounced change in the syllabic rate of speaking is evident. A reduction in the syllabic rate of speaking is the object of stretching, and hence requires no special comment except from a psychological standpoint. A loss of naturalness, referring to individual characteristics of the human voice, must be expected when the syllabic rate is cut in half. Familiarity with an individual's voice can hardly be disassociated from the average rate at which the individual normally speaks. Secondly, a change in pitch is readily noted.

The change in pitch that occurs in the speech stretching process is undesirable for two reasons: first, it causes a loss in naturalness; and secondly, there is no reason to believe that the intelligibility would be higher in some cases if the pitch alteration did not take place. This latter feature is particularly true for deep-bass voices. It is important, then, to investigate the cause for the pitch alteration, and determine whether or not a means for avoiding it can be found.

The pitch of a speech sound is determined by the behavior of the vocal cords, which are more accurately described as the vocal folds because of their anatomic structure. Whenever a voiced sound is being uttered, the vocal folds move together and then apart in such a manner as to vary the size of the opening between them. This opening is referred to as the "glottis." For a constant pitch, the vocal folds move together and separate at regular intervals. During a portion of each cycle the glottis is completely closed, and the supply of air from the lungs causes a rise in pressure which reaches a maximum at this time. When the glottis opens, there is an explosive burst of air which relieves the pressure. The time interval between these bursts determine the pitch.

It is of interest to note what happens when a person coughs. First the vocal folds close and a large build-up of pressure occurs; then the glottis opens and an explosive burst of air takes place. If a tube is inserted so that it prevents closure of the glottis, coughing cannot take place.

If the glottis opened into free air, the wave shape of the air pressure variations could ideally be represented by rectangular pulses. The time interval between these pulses is the reciprocal of the pitch frequency. Actually, an acoustical network is interposed between the glottis and free air. This network serves to modify the nature of the flow, but does not alter the pitch. Energy flow for producing the voiced sounds comes in explosive bursts and, in the stretching process employed, it is inescapable that the time interval between these bursts will be doubled. Thus, the resulting pitch is reduced by one-half. At the moment there does not appear to be any simple method of overcoming this pitch alteration.

One rather elaborate method of getting around the pitch variation is by employing a synthetic device such as the Vocoder.[1] A test was made using a Vocoder in the input of the speech stretcher. The normal pitch adjustment was first used, and then a 2:1 compensation was made. It must be concluded that the idea is better in theory than in practice, for the character of the speech changes somewhat when the pitch compensation is made. The Vocoder speech, after stretching, sounds better without the 2:1 compensation. However, in either case the Vocoder speech is quite intelligible after it has been stretched. Use of the Vocoder as a means of pitch compensation is of more academic than practical interest.

FIG. 9. EFFECT OF PLAYING ORIGINAL SAMPLE AT HALF-SPEED. FREQUENCY COMPRESSION AND ALTERATION OF ENERGY DISTRIBUTION ARE EVIDENT

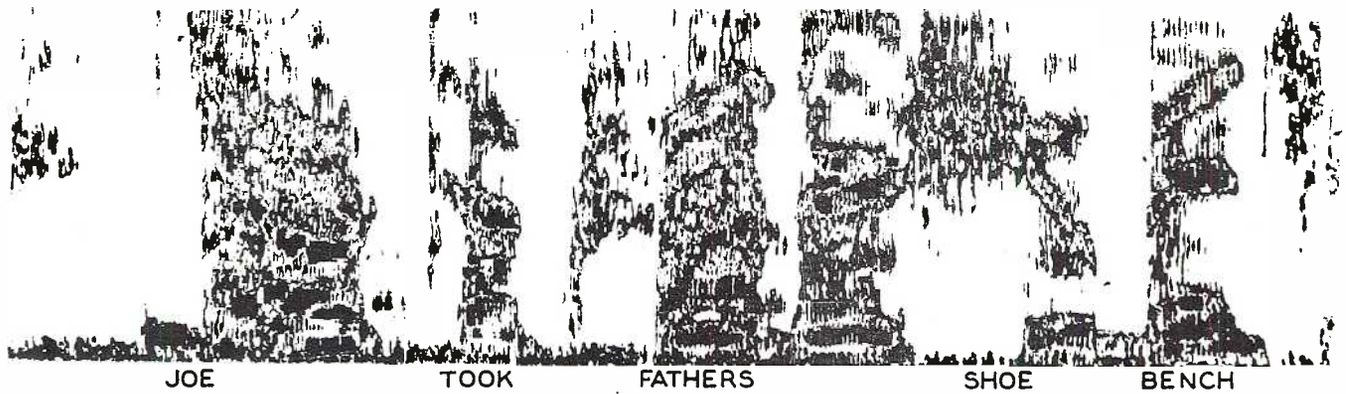

FIG. 10. SPEECH-STRETCHING EFFECT IS EVIDENT HERE, BUT FREQUENTLY HAS NOT BEEN COMPRESSED, AND ENERGY DISTRIBUTION IS MAINTAINED

Stretched-Speech Spectrogram:

The speech spectrogram offers a most convincing means of showing the performance of the speech stretcher. An original speech sample is shown in Fig. 2. A spectrogram of the same sample when played at half speed is shown in Fig. 9. In this case, time stretching is seen to take place, but the frequency compression is also evident. Alterations of the

[1]A discussion of the Vocoder itself is not practicable in a paper of this length. The interested reader is referred to the following paper: "Analysis-Synthesis Telephony with Special Reference to the Vocoder," R. J. Halsey and J. Swaffield. Journal of the Institute of Electrical Engineers, Vol. 95, Part 3, 1948.

energy distribution also takes place. To a listener, the sample played at half speed is almost completely unintelligible.

Fig. 10 illustrates the same speech sample after it has been put through the speech stretcher. The stretching by a factor of two is evident, but here frequency compression does not take place. Furthermore, the energy distributions are seen to correspond remarkably well with the original. One other point of comparison is of particular interest. Note the vertical striations that occur in a voiced sound such as "Ben" in "Bench." The pitch frequency is reciprocally related to the time separation between these striations, and by a comparison of the original and stretched samples, pitch halving is seen to result when speech is stretched.

Phonetic and Linguistic Aspects:

The tests that were made provide only qualitative results. These tests included a comparison of recorded samples of stretched and unstretched speech on the basis of aural perception. Various speakers were used to obtain both English- and foreign-language samples. The results do not permit any definite conclusions regarding idea intelligibility, but syllable and word articulation scores should undoubtedly prove to be higher in the case of stretched speech. Speech details that are not normally evident to an untrained observer are readily perceived after stretching. The extra time that stretching provides is easily appreciated when unfamiliar sounds are perceived. These features serve to emphasize the value of the speech stretcher as a useful tool for phonetic demonstration, and as a valuable training aid in the study of languages.

Noise Considerations:

In the initial stages of the research, it was hoped that the device would effect an improvement in the intelligibility of speech in such a manner as to lower the signal-to-noise threshold in speech-communications systems. Qualitative tests that were made provide no firm basis for optimism in this regard, but further experimentation is needed for conclusive results.

It was found that amplifier noise, phonograph-needle scratch, and some types of ambient noise produce a background gurgling sound in the output unless the level of these noises is kept to a reasonably low value. With proper circuit design, this feature can be made practically negligible for most conditions of operation.

Music Stretching:

Whenever there are two or more signals present at the input of the rectifier-

(Concluded on page 36)

doubler, sum and difference frequencies are introduced. Unfortunately, these added signals will normally lie within the range of the output filter, and are not therefore eliminated. In the case of speech sounds, or single musical tones, no practical difficulty is involved. This is true even though a tone is rich in harmonics. However, when piano or organ music is used — or any other type which involves a grouping of tones such as those which correspond to a chord — cross-modulation products are introduced, and discordant effects are obtained. This difficulty can be limited by the use of narrow-band, sharp cutoff filters, but a very large number of channels would then be required. There are, of course, limitations in how narrow the bandwidth can be made, because sufficient time must be allowed for energy build-up and decay.

Summary and Conclusions:

The speech stretcher provides an effective means for reducing the speech sound rate, without any serious alterations of the essential speech characteristics. Pitch halving occurs and, while this is not a desirable feature, it is a serious drawback only in those cases where it is absolutely essential to retain the degree of naturalness that is lost in the process.

Among the more obvious uses of the stretcher is its application in the field of language study. There is no doubt that the device can be of considerable help to both instructor and student. In the tests that were made, both a French teacher and one of her students were employed. Each of them was able to fully appreciate the value of the device as a training aid. The extra time for reflection aids the student in gaining familiarity with strange sounds, and the improved phonetic qualities assist him in learning how to reproduce them. When the student's spoken version of the language is played back, mistakes are more readily perceived by the student and teacher. Also, there is time available for the teacher to supply the correct pronunciation without interfering with words that are to follow.

The use of the stretcher as an aid in teaching diction and elocution also has interesting possibilities. For example, there are those who, for professional reasons, need to attain a degree of perfection in their diction; radio announcers, entertainers, and high government officials are among those in this category. Faults in diction can hardly escape an observer who hears the speech in its stretched form. Even the speech of rapid speakers can be quite closely scrutinized after a single stretching.

The use of the speech stretcher for medical purposes is a possibility that remains to be investigated. Specialized fields of most evident interest are neurology, psychiatry, and psychology. The degree of usefulness in any of these fields may well depend upon the development of specialized procedures and techniques.

Music applications are also of interest, especially in voice training. The voice teacher can often recognize deficiencies without being able to get the idea involved across to the student easily. One music expert, with whom the stretcher was discussed in some detail, is very enthusiastic about the vocal training possibilities of the device. The playing of individual instruments for stretching is also practicable, provided only one musical tone and its harmonics are involved. In other words, an instrument such as the piano or organ is not suitable.

At the outset, it was hoped that the speech stretcher could be used to effect an improvement in the intelligibility of speech in such a manner as to lower the signal-to-noise threshold in speech-communication systems. Qualitative tests that were made provide no firm basis for optimism in this regard, but further experimentation is needed for conclusive results.

For practical uses the 32-channel stretcher is overelaborate. The results that can be obtained with as few as six channels are surprisingly good. For most purposes, 8 to 10 channels would prove to be entirely adequate. In terms of cost, the device can be brought within easy reach of schools, speech clinics, and research organizations. The speech stretcher is a tool which should find increasing popularity as its potentialities become more widely known.

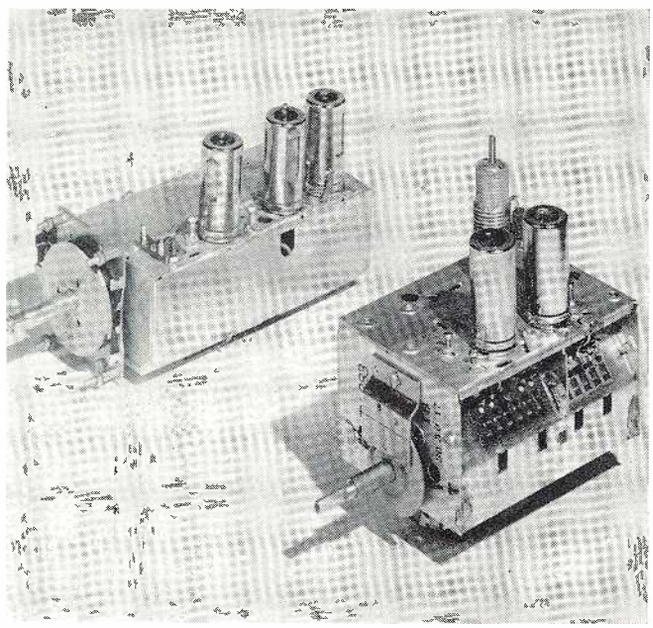

FIG. 6. PROFESSIONAL CUSTOM BUILDERS CAN OFFER A CHOICE OF CONTINUOUS OR TURRET TUNING

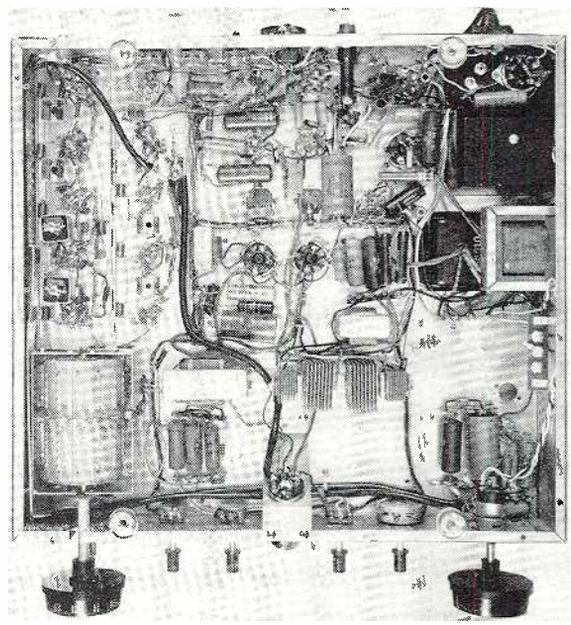

FIG. 7. UNDERNEATH VIEW OF THE TV CHASSIS

TV INSTALLATIONS

(Continued from page 14)

placeable channel-tuning sections for UHF or VHF reception. The continuous-range tuner is provided with a switch position at which a phonograph input is cut in. At that position and throughout the FM band, the video circuits are turned off automatically.

Other important features which are provided for optimum operation are keyed automatic gain control, and automatic control of horizontal sync.

Circuit Components:

In order to minimize parts failure and

(Concluded on page 38)

TV INSTALLATIONS

(Continued from page 36)

servicing, components such as plastic-molded paper capacitors, hermetically-sealed electrolytic capacitors, and selenium rectifiers are used in these sets. Selenium rectifiers have proved considerably more dependable than vacuum tube rectifiers for the power supply. A field service survey conducted over a 2-year period has disclosed only .25% failures. Used in the combination bridge and full-wave power supply arrangement which can be seen in Fig. 7, selenium rectifiers offer the important advantages of less heat dissipation, better regulation. and a saving in power consumption.

A universal type of picture-tube mounting is employed, capable of accommodating any tube from the 17-in. rectangular to the 24-in. round size. Corresponding bezels and finishing accessories are also supplied.

MCC SERVICES

(Continued from page 24)

in any service area. The FCC may authorize as many as four carriers to a given service area depending upon the needs of the community. Based upon conclusions drawn from FCC actions in effecting assignments in this service, it appears that, for satisfactory service, companies can use the same frequencies, provided co-channel stations are separated by a distance of about fifty miles.

Typical Operators:

Most MCC licensees are operators of telephone-answering services. These organizations, usually of long standing in large communities, are set up to answer a business or professional man's telephone when he is away from his office. In the event a customer's telephone rings two or three times and is unanswered, the service answers the call. They then pass the message on to the customer when he can be reached. Operators of the telephone answering services naturally want to extend their service so that they can reach customers in their cars. In the first place, these businessmen are already in the field of communications; second, they can readily superimpose the added expense on their present business overhead; third, the customers of these answering services provide a choice nucleus around which an MCC operator can build new service: fourth, reaching customers in their cars by radio is a natural extension of the service. It adds to the attractiveness of the service, and operators have been quick to exhibit it in their promotional material. Typical examples are shown in Figs. 3 and 4. Finally, furnishing radio dispatch service adds prestige to the telephone-answering company, convenience, and marks it as progressive and forward-looking.

Two other groups are made up of motor vehicle fleet operators, and businessmen who want radio communication for their own use, but who are ineligible for one of the types of private service authorized by the FCC, or who find the installation of such a service too expensive for their own use exclusively.

It is interesting to note that, before the FCC issued its final decision in the general mobile proceeding, the frequency 152.15 mc. was available on an experimental basis only to almost any type of business. As a result, so many businesses began using radio that in some crowded urban areas the interference on this channel became extremely severe. As a result, the Commission, in its final general mobile decision, deleted the frequency (effective November 1, 1949) for this almost unrestricted use, and assigned it to the MCC on the theory that a coordinated use, effected through a common carrier, would be more beneficial to the users.

During the experimental period many concerns became so dependent upon the use of radio that they instituted MCC systems in their own communities and immediately became their own best customers. To name but a few types of businesses that have done this, there are fuel oil and bottled gas distributors, ambulance services and funeral directors, protective patrol organizations, and refrigeration repair services.

FCC Rate Requirements:

The domestic public land mobile radio services are dedicated to public correspondence. All licensees in the business are required to serve the public without discrimination, just as any public utility does. The rates charged for service must be filed with the FCC. The tariff is a complicated document which, in reality, is the contract between the MCC and his subscribers. It must conform to the FCC requirements governing tariffs filed by all carriers. The tariff contains the rate structure covering the service and the terms and conditions under which service is provided. Rates are a subject upon which there is considerable information and experimental data, but at the same time little agreement among MCC operators. The rate structures vary considerably from operator to operator but with one common element — their rates are uniformly lower than those of the telephone companies which provide mobile radio service. It will, apparently, be some time before rates are worked out on a uniform basis. Such variables as overhead expense, number of units served, demand for the service in the community, and various other factors account for current differences.

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THE INCOMPARABLE

Eimac 3X2500A3

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Outstanding in performance, outstanding in life, and outstandingly low in cost . . . the Eimac 3X2500A3 triode is today the prime component in many of the newest noteworthy electronic equipments.

The excellent characteristics of the 3X2500A3 in CW, Modulator or Pulse service, over a wide frequency range, account for the diversity of applications in which it is employed.

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AM broadcast, police and aircraft communications, navigational aids, etc.

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Short wave broadcast, commercial communications and teletype service, r-f heating applications, etc.

Very High Frequencies

Television broadcast, FM broadcast, communications, r-f heating, etc.

TYPICAL OPERATION
Eimac 3X2500A3*

CLASS-B AUDIO AMPLIFIER
(2 tubes)

D-C Plate Voltage	5000 volts
D-C Grid Voltage	−190 volts
D-C Plate Current	.5 amps
Plate Load	5000 ohms
Driving Power	59 watts
Power Output	8000 watts

CLASS-C R-F AMPLIFIER – 40 Mc.

D-C Plate Voltage	6000 volts
D-C Grid Voltage	−500 volts
D-C Plate Current	2.08 amps
Driving Power	136 watts
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CLASS-C FM TELEPHONY – 110 Mc.
(grounded grid)

D-C Plate Voltage	4000 volts
D-C Grid Voltage	−500 volts
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Driving Power	1900 watts
Useful Power Output	7500 watts

MAXIMUM PULSE RATINGS

	Maximum Plate Voltage
RF Service (plate pulsed)	15 kv.
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*Below 30 Mc. type 3X2500F3 (flexible grid and cathode leads) may be used.

Complete data on the 3X2500A3 and other outstanding Eimac Tubes for CW, Modulator, and Pulse Service are available in a new catalogue . . . Write today.

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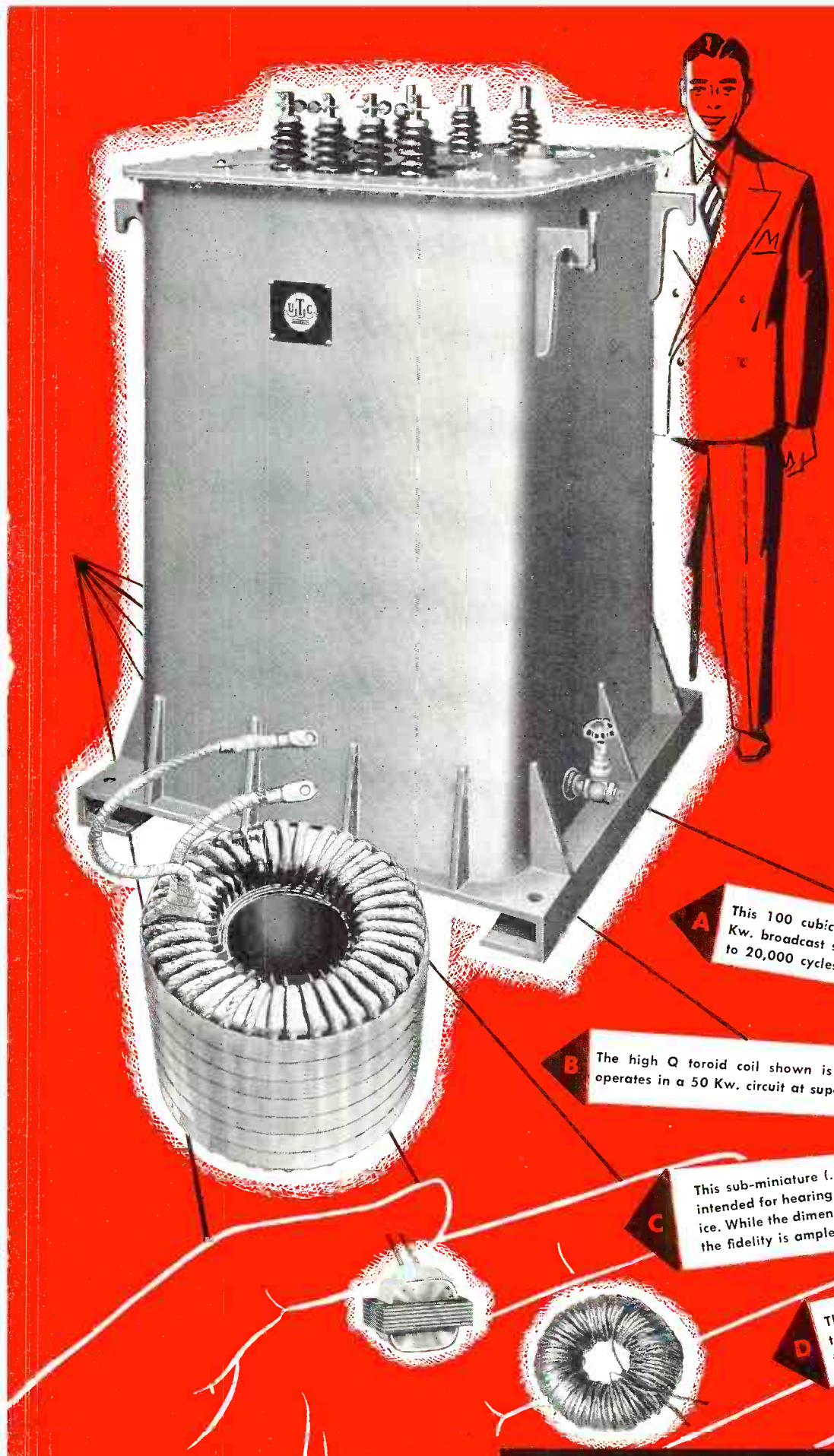

UTC

for every application

While the catalogue line of UTC components covers a wide variety of applications, many people are not familiar with the full range of products produced by UTC. It is impossible to describe the thousands of special UTC designs as they become available. The illustrations below are intended to indicate some of the range in size of these special products.

A This 100 cubic foot modulation transformer is for 50 Kw. broadcast service. Frequency response flat from 30 to 20,000 cycles.

B The high Q toroid coil shown is 12" in diameter. It operates in a 50 Kw. circuit at supersonic frequency.

C This sub-miniature (.18 cubic inch) output transformer is intended for hearing aid and other extreme compact service. While the dimensions are only 7/16" x 9/16" x 3/4", the fidelity is ample for voice frequency requirements.

D This sub-miniature (.18 cubic inch) permalloy dust core toroid is available in a wide range of inductances, and for frequencies from 1,000 cycles to 50 Kc.

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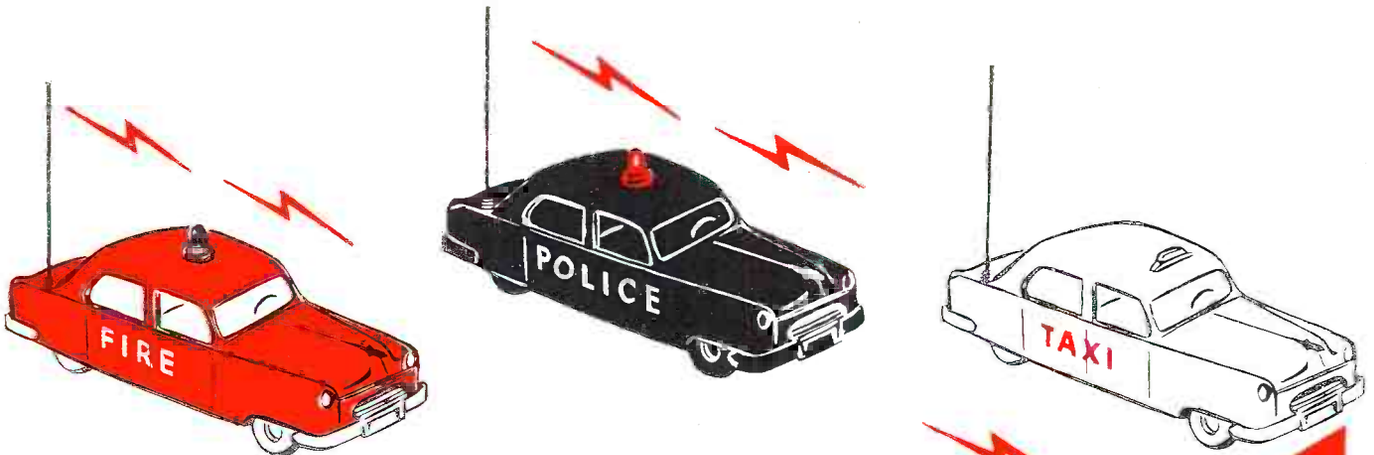

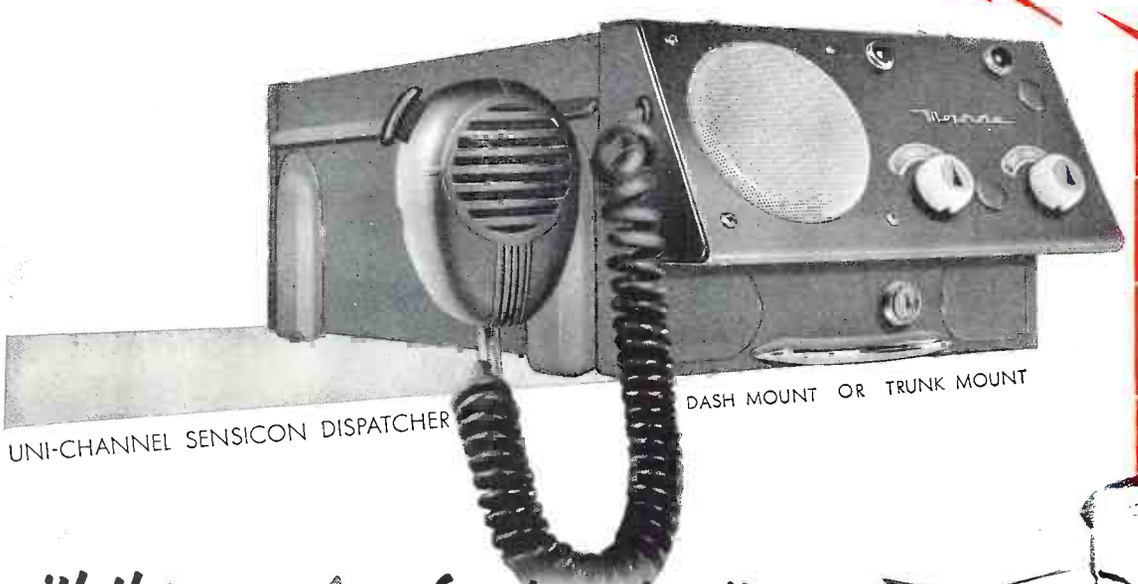

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