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FM-TV

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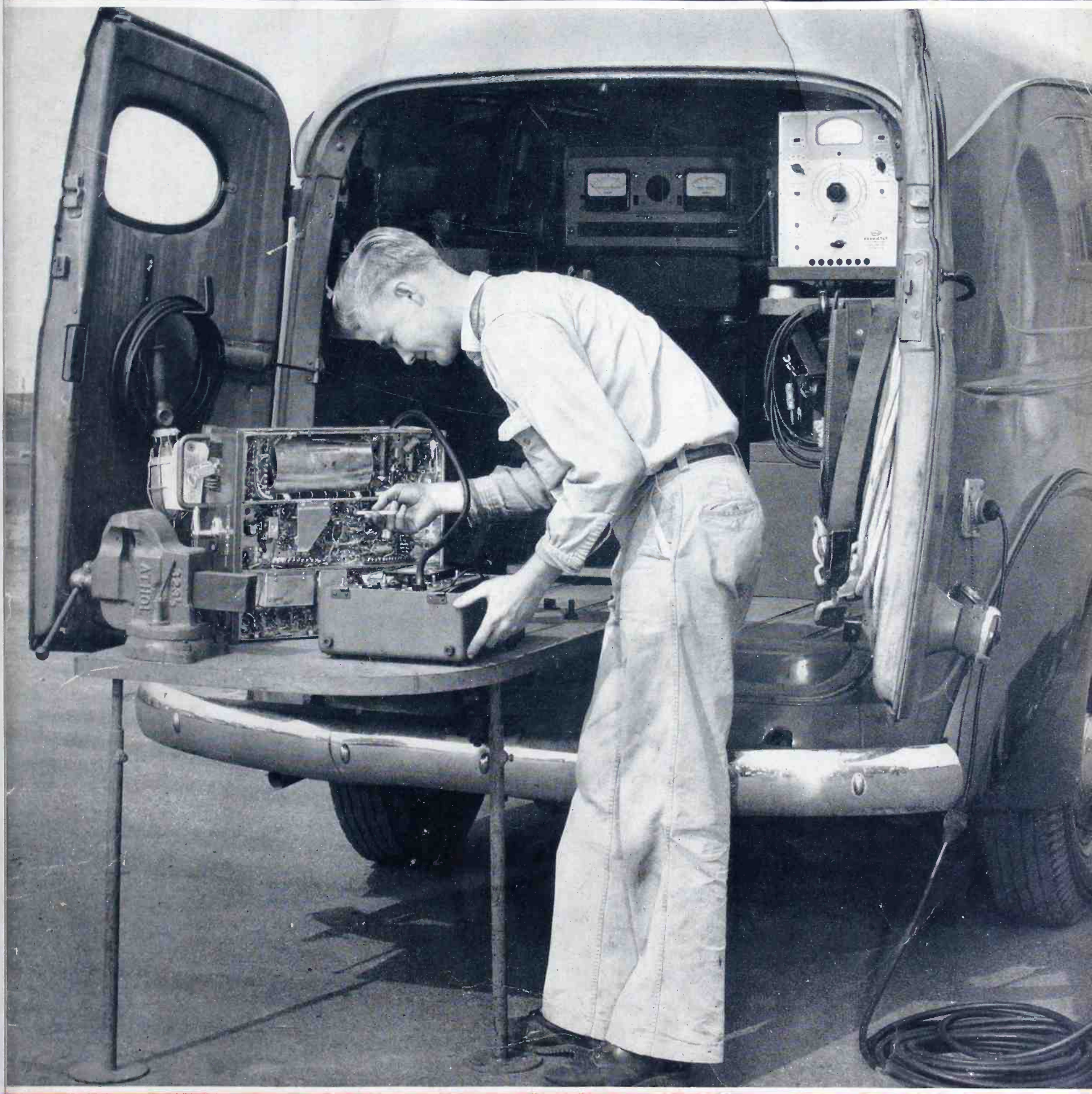

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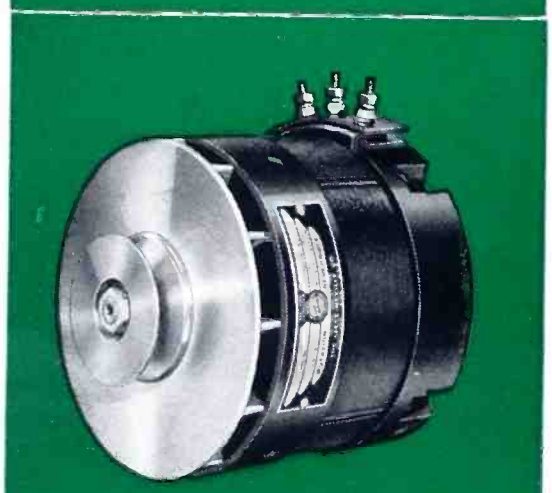

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PTM Provides INDUSTRY with complete, private, high-reliability, weatherproof communications—over any terrain—without costly line construction and maintenance

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Federal PTM—providing *all* facilities *simultaneously*—meets *all* communication requirements . . . over long distances and with remarkable reliability, using equipment of highest RF output and simplest design. For details on microwave at its best, write to Wire and Radio Transmission Systems Division, Dept. D-720.

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

VOL. 12 JANUARY, 1952 NO. 1

INDUSTRY NEWS

BROADCASTING

APPARATUS DESIGN

COMMUNICATION

AUDIO SECTION

SPECIAL DEPARTMENTS

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CPA AUDIT

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

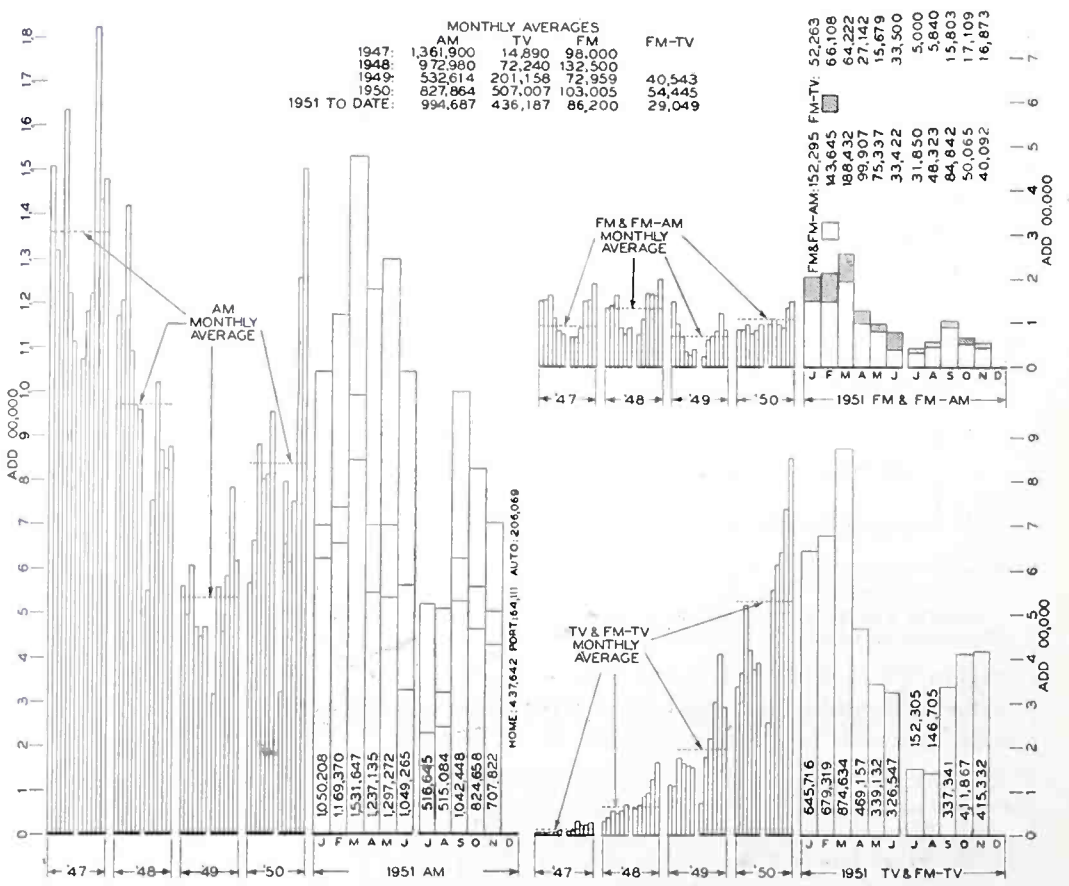
THERE is nothing particularly impressive about the production figures on home receivers, as compiled by RTMA. TV receivers were up by slightly less than 4,000, over the October figure. All other categories declined slightly. That is in contrast to production in November 1950, when all types of sets registered a high for the year to that date.

The range in TV units per month in 1951 was from a high of 874,000 in March to a low of 146,000 in August; home radio models from 988,000 in March to 184,000 in July; portables from 228,000 in June to 64,000 in November; and auto radios 603,000 in May to 206,000 in November.

Predictions by RTMA president McDaniel and officials of the leading set manufacturers indicate a substantial drop in the production of home sets in 1952, as factories shift to military equipment. Also, the January 1 report from the Director of Defense Mobilization specifies a reduction of 40% in steel and more than 60% in copper and aluminum allocated to consumer radio and TV sets. This reduction is referred to average consumption in the first two quarters of 1950.

With the rapidly increasing interest in FM tuners and high-fidelity installations for radio, record, and tape reproduction, the need is growing for data on the volume of sales of such equipment. At present, no significant market information is available. Various suggestions have been made concerning the formation of a new industry group, to be comprised of manufacturers of chassis, amplifiers, pickups, record players, tape recorders, and speakers. Such an association could perform a number of useful functions, including the preparation of production statistics. It seems, however, that it would be much more logical for such manufacturers to be grouped as a department of RTMA. Certainly, some sort of action is called for, since the total voulme of audio equipment sales is now at a very substantial level.

Receiving tube sales in the first 10 months of 1951 were 10 million above the same period of 1950. Sales through October amounted to 314,932,857. Of these, 211,273,000 were shipped for use in new sets, and 78,940,247 for replacements. Sales to government agencies totalled 5,681,734, while 19,037,876 were exported. During the month of October, sales amounted to 34,137,519 tubes.

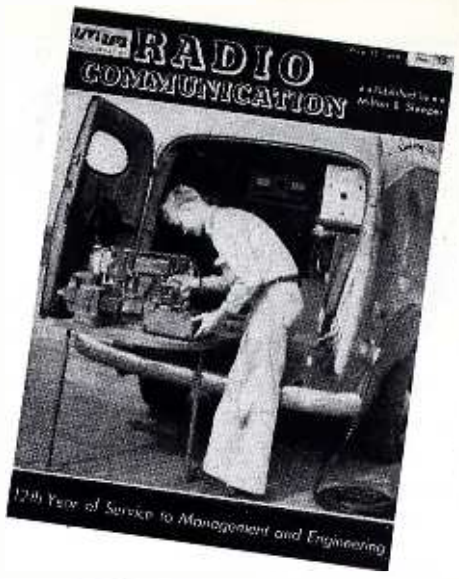


TV, FM, and set Production Barometer, prepared from RTMA figures

THIS MONTH'S COVER

The Southern Counties Gas Company of California uses this completely-equipped mobile service truck for maintenance of radio equipment at its widespread operating bases. Power for the test instruments is supplied by a portable gasoline-driven generator where outside AC power is not available.

A complete description of this installation, which is an outstanding example of fine systems engineering, will be found in 5 pages of this issue beginning on page 17. It is planned to devote comparable space in future issues to other notable systems-engineering projects, such as the New York Fire Department and Pennsylvania Turnpike installations.



SPOT NEWS NOTES

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

Industrial Communication System:

The new edition of the Registry of Industrial Radio Systems, revised each year from FCC file records, is now ready for mailing. It shows the names and addresses of licensees, operating frequencies, number of mobile units, call letters, and make of equipment for all mobile, point-to-point, and relay systems operated by the public utility, pipeline, geophysical survey, special industrial, low-power industrial, relay press, motion picture, and forest products services.

An idea of the increased number of systems in this group can be gained from the fact that it has become necessary to increase the price of this Registry to $2. per copy. This may seem to be a lot for a book of less than 100 pages. The cost is not actually in the production of the Registry itself, but in the increased work of checking the data on each individual license in the file room at the FCC. Only in this way can we make the deletions, changes, and additions to assure the accuracy of each listing in the Registry. In the past, listings of common carrier and limited common carrier systems have been included with the industrial systems. Starting this year, however, they will be published in the Registry of Air-Ground Systems, to be released in May.

Donald K. de Neuf:

Appointed general manager of Rural Radio Network. As chief engineer, he supervised the installation of the original RRN stations, now expanded to a 13-station FM net. He succeeds Michael R. Hanna, who is taking part in the joint Cornell-CBS TV film project.

New RTMA Offices:

Radio & Television Manufacturers Association has moved to 777 Fourteenth Street, N. W., Washington, D. C. Telephone number is National 3902. Newly organized statistical department, taking over work previously handled by Haskins & Sells, will have separate quarters at the new address. This department will be under the direction of W. F. E. Long.

New Manufacturing Plants:

Electronic Instrument Company, Inc., has purchased a 6-story building at 81 Withers Street, Brooklyn 11, for enlarged offices and production facilities. Early in the spring Raytheon will occupy a building of 50,000 square feet, now under construction on Seyon Street, Waltham, Mass. About 400 workers will be employed here. Sales and administrative offices of International Rectifier Corporation have been moved to a new building at 1521 E. Grand Avenue, El Segunda, Calif. The Victoria Avenue plant in Los Angeles will be maintained for research and development.

Conference on Quality Components:

Government-industry conference on improving the quality of radio components will be held in Washington on May 5 to 7, sponsored by the RTMA, IRE, and AIEE, with the active support of Government military agencies and the Bureau of Standards. Details can be obtained from J. G. Reid, Jr., National Bureau of Standards, Washington, D. C.

RTMA Reliability Chart:

As a step toward increasing the reliability of military, commercial, and home radio equipment, RTMA has prepared, in conjunction with the Armed Services Electro Standards Agency, a 14-point outline of design requirements. Copies of

(Continued on page 7)

SPOT NEWS NOTES

(Continued from page 6)

the chart, suitable for wall mounting, can be obtained without charge by writing to Radio-Television Manufacturers Association, 777 Fourteenth Street, N. W., Washington 4, D. C.

Gus W. Wallin:

Elected to the newly created position of vice president in charge of engineering at Webster-Chicago. For the past 11 years he has been in charge of military engineering at Motorola.

Characteristics of the Eye:

According to Dr. R. M. Bowie, of Sylvania, the peculiarities of the eye which aid TV in the creation of visual illusion are:

1. The eye's acuity for contrast detail far exceeds that for chromaticity detail.
2. Its threshold of flicker perception is roughly a logarithmic function of brightness.
3. Its threshold of flicker perception is at lower frequency for large areas than for small areas.
4. It is much more insensitive to flicker in chromaticity than in brightness.

NARTB Convention:

Will be held at the Conrad Hilton (formerly Stevens) Hotel at Chicago, March 31 to April 2. Exact dates of the engineering sessions will be announced later. Further information can be obtained from Neal McNaughten, Director of Engineering, 1771 N Street, N. W., Washington 6, D. C.

Frank H. Edelman:

Former chief chemist at International Resistance has been appointed technical director of Electronic Devices, Inc., 429 12th Street, Brooklyn 15, N. Y.

Air Raid Horns:

A 3-horn unit, designed to operate on compressed air, has been announced by G. B. Bashaw Company, 1969 S. E. 25th Avenue, Portland 15, Ore. Bureau of Standards report shows signal strength of 102 db at 100 ft. with 25 lbs. pressure per square inch, and an air consumption of .5 cubic feet per second. Fundamental frequency is 300 cycles, with rich harmonics at 4,000 cycles. Single horn units are also available.

Dr. Allen B. Du Mont:

Looking ahead to 1952: "Entertainment is just a part of the function and place in our lives that television will play. . . . The inherent honesty of television will be put to work in earnest in the cause of good, clean government, and a return to

(Continued on page 8)

Professional Directory

SPOT NEWS NOTES

(Continued from page 7)

the fundamentals of the American enterprise system. . . . Already more than 150 business and industrial TV units are in operation around the Country. . . . Industry officials contend that television's commercial and professional uses will overshadow its role in bringing entertainment into the living room. By the end of 1952, our industry will be producing at the annual rate of $4.5 billion, equal to the peak in World War II. . . . In our organization, already 60% of our business is in defense work, with a military backlog of over $60 million. . . . We anticipate that our total sales, which were around $50 million in 1951, will reach a company high-water mark in 1952 of between $100 million to $125 million."

P. H. Neville;

Elected president of Leece-Neville Company. Although only 37 years of age, he has previously served as vice president and secretary.

Importance of Research:

From the *New England Letter,* published by the First of Boston: "In a comparatively short period, this Country has been converted from a wilderness into a mighty industrial empire with living standards far superior to those of any major country in the history of civilization. . . . During the past three decades the number of firms engaged in industrial research has increased eightfold, while expenditures for research have increased fifteenfold. Total expenditures for research of all kinds, including the amount spent by colleges, foundations, and the Government, were roughly estimated to be in the neighborhood of $2 billion and represent a fivefold increase in a decade. While this seems like a large sum, it constitutes only about ½% of the gross national product. . . . As Arthur Dehon Little pointed out, 'When wisely conceived, intelligently directed, and generously supported, research yields returns of an order of value out of proportion to its cost. It becomes the mainspring of progress.' "

TV Antenna Data in Spanish:

For the benefit of Latin American countries, a catalog on TV receiving antennas, printed in Spanish, has been prepared by La Pointe Plascomold Corporation. Windsor Locks, Conn. The title is: La Linea de Antenas de Television mas completa y Potente del mundo.

Paul Hines:

Appointed director of engineering for

(Continued on page 9)

Professional Directory

Special Services Directory

SPOT NEWS NOTES

(Continued from page 8)

Workshop Associates, Needham Heights, Mass. He will be in charge of the new antenna laboratory now under construction at Natick, and will supervise all engineering at the Needham plant. Previously he headed Raytheon's antenna group.

Monitoring Receivers:

There is a large and increasing demand from communication systems for monitor receivers of commercial design, to provide continuous tuning from 30 to 50 and 123 or 152 to 174 mc. There are models available to cover these ranges, but for commercial use higher sensitivity and selectivity is specified, at a price of $250 to $300.

More Service:

H. I. Romnes, director of operations for A. T. & T.'s long lines department: "During 1951, the Bell System added about 6,500 miles of TV channels, bringing the total to over 24,000." Priorities and material shortages permitting, A. T. & T. "plans and hopes during the year 1952 to add Miami, New Orleans, Houston, Dallas, Ft. Worth, San Antonio, Oklahoma City, and Tulsa to its network."

Saul Decker:

Advanced by CBS-Columbia to the post of chief television engineer. In this capacity, he will be responsible for the development and design of radio and TV sets produced by the CBS manufacturing subsidiary. He will report directly to Leopold M. Kay, vice president in charge of engineering.

TV for South America:

Another Du Mont Television has been shipped to South America. This one, sold through Federal Telephone & Radio, is equipped with a trailer carrying a 50-cycle, 10-kw. engine-driven generator, so that the TV unit can be used where power lines are not available.

High-Power Vibrators:

New bulletin describing power supply vibrators for aircraft and industrial equipment has been issued by James Vibrapowr Company, 4036 Rockwell Street, Chicago 18. This series is intended for both new equipment and replacement use.

New Appointments:

David S. Rau has been elected vice president and chief engineer of RCA Communications, Inc. He has been with the company since graduation from Annapolis in 1922. Mr. Rau succeeds C. W.

(Concluded on page 46)

A triumph in the art of transmitter design..

made possible through the use of Eimac tetrodes.

Collins 300J 250-watt and 20V 1kw AM broadcast transmitters employing Eimac 4-125A and 4-250A power tetrodes.

In your own equipment . . . enjoy the advantages and economies made possible through the use of Eimac tetrodes. Write our Application Engineering Department for the latest information and technical data.

The Collins 300J 250-watt and 20V 1kw AM broadcast transmitters are a tribute to the art of transmitter design. Performance, circuit simplicity and economy of operation highlight the many features Collins Radio has incorporated in these modern transmitters.

Through the use of high-gain, long-life Eimac tetrodes, Collins has achieved considerable simplification in circuits associated with the modulator and power amplifier stages. These highly efficient tetrodes also permit the use of low drain receiver-type tubes in the driver stages. Spare tube inventory can be kept small and representing a minimum investment. As an example; the 300J employs only 16 tubes of but 7 types in the entire transmitter.

EITEL-McCULLOUGH, INC.
San Bruno, California

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

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

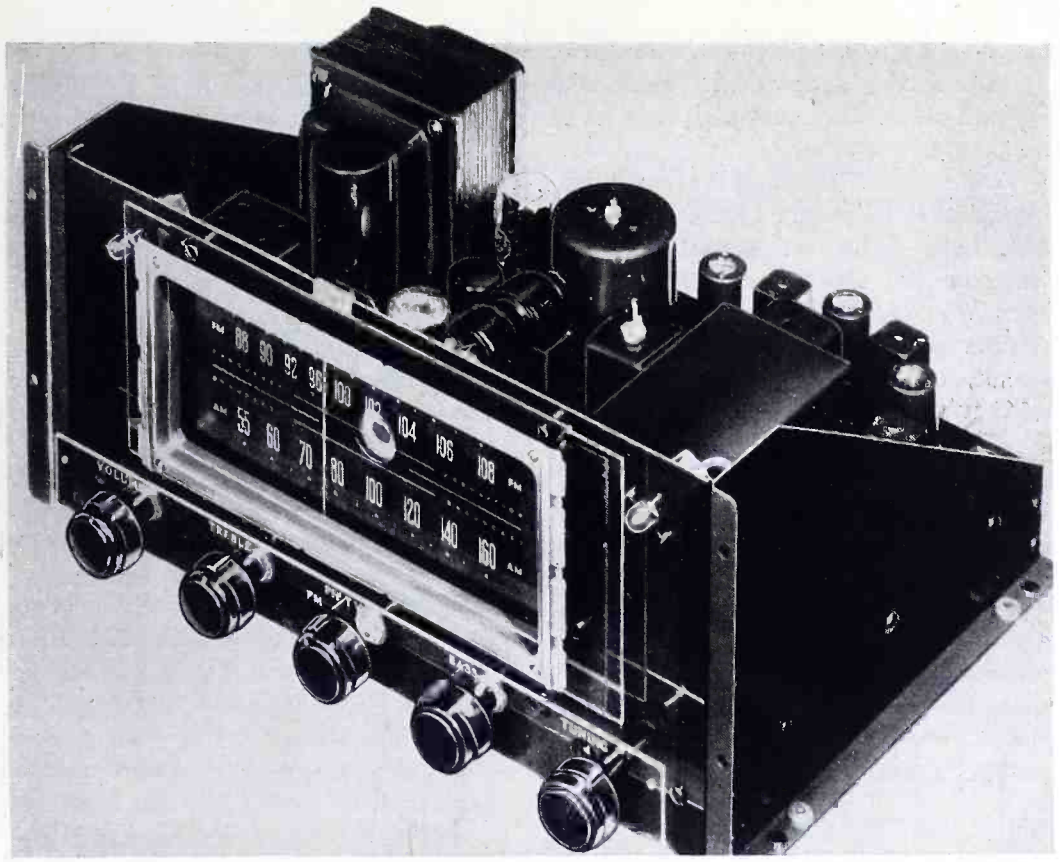


FIG. 1. FRONT VIEW OF THE SR 51 TUNER CHASSIS, SHOWING PANEL-MOUNTING BRACKETS

PATTERN FOR TV PROFITS

Our March issue will carry the first article of a series written for the information and guidance of management and engineering executives preparing to enter the business of television broadcasting.

The five most experienced television engineers in this Country are collaborating in the preparation of this series, in order to make "Pattern for TV Profits" a basic text on planning studio and transmitter facilities for post-freeze VHF and UHF installations.

Further details of this series will be announced in the February issue of RADIO COMMUNICATION.

The New Low-Distortion

SR 51 FM-AM TUNER

DETAILS OF A TUNER THAT PROVIDES TRUE HIGH FIDELITY FM AND AM TOO — *By* WILL RAYMENT*

THERE is general agreement on the point that any tuner for use in a high-fidelity installation should include a sensitive, noise-free FM section. However, while remarkable FM performance has been achieved in many tuner designs, too little engineering effort has been expended on the AM sections.

Conventional receivers and tuners, even those in the higher price ranges, suffer from two serious defects which prevent the realization of optimum AM performance. In an effort to minimize noise and interference, the IF bandpass is made so narrow that audio reception is limited to well below 10,000 cycles. It is usually 5,000 cycles, or even less. Also, the second detector circuit introduces appreciable harmonic distortion, amounting typically to 25% at 100% carrier modulation. It should be emphasized again that this is true of even the best conventional AM receivers and, in most cases, of the AM sections of tuners.

On the other hand, there is much high-quality program material being broadcast by AM stations, for not all are limited to 5,000-cycle transmission. Many metropolitan stations are assigned 20-kc. channels, which permit transmission of 10,000-cycle audio. Then, too, some sections of the Country have ordinary 5,000-cycle AM service, but have only one FM station or none at all. Distortionless AM reproduction is important to people in such areas.

It appears, therefore, that there is a real need for a tuner which can accommodate *both* FM and AM broadcast signals of any audio frequency range, and which can amplify and demodulate these transmissions with negligible distortion. The Sargent-Rayment model SR 51 FM-AM tuner, shown in Fig. 1, is designed to meet these simple but rigorous requirements, in addition to the other specifications of high-quality tuners.

*Engineer, Sargent-Rayment Company, 212 9th Street, Oakland 7, Calif.

AM Section:

The circuit of the SR 51 is shown in block form in Fig. 2. AM tuning is accomplished by ganged capacitors at the grid of the 6SK7 RF amplifier, the RF grid of the 6SA7 converter, and in the oscillator tank. The IF input transformer secondary is swamped by a .5-megohm resistor to obtain the necessary bandpass. Resistive loading of the IF output transformer is not necessary, however, since the primary is used in conjunction with the diode section of the 6SF7 to provide a DC control voltage for the 6E5 tuning eye and for AVC. The AVC is applied to the RF, converter, and IF stages.

Fig. 3 is a chart of detector distortion for various amounts of carrier modula-

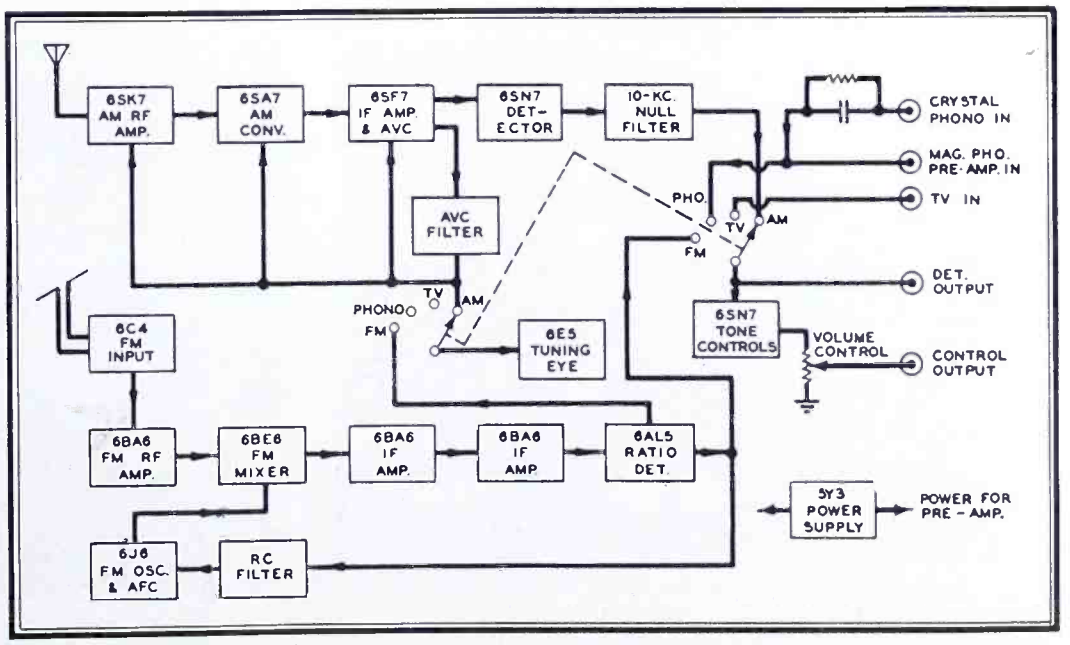


FIG. 2. A MODIFIED BLOCK DIAGRAM OF THE TUNER. NOTE THAT 2 OUTPUT JACKS ARE PROVIDED

tion. The center curve is for a diode detector operating under ideal conditions; that is, with no AC shunt impedance. With a load of 1 megohm, the harmonic distortion is increased tremendously, as shown by the top curve. At 100% carrier modulation, the distortion is increased from 3 to 23% for 400 cycles. Actually, since the detector in a conventional AM circuit ordinarily feeds an AF amplifier grid resistor, the AVC system and, in some cases, a tuning eye tube, the load may be appreciably less than 1 megohm.

However, AM detector loading is avoided completely in the SR 51 tuner. The IF output transformer secondary is coupled to the 6SN7 dual-triode detector in a unique circuit that introduces only .45% distortion at 100% carrier modulation. This is shown by the bottom curve, Fig. 3.

The audio signal is fed to a 10-kc. filter, to eliminate adjacent-channel whistle, and then to the audio selector switch. Extremely sharp attenuation, 0 db at 9 kc. and –47 db at 10 kc., is achieved by the use of a bridged-tee LCR filter circuit.

FM Circuit Design:

IF transformers and tubes have been developed to the point where stability can be maintained with gain such that the maximum useful sensitivity of an FM tuner is determined by the input circuit noise. Accordingly, the problem of increasing sensitivity is one of reducing the input noise figure. The approach to this problem employed in the SR 51 tuner has been so successful that an input of 5 microvolts produces 20-db quieting.

An input transformer feeds the grid of a 6C4 triode, used as an untuned input coupling tube. The output is impedance-coupled to the 6BA6 RF amplifier. Tank circuits at the grids of the RF amplifier, the 6BE6 mixer, and the 6J6 oscillator are capacitively gang-tuned. The remaining half of the 6J6 envelope is used as an AFC reactance tube.

Two stages of IF amplification, utilizing 6BA6's, follow the mixer and terminate in a 6AL5 ratio-detector circuit. Detector AM absorption is 70%. Outputs from the detector go to the audio selector switch through the de-emphasis circuit, and also to the tuning eye and AFC tubes.

Audio Controls:

Three input jacks are provided on the chassis, so that audio from a TV tuner and a phonograph preamplifier or crystal pickup can be switched and controlled. Two output jacks are furnished. One is connected directly to the selector switch,

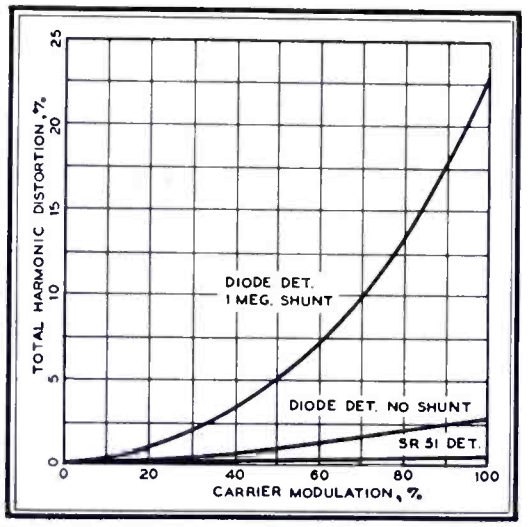


FIG. 3. SOME AM DETECTOR DISTORTION CURVES

bypassing the bass, treble, and volume controls, and is intended for use with a recording amplifier. This is labeled DET OUT. The other output jack is for general use, since it follows the tone and volume controls.

Bass and treble controls are of the RC type, and are isolated by one half of a

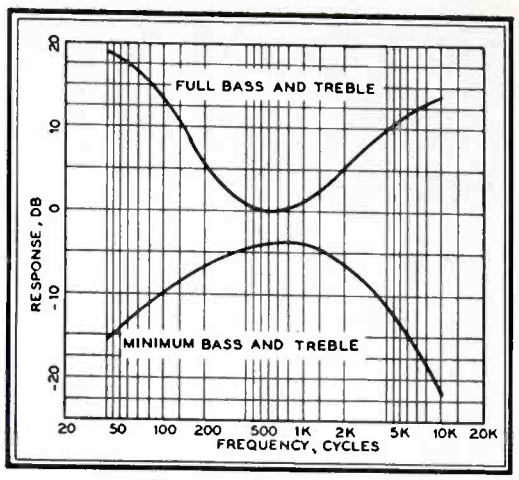


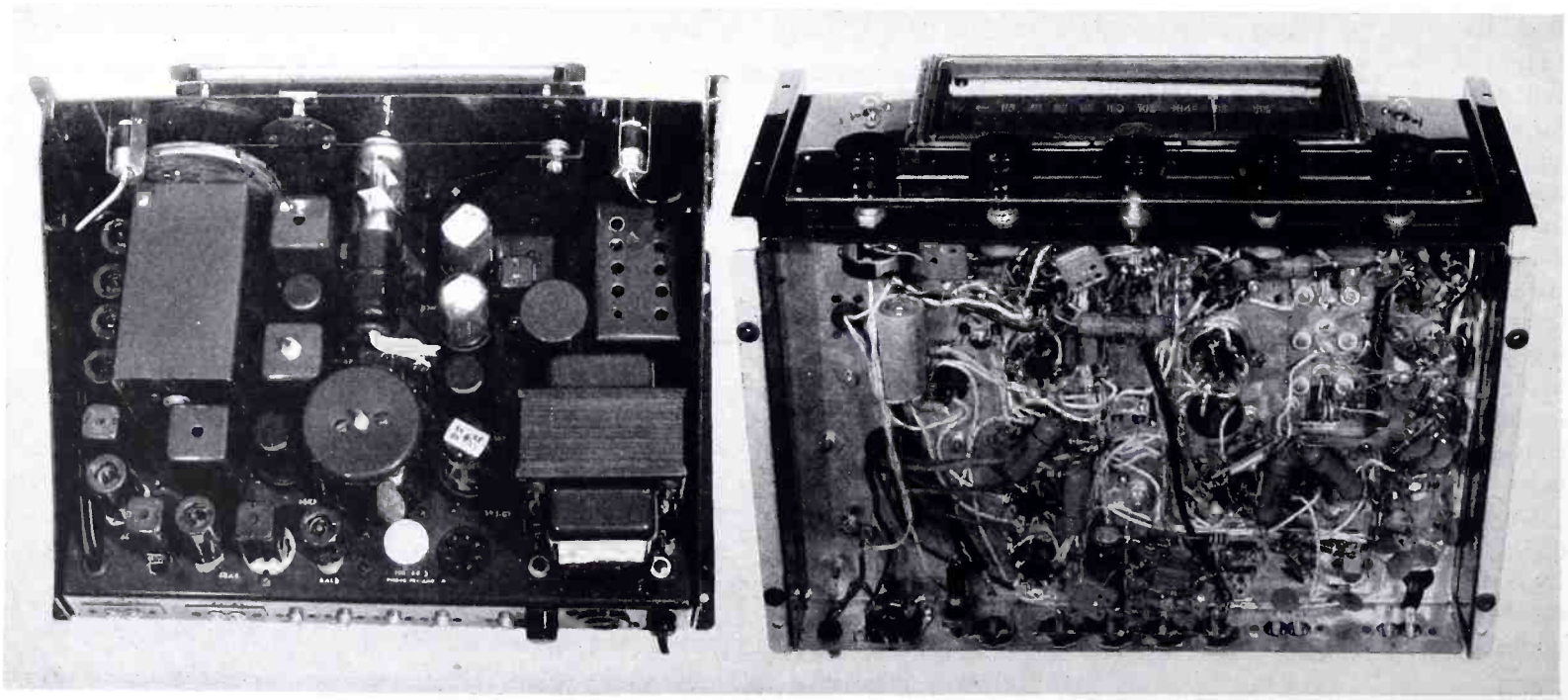
FIG. 4. SR 51 BASS AND TREBLE CONTROL CURVES

2-stage 6SN7 audio amplifier. Curves of boost and droop obtainable with these controls are given in Fig. 4. It can be seen that the maximum variation at mid-range frequencies is 4 db, while the response at 40 cycles can be adjusted from +17 to –16 db, and at 10 kc. from +14 to –22 db.

Installation:

The SR 51 has other features intended to facilitate custom installations. As can be seen in Figs. 5 and 6, the chassis is provided with rubber mounting grommets on the base, as well as brackets for panel-mounting. The dial escutcheon and plastic control-designation plate are removable, and can be fastened to the cabinet panel. A switched AC outlet is provided at the back of the chassis. Also, a power plug for a phono preamplifier is included.

Controls from left to right in Figs. 1 and 5 are ON-OFF and volume control, treble control, selector switch, bass control, and tuning control. Dimensions are 14 ins. wide by 7 ins. high by 10 ins. deep. Power requirements are 85 watts at 110 to 125 volts.



FIGS. 5 AND 6. THESE VIEWS SHOW THE RUGGED, COMPACT CONSTRUCTION OF THE TUNER. NOTE EXTENSIVE SHIELDING IN THE VIEW AT THE LEFT

HOW MAGNETIC AMPLIFIERS WORK

A CONCISE, NON-MATHEMATICAL DISCUSSION OF THE BASIC PRINCIPLES OF MAGNETIC AMPLIFIERS, AND OF THEIR APPLICATIONS — *By* EDGAR V. WEIR*

PROGRESS in the development of the magnetic amplifier has been rapid during the past few years. There are indications that many of the disadvantages thought to be inherent in this device are being overcome or minimized, with the result that the range of applications for magnetic amplifiers is expanding constantly. At the present time, they are employed most extensively in military electronic apparatus and in servo systems. It is our firm belief, however, that eventually, they will be utilized in broadcast and audio applications, and in communications equipment where the factors of ruggedness and dependability are of paramount importance.

This article is the most lucid and authoritative presentation of the basic principles of magnetic amplifiers we have seen. We believe that it will serve our readers admirably as an introduction to this relatively new branch of electrical science, with which many more of them will soon be concerned.

AN amplifier is a controllable-impedance device which is inserted between a source of power and a load. That impedance may be resistive, inductive, or capacitive, and an amplifier can be designed which utilizes any of the three types of impedance as the variable element. The vacuum tube is, essentially, a variable resistive impedance. The magnetic amplifier, on the other hand, is an inductive-impedance device.

Fig. 1 explains the basic differences in the operation of vacuum-tube and magnetic amplifiers. The tube is represented as a variable resistance which regulates the flow of current into a load. In this case, the variations in impedance are achieved through the application of a control voltage to an element in the tube.

A variable inductive impedance element is shown inserted between the source of power and the load for the magnetic amplifier. This element is represented at the top, Fig. 1, by an iron-core reactor with two windings. The inductive impedance of that reactor is varied by a small current flowing through the second, or control winding. This controllable reactor regulates the flow of current into the load through impedance control, in much the same manner as the vacuum tube, except that the variable impedance is inductive rather than resistive. The power source for the magnetic amplifier is, of necessity, AC. Its frequency is referred to as the carrier frequency. The load may be either AC or DC.

A magnetic amplifier is, by strict definition, merely one or more such reactors. Combinations of reactors or single compound reactors are employed normally, so that voltages induced in individual reactor control windings cancel out and feed back a minimum of voltage into the control circuit. Other circuit elements can be used with the reactors to provide feedback or to obtain desired response characteristics. In such cases, the entire assembly is referred to ordinarily as a magnetic amplifier.

Operating Conditions:

Reactors, as associated with magnetic amplifiers, may be non-saturating, saturating, or saturable. The terms refer, of course, to current conditions in the magnetic material used as the core of the reactor.

A non-saturating reactor is one in which the applied carrier voltage is low enough so that the flux changes occur only in the unsaturated region of the magnetization curve, Fig. 2. If a higher voltage of the same frequency is applied, then the flux changes demanded cannot be met entirely within the unsaturated region. The flux is carried above the knee, into the saturated region, for some parts of the applied waveform. The reactor then becomes a saturating reactor, and exceptionally high peak currents are reached during those periods when the flux has been forced over the knee. If the reactor constitutes only a part of a circuit, as in the case of a magnetic amplifier, it can be seen that the effective inductive impedance has been reduced during those periods. This results in more of the supply voltage being transferred to the load.

In a magnetic amplifier, that change in inductance is not effected through the application of a higher carrier voltage. Instead, an extra magnetizing force is applied through a control winding, which causes operation to occur around a new point on the magnetization curve and forces the flux changes to swing over the knee. Thus, the non-saturating reactor becomes a saturable reactor. It has been forced to operate into the saturated region by an external control.

The instantaneous current that flows during the part of the carrier cycle when the reactor is saturated is limited at any instant, of course, by the load impedance and the instantaneous value of the source voltage. From a control standpoint, however, it is dependent upon the characteristic of the magnetic material used in the reactor.

If the material is such that its magnetization curve is essentially flat after saturation is reached, then it acts as a unity-premeability reactor — as though it had only an air core — after entering that region. The magnetization curve of Orthonol, Fig. 2, demonstrates such a characteristic. In contrast, the curve for Allegheny Electric Metal 4750 shows that this particular material begins to saturate at a current level of only about

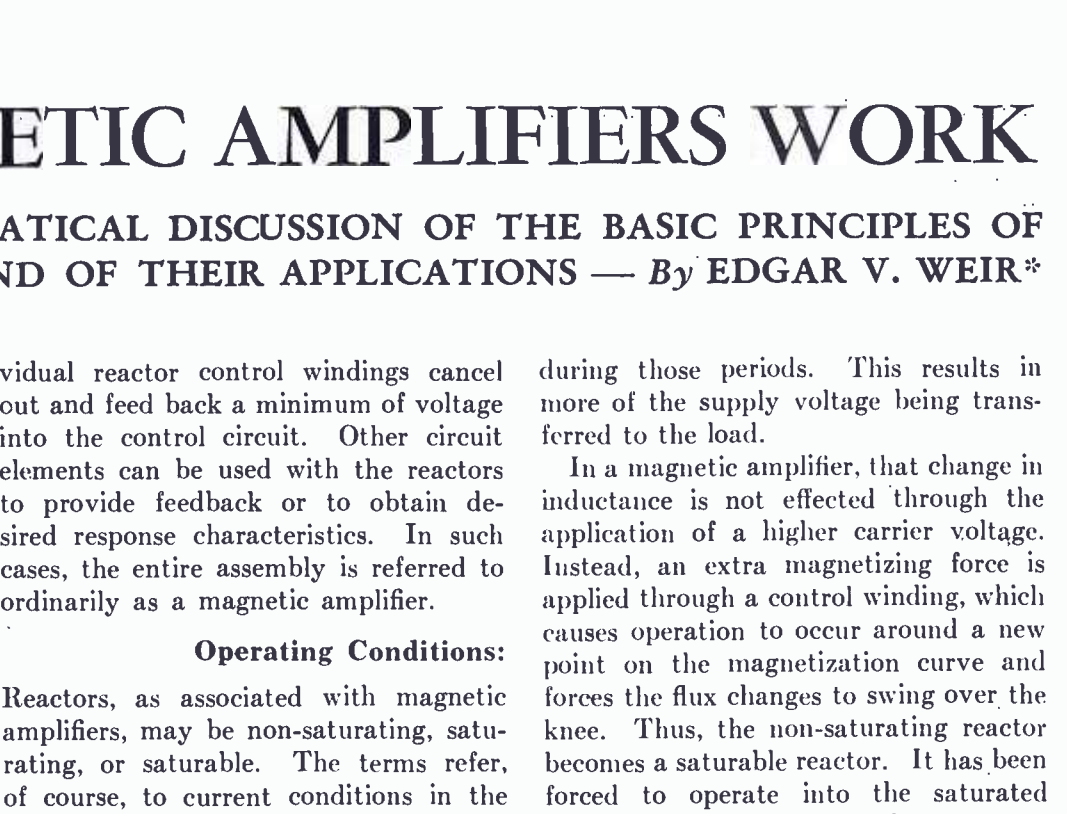


FIG. 1. COMPARISON OF THE OPERATING PRINCIPLES OF VACUUM-TUBE AND MAGNETIC AMPLIFIERS

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half the full saturation level. From a composition standpoint, the 4750 and Orthonol metals are practically the same. They have essentially the same saturation level. It is readily apparent, however, that the 4750 continues to absorb voltage at high current levels.

The magnetic characteristic determines also the minimum currents that flow in magnetic amplifier circuits. As long as voltage is applied to the reactor elements of a magnetic amplifier, some current flows. That current must be of such magnitude as to cause the magnetic material to experience the changes in flux level which are required for it to absorb voltage. This magnetizing current is of almost square-wave shape in the case of some materials, particularly Orthonol. In all cases, it is very small compared to the current that flows after saturation has been reached.

The maximum voltage level at which the reactor element can operate without passing more than just such a small magnetizing current depends upon the flux density at which the knee of the curve appears. For cores of the same size, then, the Orthonol material has the advantage over the others shown in Fig. 2. For that given core size, it is capable of controlling much more power, for example, than Mu Metal. It has a slight advantage in this regard over Permenorm 5000 Z. Orthonol has an advantage over that material in having a lower minimum

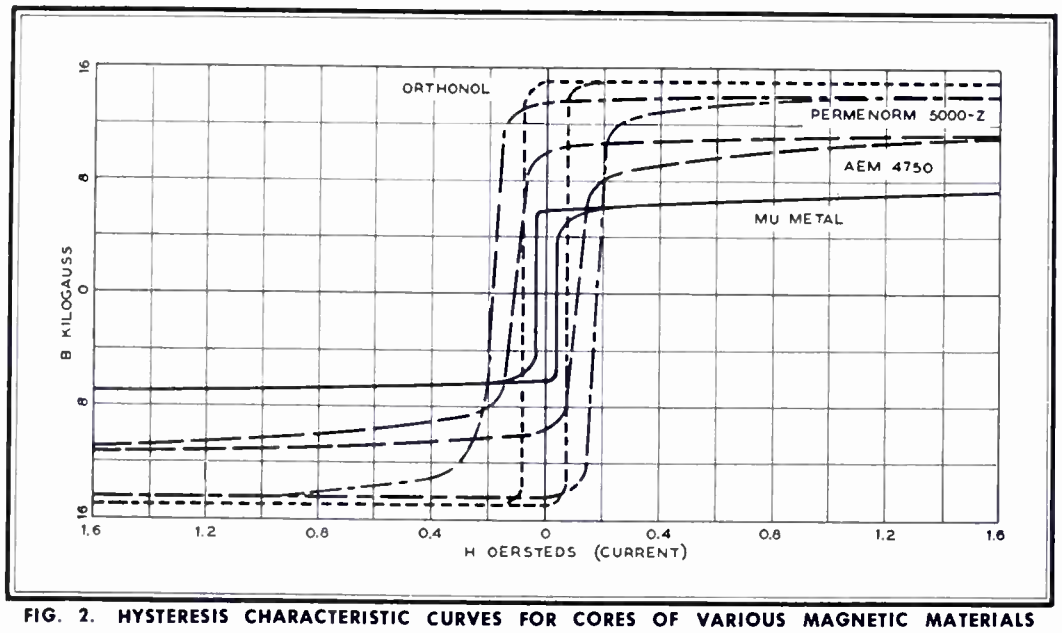

FIG. 2. HYSTERESIS CHARACTERISTIC CURVES FOR CORES OF VARIOUS MAGNETIC MATERIALS

current also. In other words, for high power-handling capacity, material which can be operated at high flux densities without reaching saturation is desirable. For applications where low minimum currents are desired, materials with very low magnetizing currents are to be preferred.

Sensitivity:

So far, no mention has been made of the influence of the magnetic material upon the sensitivity of the amplifier. Sensitivity is not dependent solely on the permeability of the core material. The shape of the magnetization curve is important also, as will be explained.

In Fig. 3A, a basic full-wave magnetic amplifier circuit is shown. This circuit has two reactor elements connected in parallel, each with a rectifier in series. Carrier voltages induced into the control

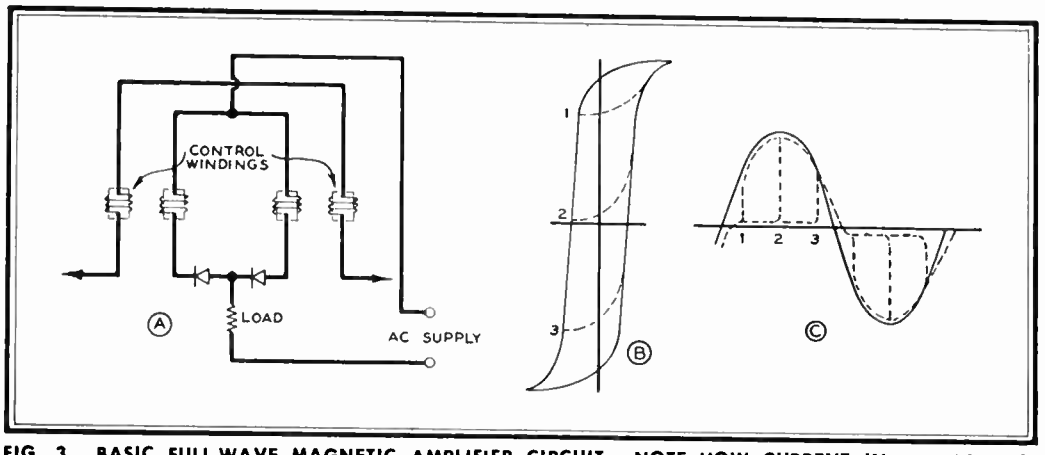

FIG. 3. BASIC FULL-WAVE MAGNETIC AMPLIFIER CIRCUIT. NOTE HOW CURRENT IN THE CONTROL WINDINGS DETERMINES FLOW OF AVERAGE LOAD CURRENT BY ESTABLISHING CORE FLUX LEVELS

windings cancel out. The rectifiers serve to switch the current flow from one reactor to the other on alternate half-cycles. This is known as the parallel self-saturating circuit. It is highly efficient and is used widely.

Normally, the reactors in this circuit are so designed that a flux swing from one knee to the other absorbs one half-cycle of the applied carrier voltage. If the rectifiers were not in the circuit, and no control were exercised, then the flux levels would go up and down between the knees to absorb the full-wave voltage just as in non-saturating reactors. In this case, however, the rectifiers block the reverse current which would carry the flux back down. It is left at the point of residual flux density corresponding to the zero current or H level, Fig. 2. A reactor in that condition would have no additional flux change available to absorb another half-cycle of voltage in the original operating direction. Actually, the rectifier permits some small reverse current to leak through, which carries the flux back to a position such as is shown as Condition 1, Fig. 3B. Even then, however, that reactor could only absorb such a small portion of the half-cycle voltage as is to the left of the dotted line rising from point 1 in Fig. 3C. The dotted line running from point 1 on through the half cycle is the outline of the load current that would flow.

If there is current flowing in the control windings, then the magnetizing force contributed by it will either add to or subtract from the effect of the rectifier leakage. If a current is flowing in such a direction as to cause the flux to drop to a level corresponding to point 2 during the off half-cycle of carrier voltage, then there will be sufficient flux change available for absorption of half the following half-cycle. The resulting current into the load is indicated as the dotted line rising from point 2 and going on through the half-cycle. Further negative control will carry the flux back to point 3, with the further reduction in output current resulting.

This indicates exactly how the control is applied to this type of magnetic amplifier. There are many variations which can be employed to compensate for the leakage of the rectifiers and to control feedback.

However, the basic principle, applying in general to all types of magnetic amplifiers, is that of establishing a flux level in advance of the operating half-cycle. This determines just how much of the operating half-cycle voltage can be absorbed by the reactor element. It controls the "firing point" of the reactor. Once the reactor reaches saturation on a particular operating half cycle, it continues to pass current through the half-cycle. To regain control during that period would require prohibitive amounts of control power.

It is now apparent how the shape of the hysteresis loop of the core material determines the sensitivity of the amplifier. The sensitivity varies according to

(Continued on page 40)

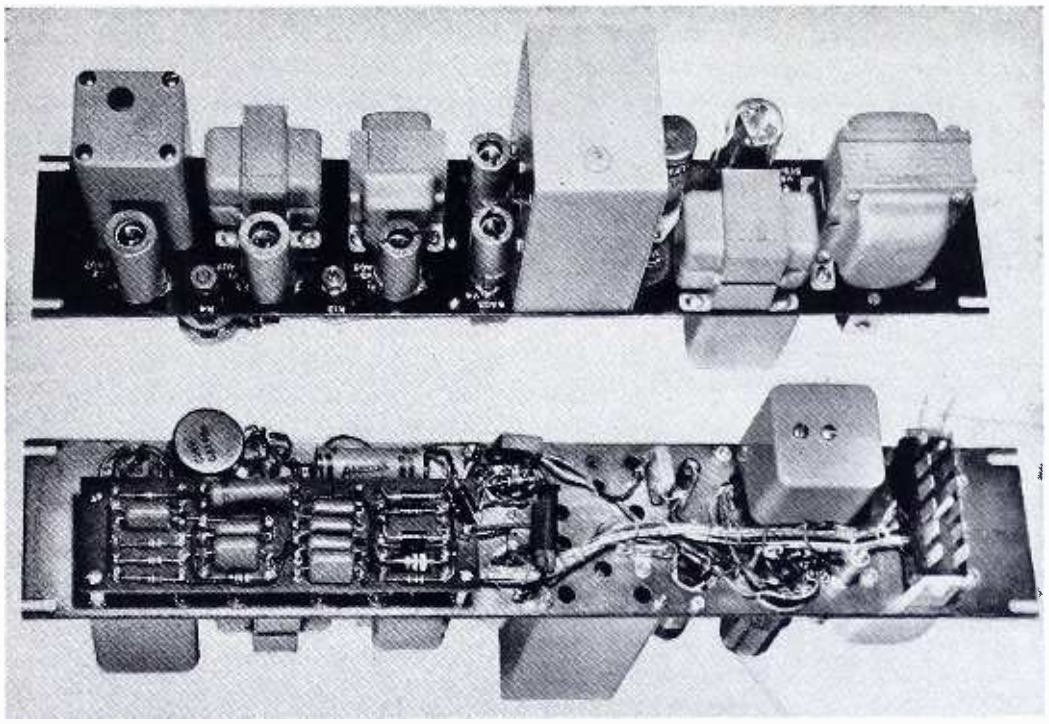

FIG. 1. A SINGLE 19-INCH RACK PANEL HOLDS ALL COMPONENTS OF A DUPLEX SIGNALING UNIT

Voice-Frequency Signaling Units for

MICROWAVE SYSTEMS

INEXPENSIVE SIGNALING UNITS FOR FREQUENCY-DIVISION MULTIPLEX SYSTEMS—*By* J. K. KULANSKY*

MICROWAVE communication systems are inherently flexible in application. Through multiplexing techniques, a single microwave carrier can be made to convey multi-channel telegraph, teletype, or facsimile information, and accommodate one or more voice channels as well. Signals can also be impressed on the carrier to provide remote supervisory control facilities; automatic fault alarm and future failure warning alarm indications; automatic transfer indication for standby equipment; extension of duplex telephone ringdown signaling; facilities for dial signaling, selective calling, and selective signaling of mobile units through repeaters; fail-safe alarm information and telemetering data.

Each of these functions, and many others, can be accomplished with one or more voice-frequency tones. However, full realization of such system potentialities has been limited in the past by the prohibitive cost of suitable voice-frequency signaling equipment. This limitation has now been removed. The Hammarlund type DSU duplex signaling unit, shown in Fig. 1, was developed specifically to meet requirements for a low-cost voice-frequency tone generating and receiving unit for narrow-band carrier or subcarrier channelizing.

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Operation of DSU Unit:

The duplex signaling unit consists of an externally-keyed, single-tone transmitter, a single-tone receiver which operates a control relay, and a built-in power supply. Transmitter and receiver operating frequencies are available in any combination from 2,000 to 6,025 cycles, thus permitting utilization of the units without requiring associated subcarrier equipment. Channels are spaced at 100-cycle intervals in the range from 2,000 to 3,500 cycles, and at 150-cycle intervals from 3,500 to 6,025 cycles.

Fig. 2 is a block diagram of the unit. The transmitter is keyed by connecting terminals 1 and 2 on J1, the Jones plug visible at the right on the bottom view of the unit, Fig. 1. This permits conduction and operation of V1, the tone generator. The single-tone output of V1 is applied to an attenuator and then to V2, a buffer amplifier. From V2, the tone signal is coupled to output terminals on J1 through a 600-ohm line-bridging transformer with an impedance of 10,000 ohms. The audio output is adjustable from −25 to +5 dbm when a 600-ohm line is connected at terminals 3 and 4.

The tone generator harmonic content is 40 db down from the fundamental, and consists principally of third and other odd-order harmonics. Harmonic output at any one frequency is down considerably more than 40 db. This is an important requirement for the prevention of cross-talk between channels. Frequency stability is better than ±1 cycle with variations in input voltage from 105 to 125 volts, over the ambient temperature range of −30° to +60° C. This stability is maintained for the operating frequency range from 2,000 to 6,025 cycles.

A line bridging transformer is provided at the receiver input terminals also. This is followed by an input level control, which is adjustable for a maximum input sensitivity of −25 dbm.

The selective line amplifier, V3, follows the level control and feeds a multi-element bandpass filter. The attenuation of this filter is such that the response of the receiver is down 20 db at the edges of the adjacent channels, and is more than 35 db down at the centers of the adjacent channels. Stability of the filter is comparable to that of the tone generator.

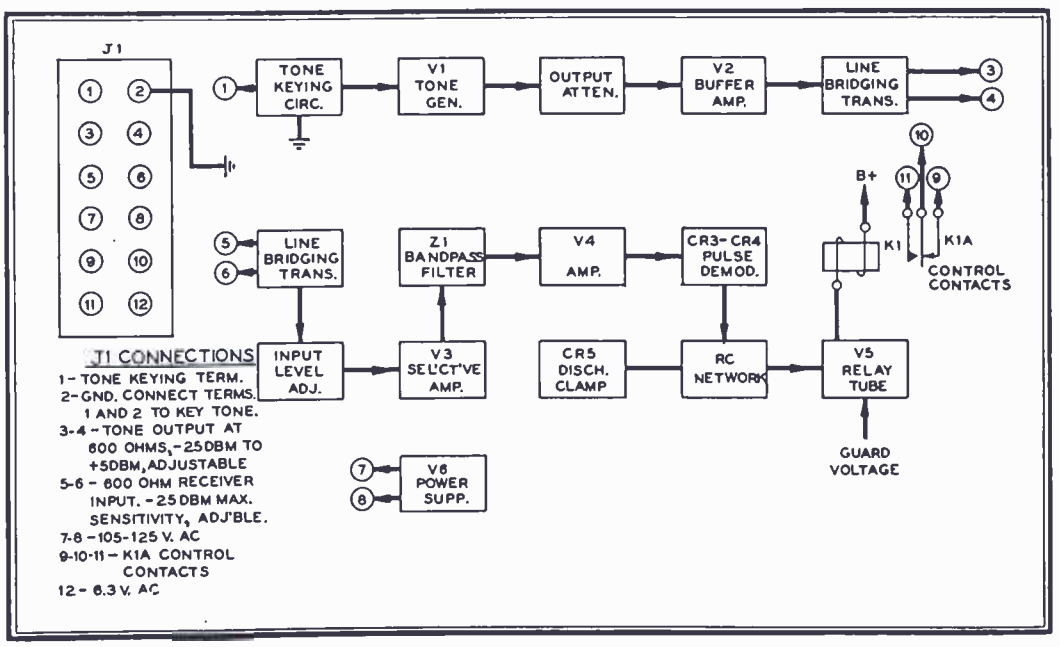
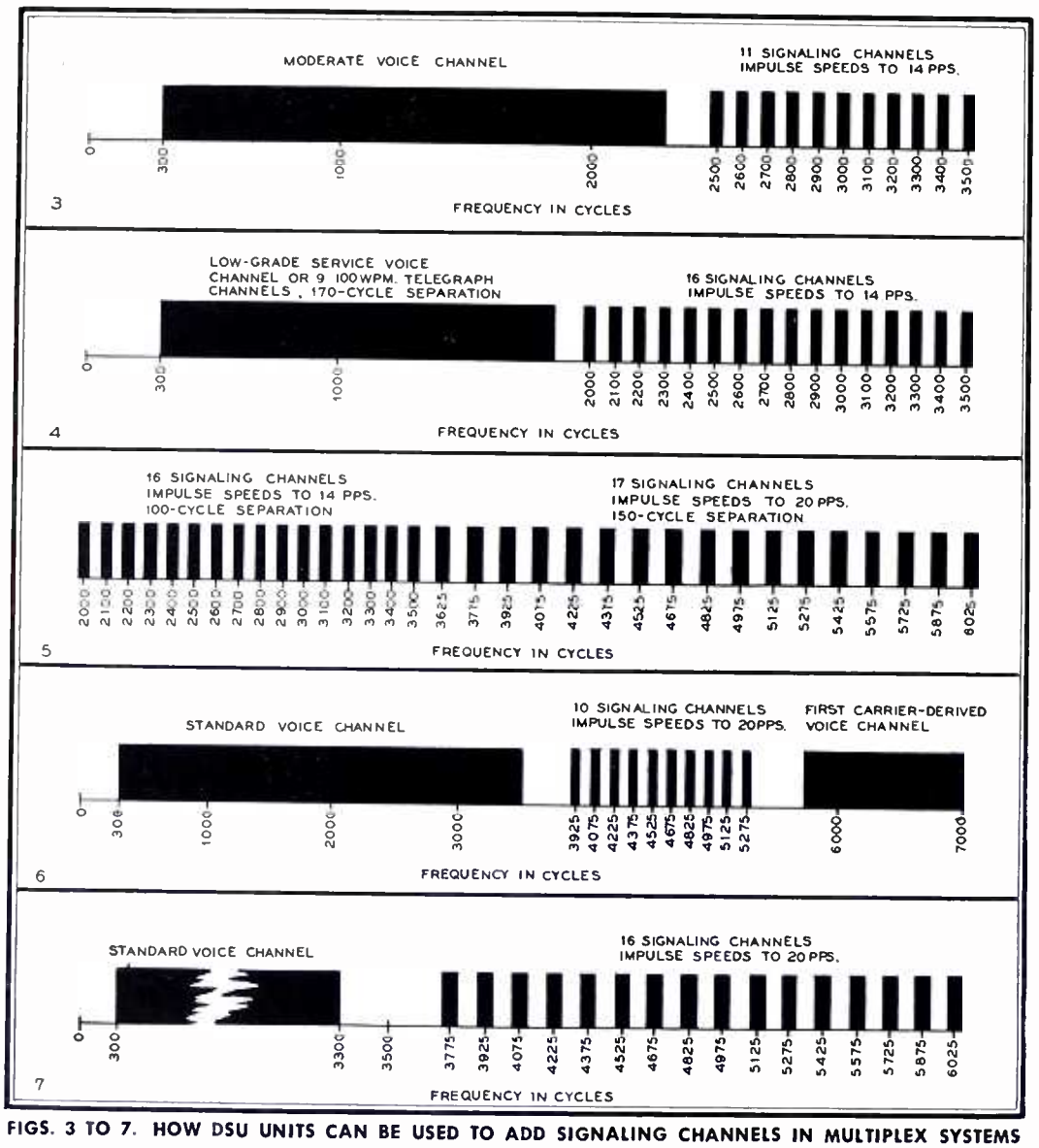


FIG. 2. BLOCK SCHEMATIC OF THE HAMMARLUND VOICE-FREQUENCY SIGNALING AND CONTROL UNIT

Following the bandpass filter is a straight amplifier stage and a demodulator employing two IN54A crystal diodes. The rectified signals are fed to an RC shaping network, which provides uniform output pulses at preset operating speeds of 1 to 30 pps. Another crystal diode is utilized in a discharge circuit to provide rapid noise-voltage decay, thus preventing false operation of the control relay by extraneous noise.

Output pulses from the shaping network are applied to the grid of a DC amplifier, V5, which has a high-speed relay as a plate load. Connections to the control relay contacts are made at terminals 9, 10, and 11 of J1. Also, the plate voltage waveform of V5 can be applied to a local telemetering instrument which utilizes impulse-duration signals.



FIGS. 3 TO 7. HOW DSU UNITS CAN BE USED TO ADD SIGNALING CHANNELS IN MULTIPLEX SYSTEMS

Frequency-Division Methods:

Of the two widely-employed methods of multiplexing, time and frequency-division, the latter offers the advantages of more efficient utilization of spectrum space, simplicity of equipment design, and proven performance capabilities. Maximum bandwidth conservation and optimum signal-to-noise ratios can be obtained in frequency-division multiplexing by the use of single-sideband, suppressed-carrier modulation. By this means, individual voice-channels are heterodyned with subcarrier frequencies so as to place them in ascending order on the frequency scale above the first voice-channel. Normally, each voice-channel is allotted a band 3,000 or 3,200 cycles wide, corresponding to a frequency range of 300 to 3,300 or 3,500 cycles.

If a voice-channel can be restricted to the range from 300 to 2,300 cycles, as in Fig. 3, as many as 11 signaling channels can be accommodated in the space gained, utilizing DSU voice-frequency signaling equipment. These channels are suitable for slow-speed impulse-duration telemetering at 14 pulses per second, supervisory control, fault-alarm indication, and various other applications.

A variation of this division process is shown in Fig. 4. Here, the lower end of the voice-channel, from 300 to 1,800 cycles, can be used as a low-grade service voice channel or to provide 9 standard telegraph channels operated at 100 words per minute. Sixteen signaling channels, with maximum impulse speeds of 14 pps., are obtained from 2,000 to 3,500 cycles.

Where it is necessary to obtain the maximum possible number of voice-frequency signaling channels, the frequency range allocated for such signaling can be extended. As shown in Fig. 5, the band from 3,625 to 6,025 cycles will accommodate 17 channels with maximum impulse speeds of 20 pps. A total of 33 signaling channels can then be obtained in the range above 2,000 cycles, with a low-grade service channel or nine 100-wpm. telegraph channels below this frequency.

A unique method of adding signaling channels to an existing frequency-division system, by utilizing DSU units, is outlined in Fig. 6. Supervisory channels are added between the basic 300 to 3,500-cycle channel and the first carrier-derived voice-channel beginning at 5,700 cycles. Ten signaling channels are shown. The exact number that can be added depends, of course, on the frequency spacing between the basic voice-channel and the carrier-derived channel, and the adjacent cutoff characteristics of each. Since subcarrier channelizing equipment is not required for these signaling channels, they can be added at very little cost.

Another convenient means of adding signaling channels without associated subcarrier equipment is illustrated in Fig. 7. The basic voice-channel, terminating at 3,300 cycles, is retained. Then, 16 signaling channels, with maximum impulse speeds of 20 pps., are employed in the range from 3,775 to 6,025 cycles. Thus, they replace the first carrier-derived voice channel.

Conclusion:

It can be seen from the foregoing examples that, when suitable signaling units are available, vocie-carrier signaling channels above 6,025 cycles will be useful and practical, since this type of equipment eliminates the need for subcarrier channelizing equipment for telemetering, supervisory control, and other signaling facilities.

Operating principles and equipment for obtaining carrier-derived voice channels in frequency-division microwave systems are similar to those employed in standard power-line carrier telephone systems. Thus, the data and suggestions given above are, in many ways, applicable to wire-lines and power-line carrier systems also.

OSCILLOGRAPH BEAM INTENSIFICATION

A new technique developed by J. H. Park of the National Bureau of Standards increases the writing speed of a high-voltage oscillograph to three-fourths the velocity of light. High intensification of the electron beam is obtained momentarily by superimposing a steeply-rising voltage pulse on the steady voltage applied to the discharge tube of

(Continued on page 37)

GAS PIPELINE RADIO SYSTEM

INTELLIGENT SYSTEMS ENGINEERING PROVIDES VERSATILITY WITH MINIMUM EQUIPMENT IN GAS COMPANIES' RADIO SYSTEM — *By* HARRY KEELING*

DURING recent years, gas transmission and distribution companies have been making increasingly greater use of radio communication equipment to expedite system operations and to insure uninterrupted service during times when floods, earthquakes, or other disasters break down wire telephone lines. The Southern Counties Gas Company of California and the Southern California Gas Company have been working together for the past ten years to develop a radio communication system which would provide the best possible service for both companies at minimum cost to each. Although the companies own and operate their own radio equipment independently, the separate installations are combined to make up an integrated system which results in maximum benefits for the individual companies without duplication of facilities. Provision has been made for channel-sharing and, in some cases, joint ownership and operation of certain facilities which are used by both. The technical design, preliminary planning, field surveys, and supervision of radio equipment maintenance for both gas companies are handled by the engineering staff of one. This is a much more economical arrangement than separate radio engineering groups maintained by each company.

Service Area:

These two gas companies serve more than 1,450,000 natural gas customers, and provide gas service to an estimated population of 5,200,000 in Southern California. In addition, about 1 million persons in the San Diego area depend upon the Southern Counties Gas Company for gas which is distributed by the San Diego Gas & Electric Company.

The Southern Counties and Southern California Gas Companies' integrated pipe line system is spread out over a very large area. They maintain and operate 17,862 miles of pipe lines in Southern California. The total area served is better than 56,000 square miles. In addition to domestic and commercial customers who rely on natural gas as their sole fuel, many industrial organizations, hospitals, schools, government agencies, and military establishments depend upon these companies for gas.

The sources of natural gas that feed this pipe-line network are far apart. A 1,200-mile pipe line from Texas to the California border, and a 250-mile pipe line from that point to Los Angeles deliver a maximum daily gas volume of about 405 million cubic feet to the Los Angeles area. Other supply sources of natural gas are widely-scattered gas and oil fields and underground storage reservoirs in Central and Southern California.

Need for Radio Service:

Public telephone facilities or leased lines are adequate for normal communications. Since 1941, however, the gas companies have been using mobile radio communication equipment to conduct certain operations on their pipe lines which could not be handled satisfactorily in any other way, and for emergency point-to-point service when normal telephone communication is disrupted. Because of the large territory served by the combined gas companies, Fig. 1, it is not economical to equip every vehicle and every operating base with radio communication equipment, as is the practice of electric utilities and public safety organizations. This is explained by the fact that gas and water pipes are underground, where they are fairly well protected from the elements. An electric utility, on the other hand, is more likely to have frequent interruptions in service, since overhead wires can be broken by wind storms and traffic accidents. Although an electric utility may have several hundred minor service interruptions during a single year, a gas utility seldom has a break in service; however, these interruptions are potentially much more serious. Thus, radio equipment of gas companies is intended primarily for emergencies, and may have only limited day-to-day use. Nevertheless it must, like fire-fighting equipment, be maintained in proper operating condition so that it is ready for instant service should the need arise.

System Design Problems:

Peculiarities of terrain and frequency utilization in Southern California have created distinct problems in system engineering. The rapid growth of television in this area has precluded the use of 72 to 76 mc., one of the primary operational fixed-station and repeater frequency bands. In Los Angeles, seven television transmitters are located atop mile-high Mt. Wilson, providing useful service ranges well over 100 miles in some directions. Channels 4 and 5 were among the first television frequencies utilized in Southern California. The interference to television receivers caused by 72 to 76-mc. transmitters created a public-relations problem. In the early developmental stages of the gas companies' communication system, it was anticipated that mountain-top repeaters would be used for primary coverage, and that they would be controlled by 72-mc. circuits. In order to eliminate the possibility of interference to television reception, however, microwave control circuits were selected finally as the most desirable choice in the Los Angeles area. Motorola

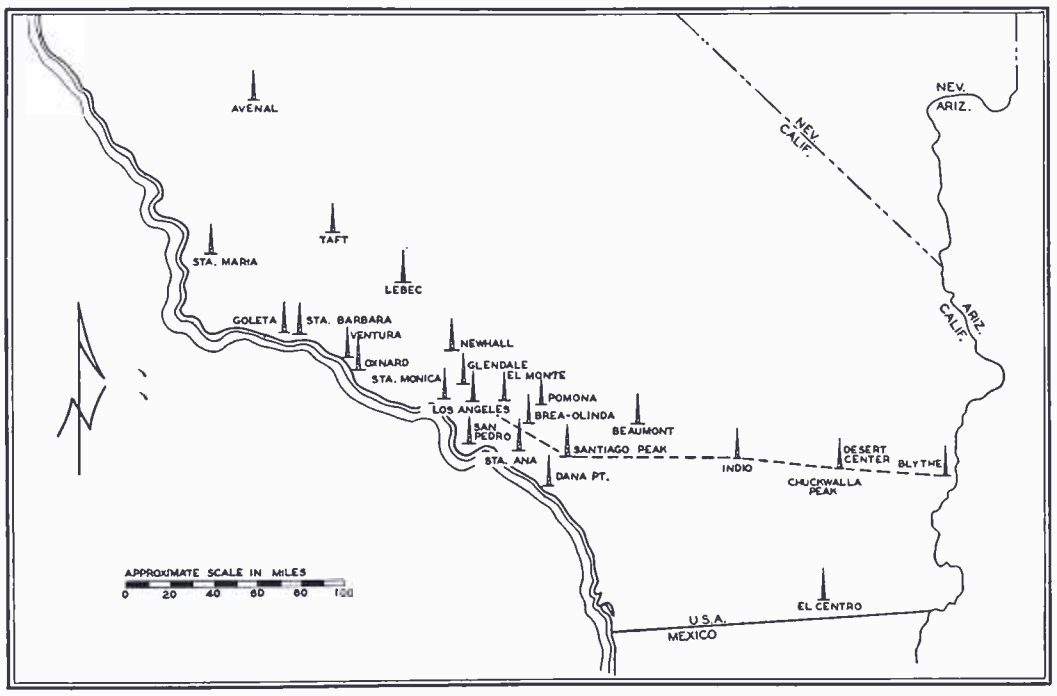


FIG. 1. TOWERS INDICATE BASE-STATIONS. DASHED LINES SHOW PRESENT POINT-TO-POINT CIRCUITS

* Engineer, Southern Counties Gas Company of California, Los Angeles, Calif.

microwave equipment, therefore, is used to control the relay station on Santiago Peak, 55 miles to the east.

Early in 1949, the FCC announced that it would discourage the expansion of systems operating on 2.292 mc., a frequency then in use by these gas companies. This announcement accentuated the need for a completely new system. One of the first steps in the development of the new system was the design of a communication facility which would provide mobile radio communication for the newly constructed pipe line extending from Blythe, on the California-Arizona border, to Los Angeles. This Texas pipe line leg, Fig. 1, was considered to be of primary importance; accordingly, the communication system was developed there first. Future expansion was provided for, so that branches in the San Joaquin Valley and along the coast of Southern California northward to Goleta and Santa Maria would be included in the system eventually.

Description of the System:

The new radio communication system for the gas companies has been under development for the past two years, and is now almost completed. This system was designed to provide the following types of service:

1. Conventional mobile service between base stations at the principal operating headquarters and supervisors' vehicles, construction trucks, and patrol cars. This VHF system is operated simplex so that, where it is necessary, direct mobile-to-mobile or portable-to-mobile operation is possible for maintenance and repair work on pipe lines in remote areas.

2. Emergency point-to-point service, to provide communication between the principal operating headquarters of the companies during times when the normal wire-line communication system is inoperative. In all but a few cases, this service is provided through the VHF base-station transmitters.

3. Extended talk-back range for mobile units operating in remote areas, through the use of unattended mountain-top repeater stations. It is expected that, in the future, complete emergency point-to-point service over distances involving several hundred miles will be provided by these mountain-top repeaters.

In order to keep the overall system cost within the budget, it was necessary that the number of installations be held to a minimum. Also, it was anticipated that during times of disaster, when radio equipment was most seriously needed, commercial power or public telephone service might be inoperative. Therefore, gasoline-driven generators have been provided at all base stations. Where a remote transmitter is used, the generator is turned on automatically in the event of a control-circuit failure.

Motorola Quik-Call selective calling is used throughout the system. Many base stations situated throughout Southern California are installed at operating bases that do not have 24-hour working schedules. These stations have operators on duty during normal working hours, but the control console is left unattended at night. Selective calling facilities have been incorporated in all base station equipment, so that unattended stations can be alerted at any time. In an emergency, the receiving units turn on signal lights in the operators' homes, or operate horns or bells which summon the night watchmen. Also, each base station has equipment for calling selectively mobile units or base stations within direct range or through repeaters, as may be required.

Selective calling and supervisory control equipment is employed also throughout the system for switching frequency, controlling mountain-top repeaters, and various other functions, some of which are described later. At the present time, the alarms and signals for alerting unattended stations are actuated from other base stations only. However, the long-range plan calls for equipping key mobile units with Quik-Call facilities also.

In general, the radio system is operated on a decentralized basis. This is in keeping with the companies' general policy of controlling their facilities from a number of small operating bases rather than from one central headquarters. This practice eliminates the need for long communication lines between central headquarters and individual operating areas. In the event of disaster, a decentralized system is less vulnerable to disruption.

After a thorough study of topographic maps, supplemented by field tests, it was

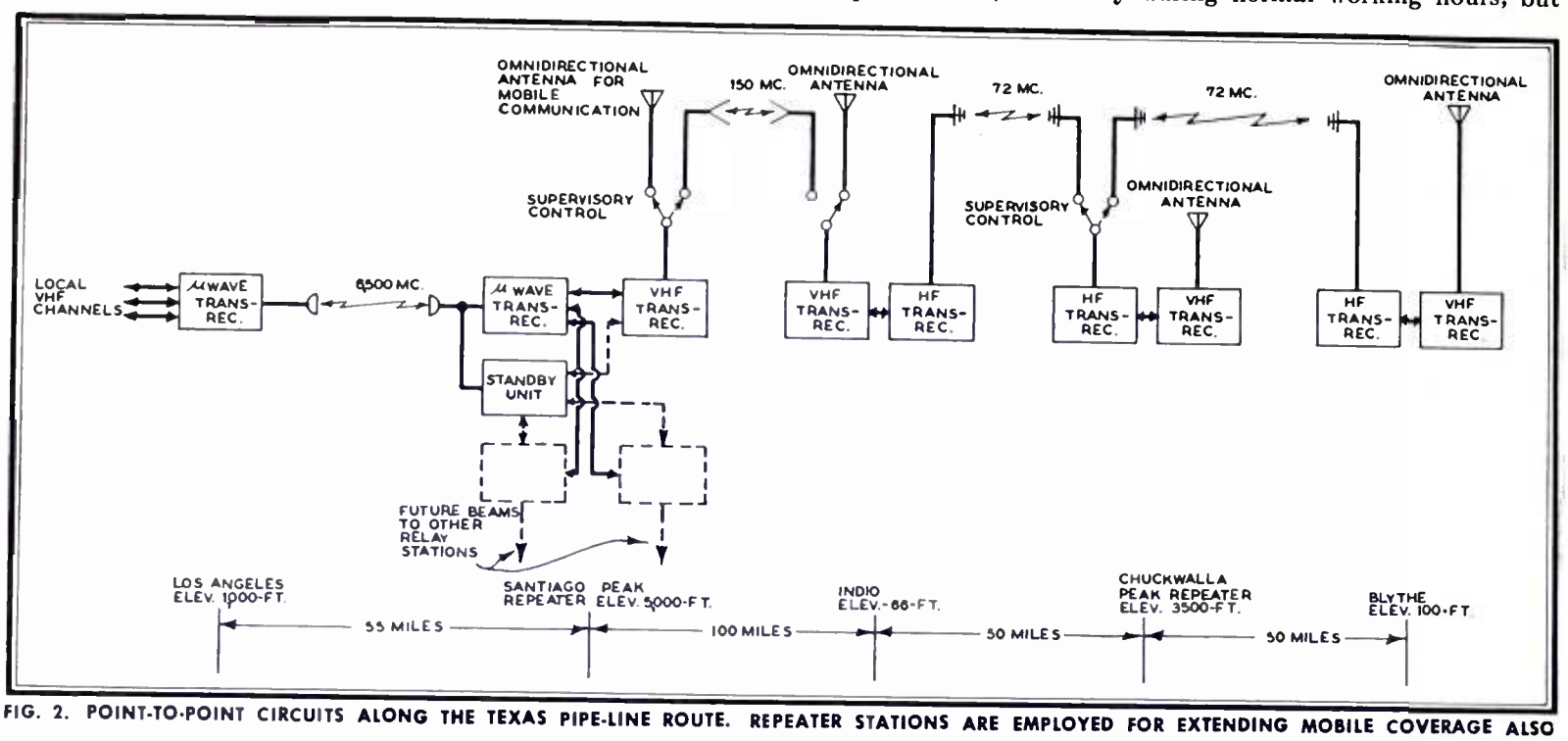


FIG. 2. POINT-TO-POINT CIRCUITS ALONG THE TEXAS PIPE-LINE ROUTE. REPEATER STATIONS ARE EMPLOYED FOR EXTENDING MOBILE COVERAGE ALSO

FIG. 3. MICROWAVE TRANSMITTER-RECEIVER AT THE CENTRAL HEADQUARTERS IN LOS ANGELES

found that satisfactory radio communication over the 250-mile distance between Los Angeles and Blythe could be accomplished through the use of two unattended repeater stations, in addition to the base station at Indio. A diagram of this system, showing frequencies employed, is given in Fig. 2. The first repeater station is located on Santiago Peak near Santa Ana, at an elevation of 5,000 ft., and is 55 miles airline from Los Angeles. As mentioned previously, a microwave link was selected as the most practical method of control of this station from Los Angeles. There were many other agencies already using Santiago Peak as a site for unattended base stations and repeaters, and commercial power was extended to the top of the mountain. However, wire communication circuits are still unavailable. All the radio equipment is controlled through radio circuits. Since Santiago Peak is located in Orange County, near the center of the combined gas companies' territory, it is expected that it will be used in the future to provide emergency point-to-point service to networks running north along the coast and northeast to the San Joaquin Valley.

Santiago Peak Relay Station:

The Santiago Peak relay installation is unusual in many ways. A 6,500-mc. microwave link from the gas company headquarters in Los Angeles controls this station. Fig. 3 shows the microwave transmitter and antenna at the Los Angeles terminal. The Los Angeles dispatcher has full supervisory control over the point-to-point and land-to-mobile circuit from Los Angeles through the repeater.

Automatically-switched standby equipment is supplied at the Santiago Peak

FIG. 4. REPEATER STATION ON SANTIAGO PEAK

end of the circuit to provide absolute reliability. RF housings include two complete transmitter-demodulator units, one for regular operation and one for emergencies. Sensing circuits in the equipment act upon the failure of any tube or component, and initiate the automatic

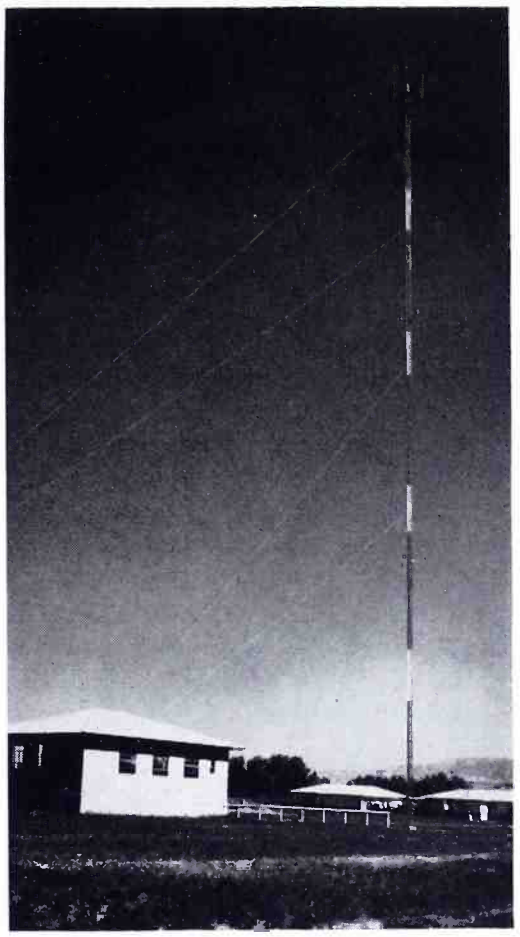


FIG. 5. INSTALLATION AT INDIO BASE-STATION

switchover to the standby gear. Thus, little or no actual outage of the control circuit is experienced. This automatic changeover feature is not utilized at the Los Angeles terminal, since an adequate maintenance staff is available on short notice. In Fig. 4, the microwave equipment is at the left of the building. The pole at the right carries the omnidirectional VHF antenna for mobile communication and the corner-reflector antenna beamed toward the base-station at Indio.

Provision for 3 voice channels has been made in the microwave system. This will permit future expansion of point-to-point facilities, so that this system can be tied in with the other two main divisions of the pipe-line system.

The microwave equipment employs a double-FM modulation system. Each input voice channel frequency-modulates a subcarrier transmitter on a frequency in the 120-kc. to 1-mc. range. The subcarrier transmitter outputs are combined and fed to the transmitter Klystron to modulate the FM carrier. Standard deviation of ± 5 mc. is utilized for 100% modulation. Because of the direct line-of-sight path between the two terminals, it was unnecessary to use the tower reflectors normally associated with Motorola microwave equipment.

The relay-station transmitter, operating at 150 mc. with a normal power output of 60 watts to an omnidirectional antenna, is used for communication with mobile units operating within 80 to 100 miles of Los Angeles. However, this transmitter can be switched remotely to a directional antenna for emergency point-to-point service between Los Angeles and the Indio base-station. The antenna, a corner reflector, feeds a separate 150-mc. receiver equipped with selective calling control facilities.

Fig. 5 shows the 200-foot antenna tower at Indio. The 150-mc. antenna for mobile communication is located at the top on the left side of the tower. Below this is the 150-mc. corner reflector for point-to-point work with Los Angeles through the Santiago Peak repeater. The 72-mc. directional antenna for communication with Blythe through the Chuckwalla Peak repeater is at the top of the tower on the right.

Equipment at the Indio station is shown in Fig. 6. The 72-mc. rack is at the left, and the 150-mc. equipment is at the right.

The dispatcher at Indio can switch the Santiago transmitter to the Indio antenna and, at the same time, raise the power from 60 watts to 250 watts. The operator at Los Angeles is then in direct communication with Indio, a distance of about 150 miles. In a similar way the Los Angeles operator, with supervisory controls, can switch the base-station transmitter on Santiago Peak from the omnidirectional to the beam antenna.

At the present time, it is planned to retain a manual relaying procedure at

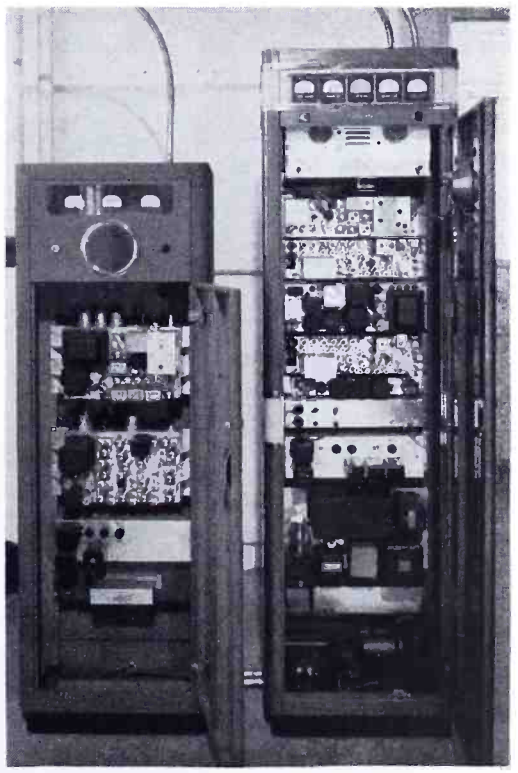


FIG. 6. THE 72 AND 150-MC. RACKS AT INDIO

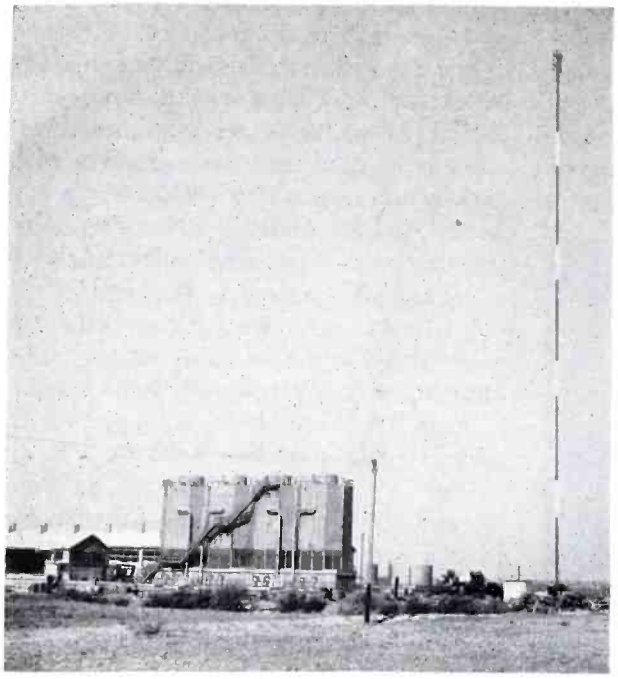


FIG. 9. COMPRESSOR STATION AT BLYTHE HAS 200-FOOT TOWER. FIG 10. INSTALLATION ON TOP OF CHUCKWALLA PEAK, AT ELEVATION OF 5,000 FT.

the Los Angeles station in order to provide extended talk-back range from mobile units to the base stations in the general area of Santiago Peak. Experience has indicated that the omnidirectional antenna on the Peak provides dependable coverage and reception of mobile units operating within a 100-mile radius of the station. This coverage is solid, except in the few areas where the signal is cut off by intervening hills. Thus, any mobile unit within this range can have a message relayed to its base station through the Los Angeles dispatcher, and vice versa.

In the event that talk-back relay traffic becomes greater than is practical to handle manually through the Los Angeles office, future plans call for additional control circuits between the other base stations and Santiago Peak. This will provide the base stations with their own facilities for handling traffic through Santiago Peak to the mobile units they control.

Typical of these operating base stations is that at Brea-Olinda, shown in Figs. 7 and 8. Note the selective-calling control box at the left in Fig. 7, and the standard triple-skirt coaxial antenna, Fig. 8.

Chuckwalla Peak Relay:

Aside from the various base stations located in the Los Angeles County area, other important stations utilizing 250-watt transmitters are situated at Beaumont, Indio, and Blythe. The Blythe and Indio stations have 200-foot towers which provide them with adequate mobile coverage. In addition to the 250-watt transmitters operating in the 150-mc. band, these stations have 72-mc. control equipment for point-to-point work through the Chuckwalla repeater, and for communication through the repeater with mobile units along the 100-mile distance between Blythe and Indio. Fig. 9 shows the Blythe Compressor Station tower installation, with the 150-mc. omnidirectional antenna and the 72-mc. Yagi array beamed toward Chuckwalla Peak.

This unattended repeater station is located in the mountains near the community called Desert Center, approximately midway between the two base stations it serves. The Peak is situated in the midst of rugged desert terrain, which is listed as "inaccessible and unexplored" on Department of Interior maps. This desert country is characterized by extremes of temperature and weather, from snow in the winter to 120° F. in the summer, and a scarcity of roads and power lines.

Preliminary studies of aerial maps and photographs suggested the possibility of a suitable location for an unattended re-

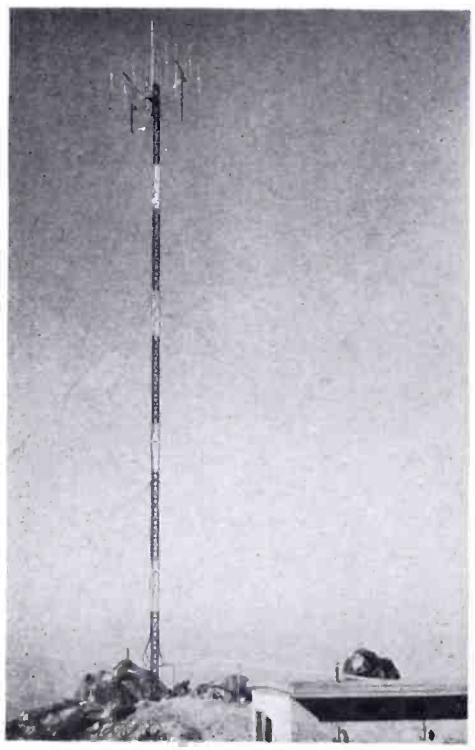
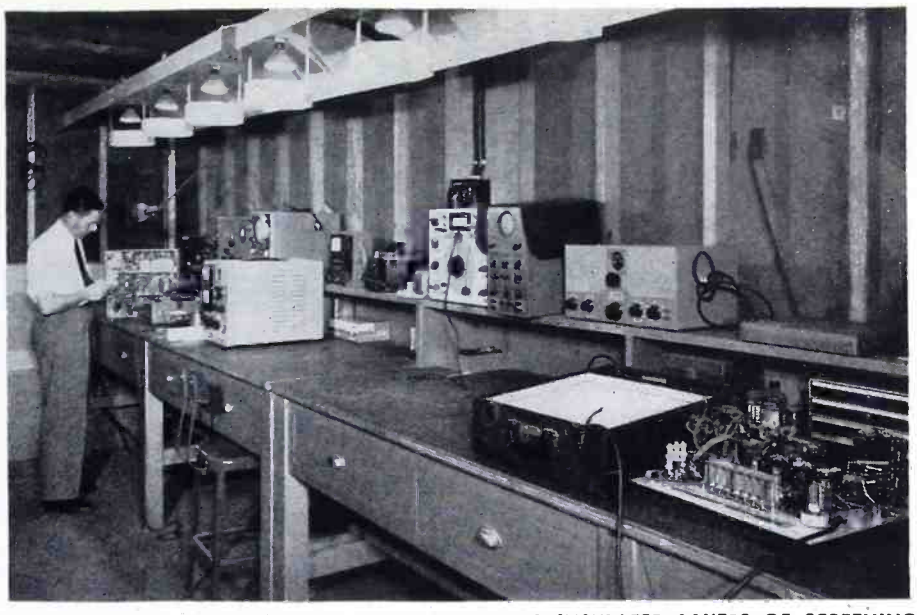


FIG. 11, LEFT: THE NORTH ANTENNA TOWER ON CHUCKWALLA PEAK

FIG. 7, BELOW: THE CONTROL CONSOLE AND SELECTIVE CALLING EQUIPMENT AT BREA-OLINDA. AUTHOR IS LEANING ON THE CONSOLE

FIG. 8, RIGHT: BREA-OLINDA VHF ANTENNA IS TYPICAL OF SYSTEM



FIGS. 14 & 15. MAINTENANCE AND TEST ROOM AT LOS ANGELES HEADQUARTERS IS SURROUNDED COMPLETELY BY 2 INSULATED LAYERS OF SCREENING

peater station in this general vicinity. Several months of reconnaissance work in four-wheel drive vehicles and on foot were required to determine finally that Chuckwalla Peak was the most accessible and desirable location for a station. In order to reach the summit of this range, at an elevation of 3,750 feet, it was necessary to construct a 3½-mile access road from the floor of the valley. The top of the peak was blasted level, Fig. 10, and two 100-foot steel towers were erected to support the antenna structures. Then, a concrete block building to house the radio equipment and two diesel generators was constructed. The building and tower structures have been designed to withstand 120 mph. wind loads.

Inasmuch as the station was designed for unattended operation for relatively long periods of time, every effort has been made to make the equipment as trouble-free as possible. The two diesel power-generating units are so arranged that they run alternately on either 2½ or 5-day cycles. The engine cooling systems are designed to provide continuous operation for 90 days or more, in temperatures exceeding 120° F. Fuel storage facilities are adequate for uninterrupted 90-day runs. Complete supervisory control facilities have been provided so that the operator at Blythe or at Indio can shift the load from one engine to another, should the necessity arise. The engines are protected also by the usual high-temperature low-oil pressure cutouts and, if these safety devices should operate, the malfunctioning engine is shut down and the second diesel started automatically. At the same time, a 1,000-cycle note is placed on the VHF carrier so that operators at Blythe and Indio are notified immediately of the trouble.

The operators can crank either of the engines by radio, should the cycling procedure be interrupted for any cause. Also, they can control the operation of the 60-watt VHF transmitter for talking to mobile units along the pipe line beyond range of the Indio and Blythe base stations. Selective line switching units are provided so that either Blythe or Indio operators can turn off the mobile-frequency transmitter when talking point-to-point.

Fig. 11 shows the north antenna tower, which carries the mobile-frequency coaxial antenna and the two Yagi transmitting antennas directed at Blythe and Indio. These operate at 75.58 mc. The two receiving antenna arrays, operating at 72.18 mc., are mounted on the south tower, which can be seen at the right in Fig. 10.

At the base of the north tower, a bronze plaque is imbedded in the rock. The tablet was installed in memory of Lt. Art Shropshire, designer of the buildings on Chuckwalla Peak, who was recalled to active duty and died in Korea.

System Maintenance:

Most of the routine maintenance work on the radio system is handled by outside contractors. However, the Southern Counties Gas Company has complete test and repair facilities to provide emer-

(Concluded on page 40)

FIG. 12. THE 4-WHEEL DRIVE VEHICLE FOR MAINTENANCE AND SUPPLY RUNS TO REPEATERS. FIG. 13. FIELD SERVICE TRUCK HAS PORTABLE GENERATOR

MOBILE RADIO

NEWS AND FORECASTS

THE FCC has quite consistently followed the policy of encouraging the development of competitive radio services. It has been maintained, however, on various occasions, that the Commission should take into account the number of competing services that can be operated profitably in a given market.

Most recent case of this sort arose in Rome, N. Y., a city of 41,000 population, where Woodruff G. Evans has operated a limited common carrier system since April, 1948. Last January, he filed a protest against the granting of a license to Martin J. Nunn, who applied for authorization to operate a similar service in the same city.

Basis of the Evans protest was that since he had obtained only nine subscribers, and had not reached the break-even point in his operation, it would not be in the public interest to authorize another service to compete with him.

Fallacy of the Evans position is its assumption that 1) without competition he would be able to obtain a sufficient number of subscribers to assure an operating profit before using up his capital, provided the FCC would protect him against competition, and 2) that the total number of subscribers that could be obtained in the Rome area by aggressive sales promotion would not be enough to support two common carrier services.

If only one frequency assignment were available in Rome, Mr. Evans would have it by right of pioneering in the common carrier service. Still, that privilege would carry the obligation to attract the largest number of subscribers by dint of active sales effort, for only in that way could his monopoly be justified.

On the other hand, with two assignments available, Mr. Evans must rely on his own resources, and not Government protection, as the means for meeting competition. If the newcomer is less able than Mr. Evans, he will only spur the latter to secure his position by rendering still better service. If the newcomer is more able than Evans, he should certainly be given the opportunity to put his ability at the disposal of the community, and if he builds up a larger number of subscribers, it will be by virtue of providing more satisfactory service. Certainly, it would not be in the public interest to foster an inferior service by protecting it against competition from a company capable of rendering superior service!

Radio Location Service:

In a Report and Order announced on December 19, the FCC amended the Rules Governing Industrial Radio Services by adding Subpart M, effective February 1, 1952. Purpose is to facilitate the eventual establishment, on a regular basis, of an industrial radiolocation service to be used primarily in connection with geographical, geological, and geophysical activities. All stations licensed under the new Subpart M will be on a developmental basis only and, to encourage further development of radiolocation techniques, deviations from the Rules may be authorized.

Recognizing that there are areas commercially exploitable for oil at distances 40 to 70 miles or more off shore in the Gulf of Mexico, the Commission has assigned the band of 1,750 to 1,800 kc. for radiolocation use, with the provision that licensees in that band must assume responsibility for protecting the disaster service against interference. Use of this band will be limited to the assignment of 25 kc. of spectrum space to each licensee for all his stations. Assignments in this band will be protected to the extent of a 20-db ratio of desired to undesired signals, and frequency assignments will not be repeated at intervals of less than 360 miles.

In addition to the 1,750 to 1,800-kc. band, the use of frequencies in the following bands may be authorized for land and mobile radiopositioning stations, subject to the condition that harmful interference will not be caused to radionavigation stations:

2,900 to 3,246 mc.	5,460 to 5,650 mc.
3,266 to 3,300	9,000 to 9,300
5,250 to 5,440	9,320 to 9,500

Speed-measuring devices may be authoized in the band from 2,450 to 2,500 mc. on condition that harmful interference is not caused to fixed and mobile communication services, and that harmful interference must be accepted from industrial, scientific, and medical equipment.

Frequencies listed above do not provide for voice communication. Wire lines or frequencies allocated to such services as petroleum, special industrial, or low-power industrial must be used for that purpose.

Louis G. Caldwell:

Comment contained in a letter from Jeremiah Courtney: "Louis Caldwell, first General Counsel of the FCC, was the acknowledged dean of the radio bar in both broadcast and non-broadcast matters. In the latter field, he acted in a variety of capacities, including that of counsel for Aeronautical Radio, Inc. since its organization as the communication agency of the domestic airlines. The broadcast and non-broadcast fields have grown so much, and have become so complex, that Caldwell was probably the last lawyer to enjoy an intimate knowledge of and a wide practice in both fields.

"His friends were as many as his knowledge of the radio field was wide. A prolific writer, especially in his younger days, his passing brought poignantly to mind the advice he gave me, at one of the Aeronautical Radio functions, on his way of accomplishing the many extra-curricular labors he crammed into a life filled to overflowing with regular duties. He said: 'If you have a difficult article to write or a study you want to complete, give it fifteen minutes a day. Otherwise, the enormity of the job will lead to putting it off, and it will never be done.' His advice was always valued highly, and the many distinguished works Caldwell left behind testify to the fact that he was a man who practiced what he preached.

"It is truly regrettable that the rich experience acquired by many Government lawyers, in the course of their highly specialized practice before administrative agencies, has not been more completely reduced to writing. Anyone who has participated from the Government side in the last general allocation proceeding, for example, has a wealth of experience of a type that is all too often lost to the succeeding individuals within the Government. Then, too, the people who could enrich the field with their writings are precisely the busiest. For them, Caldwell's fifteen-minutes-a-day recipe is the answer. It may lead me to the preparation of a long-contemplated booklet for those who have continual dealings with administrative agencies, explaining when to see or write their Congressmen about matters pending in governmental departments; how to handle such appointments; when (equally important) not to see or write their Congressmen; when to see the staff dealing with the matter in question; when and when not to see the Commissioners of Government agencies; and discussing other questions that perplex those not versed in the administrative art."

System Engineering:

Added functions required of radio communication systems and the increasing need of conserving channels are creating new demands for the services of engineering consultants. A recent example is the microwave relay system now being completed for the New Jersey Turnpike Administration. Operating on 960 mc., the installation provides a voice channel for monitoring the entire system, another for dial-phone administrative calls, a party-line teletype, and two voice channels for communication by VHF with State Police cars and maintenance trucks. For the latter purpose, there are VHF base stations at five of the seven microwave relay points.

The basic engineering requirements and the operational details were established by the Paul Godley Company, working in conjunction with RCA's engineering products department which designed and manufactured the equipment, and the RCA Service Company which handled the installation.

From the administration headquarters at New Brunswick, it is possible to communicate with all patrol cars, maintenance trucks, and toll gates along the Turnpike. The dial phones and teletype link the police divisions with one another, and with the Trenton headquarters of the State Police. A switching arrangement at the Turnpike headquarters makes it possible to separate the system into two, three, or four sections. With end-to-end operation, a single one-party line is provided. If serious traffic congestion develops in one region, that section can be isolated from New Brunswick, leaving it free to handle local traffic without tieing up calls over the remainder of the system. During such an emergency, messages exchanged in the isolated section can be monitored from headquarters, or the section can be cut back into the system by throwing a single switch. Cost of the complete system will be somewhat above $100,000, according to best estimates.

Amateur Civil Emergency Service:

The FCC announced on December 19 a proposed rule making for the Radio Amateur Civil Emergency Service. Comments related to this matter may be filed on or before February 15. Operation of this service will be limited to the present national emergency, as proclaimed on December 16, 1950, and authorizations may be terminated by the Commission at any time, without a hearing.

Purpose of this service is to provide for the organization of amateur-operated networks under the immediate direction of Civil Defense Radio Officers. The proposed Rules and plan of operation are set forth in great detail, occupying 17 mimeographed pages.

Under this plan, the following bands will be used by stations operated under the direct supervision of designated or responsible officials of the civil defense organization:

CW TELEGRAPH, AM TELEPHONE
1,800 to 1,825 kc.
1,875 to 1,900 kc.
1,900 to 1,925 kc.
1,975 to 2,000 kc.

CW TELEGRAPH, FS TELEGRAPH
3,500 to 3,510 kc.

CW TELEGRAPH, FS TELEGRAPH, AM TELEPHONE, AM FACSIMILE
3,990 to 4,000 kc.

In addition, the following bands will be used by all authorized stations:

CW TELEGRAPH, AM TELEPHONE, AM FACSIMILE, NARROW-BAND FM TELEPHONE
28.55 to 28.75 mc.

CW TELEGRAPH, FS TELEGRAPH, AM TELEPHONE
29.45 to 29.65 mc.

CW TELEGRAPH, AF AM TELEGRAPH, AM TELEPHONE, AM FACSIMILE, NARROW-BAND FM TELEPHONE
50.35 to 50.75 mc.

CW TELEGRAPH, FS TELEGRAPH, AF AM TELEGRAPH, AF FM TELEGRAPH, AM TELEPHONE, AM FACSIMILE, WIDE-BAND FM TELEPHONE
53.35 to 53.75 mc.
145.17 to 145.71 mc.
146.79 to 147.33 mc.
220.00 to 225.00 mc.

Very stringent rules are proposed as to persons authorized to operate stations in this service, and for the operating requirements and procedures.

2-Way Radio in England:

"In the U. S., Business Radio is largely confined to taxi and car-hire services, and, as they have only four channels below 450 Mc/s, as many as 400 taxis operate in the same channel in some of the larger cities. In this country [England] any applicant — from bookmaker to builder, doctor to dairy farmer, and taxi-owner to towage company — is accommodated within one of the business radio bands."

This reference to radio communication systems is quoted from the December issue of England's leading radio engineering magazine, the *Wireless World*. It must have puzzled a considerable number of our subscribers in England who saw the latest FCC summary in RADIO COMMUNICATION last month, showing 10,000 public safety, 3,200 land transportation, and 1,000 industrial service transmitters, operating with more than 300,000 vehicles equipped with 2-way radio. Of these systems, taxi operation only accounts for some 15%. If any of our subscribers abroad are interested in checking over the use of 2-way FM radio for mobile, point-to-point, and relay service in the U. S., we'll be glad to send them copies of our Registries of Radio Systems on request, without charge.

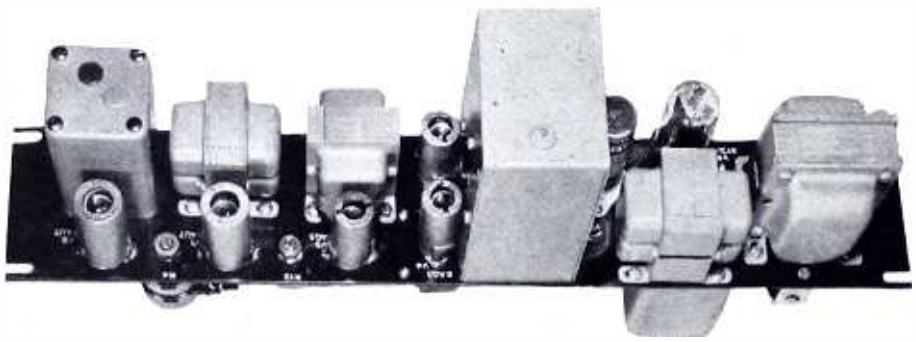
In England, 71.5 to 72.8 mc., 76.7 to 78.0 mc., 85 to 88 mc., 156 to 184 mc., and 460 to 470 mc. are assigned to business radio service. In the first three bands, channels are 50 kc. wide, in contrast to our 40-kc. channels at those frequencies, and 100 kc. wide in the fourth band, as they are here. According to a report made to the House of Parliament at the end of last July, there were 392 fixed and 1,902 mobile transmitters used for business radio at that time. These figures do not include police and fire systems.

An article on taxi radio which appeared in the December issue of the *Wireless World* describes the 12-watt fixed and mobile AM equipment manufactured by Pye Tele-communications, Ltd. Mobile units, working on 12 volts, draw 4.5 amperes for the receiver, 1.5 amperes for the transmitter tube heaters, and a total of 14 amperes during transmission. According to this article, taxicabs "have to be fitted with loudspeakers in order that the driver's attention should not be distracted from his primary function of driving, which might well be the case if a calling device in the form of a buzzer or lamp were used and the driver required to search for and pick up a hand telephone set." Instead, "the microphone is carried by a horizontal swivelling arm attached to a vertical rod mounted on the glass partition which divides the driver's compartment from the luggage space. . . . He can speak into it without actually turning his head and taking his eyes off the road." The press-to-talk switch is mounted "on an arm extending out from the instrument panel . . . just below the rim of the steering wheel. The knob of the switch projects outward . . . and by extending the first two fingers of the left hand it is quite easy to operate the switch without relaxing the grip on the wheel." That may be less complicated than it sounds, but our use of a hand mike or a telephone handset seems much simpler.

HAMMARLUND REMOTE CONTROL &

HAMMARLUND manufactures a complete line of economical and versatile equipment for remote control and data-transmission systems. This fast-acting electronic apparatus is based upon technically sound, time-tested designs. Hammarlund systems can be used with existing installations of any manufacturer, operating over wire or radio circuits, to provide safe, convenient, and reliable performance.

Among the applications of Hammarlund equipment are selective signalling, selective calling, fleet calling, control and selection of remote transmitters and receivers, remote on-off switching of industrial equipment, supervisory control, pipeline control, and telemetering. A few examples of Hammarlund Remote Control and Data-Transmission Units are illustrated here:



Hammarlund Model DSU — Duplex Signaling Unit

THE HAMMARLUND standard Duplex Signaling Unit consists of a tone generator and a receiver which operate at a predetermined frequency. Transmitted and received signals perform on-off switching, provide continuous indication of operating conditions, and automatic indication of wire-line or power-source failure at all points in the system.

A frequent application of this unit is its use in the form of a simple and inexpensive ringdown panel for communication circuits. One panel is used at each end of the circuit so that an operator at either end can signal the opposite end. This method eliminates the expense of monitor amplifiers, and relieves the individual operators of the annoyance of having to listen to all communications, since it is possible to signal only the operator who is wanted.

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Hammarlund SCPB-3020
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DATA TRANSMISSION EQUIPMENT

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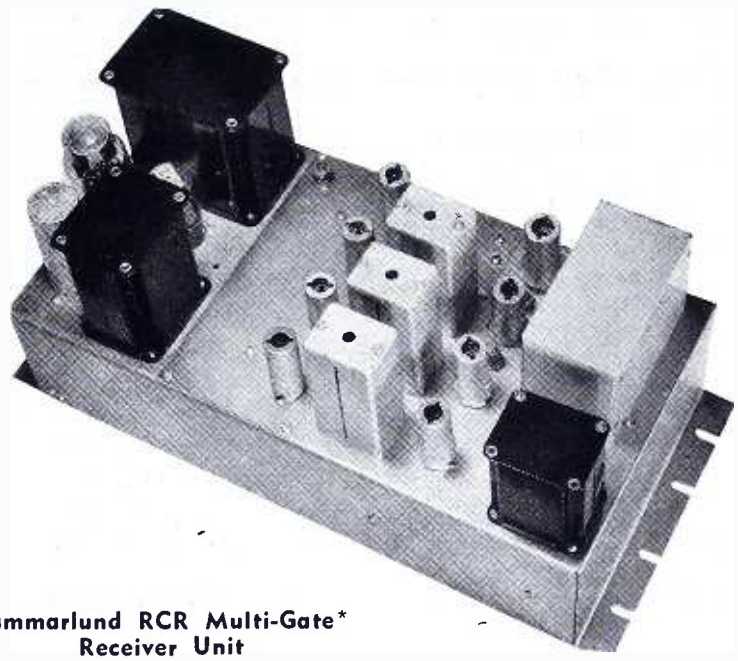

Hammarlund RCR Multi-Gate*
Receiver Unit

ters on and off over a wire or radio circuit. An initial master gate pulse of one audio frequency is sent out, followed immediately by a shorter operative gate pulse of a different frequency. The signaling time is approximately one-half second.

Transient currents, shock excitation, and impedance variations on wire lines, or static interference on radio circuits have no effect on the Multi-Gate System. The system is also immune to disturbances common to wire and radio circuits such as high-frequency attenuation, frequency and phase distortion, signal-level variations, and voice operation in other channels on the circuit.

* Trade Mark Applied for

We invite you to submit details of your requirements. Hammarlund engineers will gladly assist in coordinating remote controls and data-transmission units with any make of communication installation.

HAMMARLUND MFG. COMPANY, INC.

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

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Rates & Revenue Requirements Branch
Martin R. Haven, Chief

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Ralph D. Jones, Chief

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Marion H. Woodward, Chief
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Rates & Revenue Requirements Branch
Asher H. Ende, Chief

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Paul Summerhays, Chief
108 New Montgomery St., San Francisco, Calif.
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Compliance Branch
LeRoy Schaaf, Chief

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Frederick W. Ford, Chief
Emma C. Burke, Secy.
Rob't J. Rawson, Asst. Ch.

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Paul Dobin, Chief
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Arthur Scheiner, Asst. Ch.

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506 Fed. Bldg., N. Y. C.

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411 Fed. Annex, Atlanta, Ga.

Gulf States Region
J. H. McKinney
332 U. S. Appraisers Bldg.
Houston 11, Texas

South Pacific Region
K. G. Clark
Customhouse, San Francisco

North Pacific Region
G. V. Wiltse
801 Fed. Office Bldg, Seattle

Central Region
Wm. J. McDonnel
U. S. Court House, Chicago

Great Lakes Region
E. H. Lee
1029 New Fed. Bldg., Detroit

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L. R. Dawson
Box 1142
Lanikai, Oahu, T. H.

Alaska Region
C. T. Manning
Fed. Bldg., Anchorage, Alaska

DISTRICT OFFICES

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(Vacancy)
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District 2
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748 Federal Bldg., N. Y. C.

District 3
R. A. Phelps
1005 U. S. Customhouse
Philadelphia

District 4
H. A. Cohen
508 Old Town Bank Bldg.
Baltimore 2, Md.

District 5
Edward Bennett
New P.O. Bldg., Norfolk, Va.
(Vacancy)
New P.O. Bldg.
Newport News, Va.

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Fed. Annex, Atlanta
A. R. Bahlay
P.O. Bldg., Savannah, Ga.

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Arthur Fish
Fed. Bldg., Miami, Fla.
C. H. Neeb,
P.O. Bldg., Tampa, Fla.

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Audubon Bldg., New Orleans
G. E. Franklin
U. S. Courthouse Bldg.
Mobile, Ala.

District 9
L. L. McCabe
U. S. Appraisers Bldg.
Houston
E. D. Coburn
P.O. Bldg., Beaumont, Tex.

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U. S. Term. Annex
Dallas, Tex.

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U. S. Courthouse Bldg.
Temple & Spring Sts.
Los Angeles
N. R. Landry
U. S. Courthouse Bldg.
San Diego, Calif.

District 11
James Homsy
U. S. Courthouse Bldg.
San Pedro, Calif.

District 12
F. V. Sloan
Customhouse, San Francisco

District 13
J. M. Chapple
Fitzpatrick Bldg.
Portland, Ore.

District 14
H. H. Arlow
Fed. Offiice Bldg.,
Seattle, Wash.

District 15
W. E. Clyne
Customhouse, Denver, Colo.

District 16
D. A. Murray
Uptown P. O. Bldg., St. Paul

District 17
H. T. Callaher
Fidelity Bldg.
Kansas City, Mo.

District 18
H. D. Hayes
U. S. Courthouse, Chicago

District 19
E. S. Heiser
New Fed. Bldg., Detroit

District 20
P. A. Holloway
P.O. Bldg., Buffalo, N. Y.

District 21
P. R. Fenner
Stangenwald Bldg., Honolulu

District 22
A. T. Cline
Fed. Bldg., San Juan 13, P. R.

District 23
H. D. DeVoe
Shattuck Bldg.
Juneau, Alaska
(Vacancy)
U. S. Courthouse Bldg.
Anchorage, Alaska

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Box 788, Grand Island, Neb.
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E. W. Sanders
Box 458, Millis, Mass.
Wm. Hoffert
Box 744, Santa Ana, Calif.
Adolph Anderson
Box 31, Laurel, Md.
Geo. McLeod
Box 989, Livermore, Calif.
R. A. Landsburg
Box 5165, Portland, Ore.
H. B. Dunphey, Jr.
Box 4, Powder Springs, Ga.
Lee Dawson
Box 1142, Lanikai, Oahu, T. H.
Edwin Forsyth
Box 719, Anchorage, Alaska

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J. L. Kurdeka
Box 499, Twin Falls, Idaho
E. G. Coston
Box 187, Fort Lauderdale, Fla.
J. E. Gilfoy
Box 99, Lexington, Ky.
J. F. DeBardeleben
Box 1448, Muskogee, Okla.
H. F. Rawls
Box 300, Bay St.,
St. Louis, Miss.

EQUIPMENT FOR MCC OPERATION

HOW A TELEPHONE ANSWERING COMPANY USES EXISTING EQUIPMENT AND PERSONNEL TO ADD MCC SERVICE AT LITTLE COST — *By* PHILIP D. HAMLIN*

TELEPHONE answering today is big business. In its basic form, it is a simple process. Normally, a businessman is in his office not more than eight hours a day. Many of his customers, however, would like to contact him, place orders, or leave messages at other hours. They can be accommodated simply by having an extension from his office telephone installed at some other location, which is attended around the clock. Then, when his telephone rings, if there is no one in his office to answer it, the telephone answering service takes over, answering with the name of his firm and transacting his business. Trained secretaries follow his instructions to the letter.

From this basic service have grown many additional ones, which can be handled with the facilities already installed for telephone-answering. For example, Sears, Roebuck Company employs this service on a nation-wide scale for taking telephoned catalog orders. Many emergency organizations are customers such as AAA and those who furnish local towing, commercial refrigerator, ambulance, and elevator and oil burner repair services. Not the least important is television repair service, which has become so vital to many users that not a moment's delay will be tolerated. Broadcasting stations use the service for calls made in response to limited-offer advertising. All kinds of public opnion polls use it for sampling, although in this particular application it is utilized for making calls. There are many other applications, and new ones are being developed constantly.

One of the most recent developments in this field is mobile radiotelephone dispatching and message handling. At first glance, this would appear to be competitive with the telephone company. Actually, it is an entirely different kind of service, since the Bell System only provides facilities for direct two-way conversation.

This has tremendous appeal, but only to the man who is in no particular hurry. The reason is simply that there are only a few frequencies available for this common-carrier mobile radio telephone service. The number of parties required to share each frequency is sometimes enormous. Experience indicates that where 80 or more have shared a line, it is rarely possible to get immediate service. The average user, after getting a call through, makes no effort whatever to be brief; rather, he exchanges pleasantries with the other party, and wastes much of the air time. This tendency toward prolonged conversation, in addition to the time consumed in reaching the operator and having her contact the land line, keeps the available frequencies crowded. Fifteen-minute waits are not at all unusual. Many users have discontinued the service because they found themselves home or at their destination before a mobile call could be completed.

The telephone answering service, on the other hand, handles messages through an operator who is trained in brevity and who has absolute control of the air time. If a customer wants a doctor in an emergency, he is not interested in exchanging pleasantries. He wants only to have his call conveyed to the doctor in the shortest possible time. He wants to know when the doctor will arrive and he may need very brief instructions on what to do while waiting. The same is true where trucks are dispatched for pickups or deliveries, or calls for servicemen are handled. The essential information can be capsulized and re-transmitted by the telephone answering service. The very impersonal aspect of this relaying discourages redundancy. Also, a telephone answering organization can offer highly competitive rates because of the controlled air time.

The integration of mobile radio service with the regular telephone answering service presents an operating problem which has been solved by the equipment to be described. The economic success of adding radio communication is dependent entirely upon the utilization of existing facilities, particularly in the initial period of operation. All such systems begin with a central radio station and contracts for a few mobile units. It would be economic suicide to assign one operator to each of the three shifts, with nothing to do but respond to the calls of a few mobile units. Such operators have to be trained in the use of radio, in addition to secretarial skills. Obviously, the regular operators must be utilized, and this calls for a method of operation which will permit them to handle radio calls with almost the same habit patterns employed in telephone answering.

Switchboard Equipment:

The problem was presented to our development engineer, Mr. C. B. Ramsey. First, a study was made of the operating habits of switchboard personnel. The remote-control unit provided with the General Electric central-station equipment was then analyzed, and it was decided to use it as a basic unit upon which to build the control equipment.

Accordingly, a new case about 20% larger than the original was designed. The standard remote-control unit was installed in the case, Fig. 1, together with the additional equipment necessary. A key switch marked LOCAL and SWITCHBOARD was added. Its purpose is to switch

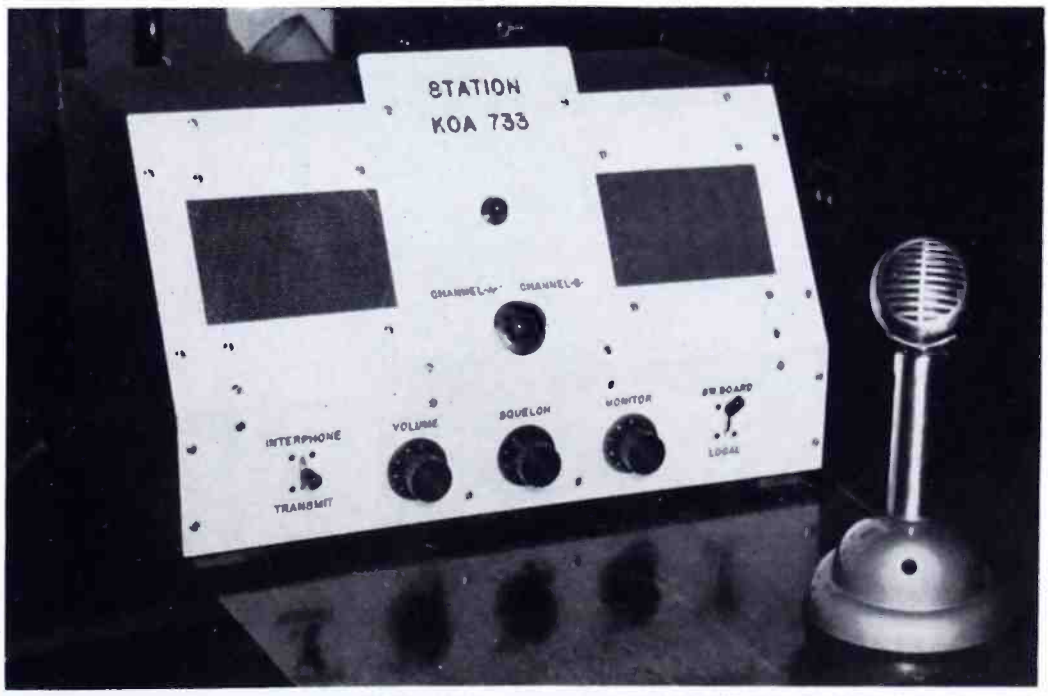

FIG. 1. MODIFIED GE REMOTE-CONTROL UNIT, USED AS SUPERVISORY MASTER-CONTROL EQUIPMENT

*Manager, Holert Electronic, Inc., 2300 W. Spokane St., Seattle 6, Washington.

control between this supervisory equipment and the switchboard operator's unit. With the switch in the local position, operation is exactly the same as with the original GE remote-control unit, with the exception that channel A or B lighting is utilized to indicate transmitter standby condition. The red light at the center of the panel glows when the transmitter is keyed. When the key is in the switchboard position, however, the volume control, squelch control, and microphone key are disconnected, and the monitor speaker control is switched in automatically. This provides control of the speaker volume for both incoming and outgoing signals. All other necessary circuits are transferred to the switchboard operating unit.

At the switchboard position, shown in Fig. 2, a telephone-type drop relay is controlled by a circuit utilizing a 6AL5 rectifier and a GL645 thyratron relay tube. Upon receipt of an incoming call, part of the signal is rectified and applied to the thyratron. After a pre-set delay period, the relay drops, turning on an orange light and, if the operator chooses, ringing a buzzer also. The buzzer can be switched out at the operator's discretion.

When the operator goes on duty, she plugs her dual phone jack into the radio unit as shown in Fig. 2. The switch marked TELEPHONE-RADIO, when left in the TELEPHONE position, bypasses calls through the unit to the switchboard. The operator handles all switchboard calls as though the radio unit were not there. When the relay drops, indicating an incoming call, she plugs her patch cord into the drop relay jack at the top of the unit. The orange light and the buzzer are turned off automatically, and a white light to the left of the relay jack is turned on, indicating that she has answered the call. This is done so that similar units between every two operators, with identical lights, will indicate to the other operators that the call has been answered.

When the operator's patch cord is plugged into the drop relay jack, the relay is restored to its original closed condition. The operator then pulls the RADIO-TELEPHONE key forward to the RADIO position, and is thus connected to the radio circuit. The transmitter key is then operative. When the call is completed, the operator's patch cord is returned to its normal position, ready for another call. On this unit are squelch and volume controls also. These controls have no affect upon the setting of the controls at the standard remote position, when the supervisor wishes to take over.

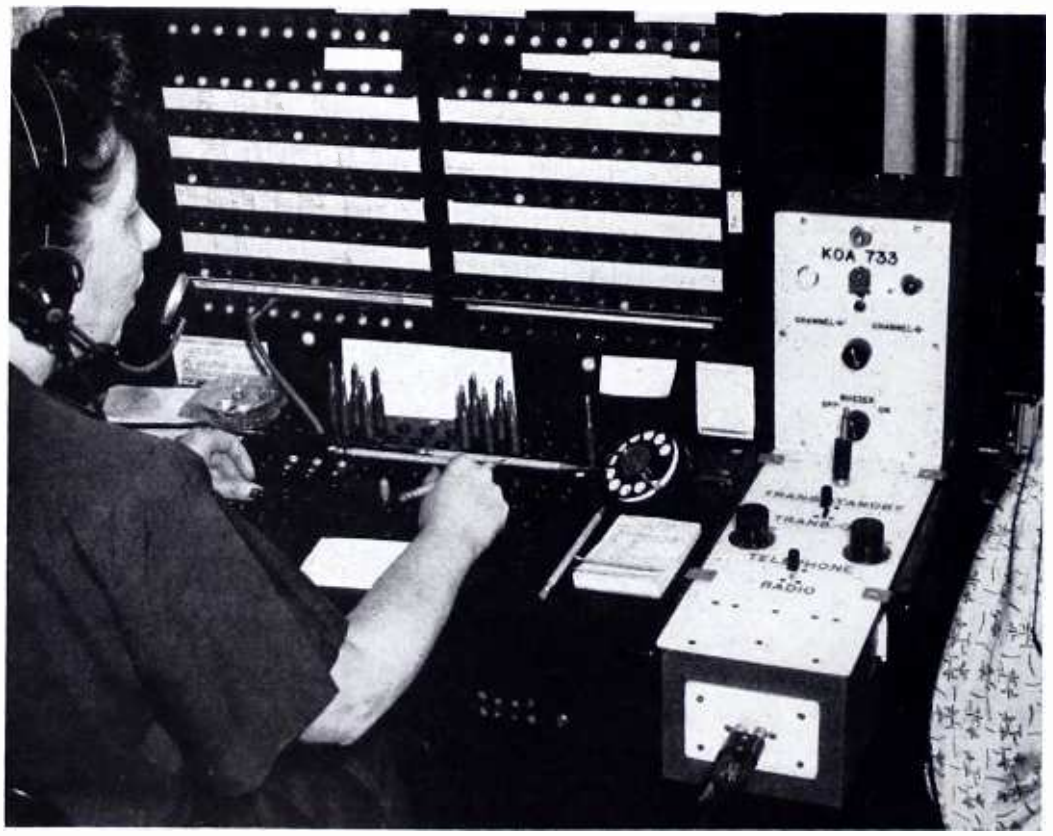

FIG. 2. OPERATOR'S-CONTROL UNIT INSTALLED AT TELEPHONE SWITCHBOARD. NORMALLY, EQUIPMENT IS BYPASSED TO BOARD. OPERATOR CAN SWITCH IN UNIT TO INITIATE OR ANSWER MOBILE CALLS

The delay period was provided to prevent operation of the relay by spurious responses or momentary inaction of the squelch circuit. A three-second call trips the relay at maximum call-back range. Subscribers are instructed to call in with the sentence, "KOA733, this is mobile unit . . ." Thus, the relay trips, the light goes on, and the operator plugs in her patch cord in time to catch the mobile unit's identifying number.

Capacitive coupling between audio lines makes it possible for the land-line caller to hear the mobile unit's answer, although his call is not permitted to modulate the transmitter. Thus, a worried mother can call for a doctor through the operator, hear her question relayed to him, and then listen to his answer and instructions, while the answering service maintains rigid discipline and control of air time.

Each operation is displayed at the supervisory remote-control position by lights under appropriate wording on the panel.

All relays and indicator lights are operated by heavily-filtered DC to prevent hum. The main switchboard unit has its own power supply, which can furnish power to five other auxiliary units. Eventually, it is planned to provide a unit between every two operators. Each unit will have two dual jacks, so that two operators can plug into one unit, and each will have her own TELEPHONE-RADIO key. In this way, incoming calls will be displayed to all operators. Any girl free at that moment will take the call. When she plugs her patch cord into the drop relay jack, all other operators will be notified by the flashing white light on each unit that the call is being handled.

The system as shown was custom-engineered for the Seattle Business Exchange, a telephone answering service. Some consideration has been given to production of the units for sale to other services with similar needs but, at this writing, insufficient information is available to determine the degree to which such a unit can be standardized. Logging companies, oil companies, and others having their own telephone systems have indicated interest, but variations in switchboard equipment and requirements make custom building almost mandatory for these users. Further study will be devoted to this problem.

BLIND PROGRAM QUALITY MONITORS

BROADCAST stations of many European countries employ full-time program monitors, whose only task is to listen critically to the radiated programs. Experienced monitors can detect the slightest deviation from standard audio quality. This gives a continuous check on all the studio equipment, the modulator, and the transmitter, and is of practical value in reducing outage time as well as maintaining a high quality standard. However, the work is exhausting and difficult to undertake for long, uninterrupted periods. This article, reprinted from the *Documentation and Information Bulletin* of the European Broadcasting Union, describes the improved results obtained by employing blind persons as monitors.

The Nord West Deutscher Rundfunk, as part of its technical supervisory arrangements, has a department whose

(Continued on page 33)

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New FCC Applications

This list includes applications for mobile, point-to-point, control, and relay communication facilities filed with the FCC during December, 1951.

AERONAUTICAL & FIXED

Aeronautical Radio Inc Washington D C Newark N J
1b 130.10 T

AERONAUTICAL NAVIGATION

Northern Consolidated Airlines Inc Box 1439 Anchorage Alaska

AERONAUTICAL MOBILE UTILITY

Pocatello, City of Idaho Phillips Field 3b 31.05 Ra
Cornell Aeronautical Lab Inc Box 235 Buffalo N Y
3m 121.90 Ta
Kaiser-Frazer Corp Willow Run Mich 1 m 121.90 X

AIRLINES

Northern Cons Airlines Inc Anchorage Alaska
1b 122.80 X
Aircraft Service Co Box 829 Boise Idaho 1b
122.90 Xa
Natrona Aircraft Service Box 193 Casper Wyo
1b 122.80 Xa
Cruse Aviation San Benito Tex 1b 122.80 X
Sky Service Inc Linden N J 1b 122.80 T
El Monte Airport El Monte Calif 1b 122.80 B
Broden, Edwin S Easton Pa 1b 122.80 X
Elkhart Flying Serv Inc Elkhart Ind 1b 122.80 X
Stone Wells Flying Serv Jacksonville Fla 1b 122.80 X
Faroldc, Geo J Key West Fla 1b 122.80 X
Rayburn, Samuel E Jr Waynesville Mo 1b 122.80 X
Gibbons, Geo C Box 668 Miami Fla Opalocka Fla
1b 122.80 X
Greenwich Air Serv Bridgeton N J 1b 122.80 X

CIVIL AIR PATROL

Civil Air Patrol Nevada Wing Reno Nevada
1b 2.374, 4.585, 5.500, 148.14 Xa
Civil Air Patrol Tenn Wing Union City Tenn
1b 2.374, 4.585 G
Civil Air Patrol Nati Capital Wing Falls Church Va
1b 2.374, 4.585 X
Civil Air Patrol Hdqtrs Grp 2 Florida Wing Jacksonville Fla 1b 2.374, 4.325, 4.585 G
Civil Air Patrol Nevada Wing Winnemucca Sqdn
Winnemucca Nevada 4b 2.374, 4.585, 5.500,
148.14 GX, 10m 2.374, 4.585, 5.500, 148.14 TX

POLICE

Clay County Sheriff Green Cave Sprgs Fla
1b 154.95; 10m 154.95 M
Rush County Sheriff La Crosse Kans
1b 39.58; 10m 39.58 R
Anaheim, City of, Calif Fire Dept 1b 46.06 M
Solano County Sheriff Vacaville Calif 1b 155.49 M
Alpena City of, Mich Sheriffs Dept
1m 42.58, 42.74 M

This listing, planned as a regular monthly feature, is made possible by the cooperation of the Federal Communications Commission. Each listing shows the name and address of the applicant. If the transmitter is to be located in a different city, the name of the city appears on the second, indented line. The number and type of facilities are shown, with the respective frequencies and the make of equipment for which applications have been filed. These may, of course, be changed before licenses are issued. Explanation of the code letters used in this listing appears below.

WEEKLY REPORTS

For the benefit of those who want to receive this data in advance, RADIO COMMUNICATION can furnish weekly reports. Requests for information on this service, and questions concerning these listings should be addressed to the Registry Editor.

CODE LETTERS

The following letters indicate the type of facilities for which applications have been filed. Unless indicated otherwise, FM operation is to be employed:

a AM operation	p Portable unit
b Base station	q Control station
m Mobile unit	r Repeater or relay

Make of equipment is indicated by one of these letters:

A Hallicrafters	L Link
B Belmont-Raytheon	M Motorola
C Comco	N Gen. Railway Signal
D Doolittle	O Farnsworth
E W. Coast Electronics	P Philco
F Federal Tel. & Radio	R RCA
G General Electric	S Railway R. & S.
H Harvey	T Bendix
J Comm. Equipment	W Westinghouse
K Kaar	X Miscellaneous

Graham County Sheriff Hill City Kans
1b 39.58; 12m 39.58 M
Wayne County Sheriff Croydon Iowa
1b 37.10; 5m 37.10 M
Pound, Town of, Wise Va 5m 39.50
Jim Hogg County Sheriff Hebbronville Tex
1b 37.20, 37.18 M
Benton County Sheriff Bentonville Ark
1b 37.10; 6m 37.10 M
Hughes, City of, Ark 5m 37.10 M
Brown County Sheriff Hiawatha Kans
1b 39.58; 8m 39.58 M
Govt of P R Box 3826 San Juan P R Insular Police
1b 2.490 Ra
Eunice, City of, N Mex 3m 39.90 M
N Dakota State of, Bismarck N D 1b 42.26, 42.38 M
Fallurrias, City of, Tex Bx 102 2p 37.26; 2m 37.26 M
Osborne County Sheriff Osborne Kans
1b 39.58; 14m 39.58 M
Wakeney, City of, Kans 1b 39.58; 6m 39.58 M
Plandome, Village of, N Y 2b 155.61; 6m 155.61 M
N Augusta Town Council S C
1b 155.55; 15m 155.55 G
Kansas State of, Topeka Kans Norton Kans
1b 44.98 M
Lemoore, City of, Calif 1b 155.49; 5m 155.49 M
Agana Police Dept, Agana Guam
1b 37.20; 12m 37.20 M
Tomah, City of, Wis 1b 39.34; m 39.42 M
New Bern Sheriff's Office New Bern N C
1b 39.10; 5m 39.10 M
State of Calif, Sacramento Calif Los Angeles Calif
1b 42.34 G
Garden City, Town of, Ala 1b 155.01; 5m 155.01 M
Whitefish Bay, Village of, Wis
1b 155.01; 2p 155.37; 2m 155.37
Roanoke, City of, Va 1b 155.01; 10m 155.01 G
Prestonburg, City of, Ky 1b 39.50 M
New Richmond, City of, Wis 1m 39.34, 39.42 M
Columbus, City of, Ga Police Dept
1b 159.09; 85m 159.09 M
Abbeville, City of, S C 1b 155.19; 10m 155.19 M
Calhoun Falls S C 1b 155.19 M
Dye West S C 1b 155.19 M
Minn, State of, 1279 Univ Av St Paul Minn Dept
Hwy Patrol 3rb 42.82; 3p 42.82 M
O'Fallon Fire Dept Ill 1b 154.19; 10m 154.19 M
Wakefield, Town of, Mass 1b 46.06; 12m 46.06 L
Clayton, City of, Mo
1b 155.67, 155.37 G, 14m 155.67 D
Sauk Centre, City of, Minn 1b 156.75; 5m 156.75 X
Alger City Sheriff Munising Mich 1m 42.75, 42.58 M
Waldwick, Boro of, N J 4m 37.10, 158.73 LM
Avalon, Boro of, N J 1b 156.21; 10m 156.21 R

(Continued on page 31)

NEW APPLICATIONS

(Continued from page 30)

FIRE

Oreland Fire Co No 1 Oreland Pa
1b 154.13; 25m 154.13 P
Owosso, City of, Mich 2b 154.19; 10m 154.19 M
Pleasantview Fire Protective Dist nr La Grange Ill
1b 154.25; 5m 154.25 M

FORESTRY

N Carolina, State of, Raleigh N C 1b 31.34, 31.46 L
Westport, Town of, Mass 1b 31.34; 6m 31.34 G
Georgia Forestry Comm Waycross Ga 8b 159.39 M
Kittery, Town of, Me 1b 45.14; 1m 45.14 L
Cleveland, City of, Ohio 1b 37.18 G
Maine Forestry Dept Augusta Me 1b 31.62 M
Alabama, State of, Montgomery Ala Dept of Conservation Nr Ada 1b 159.45 M
N H Forestry & Rec Dept Concord N H
West Boylston, Town of, Mass Forest Fire Warden
12m 31.34 M

HIGHWAY MAINTENANCE

West Va, State of, Buckhannon W Va Hwy & Constr
Gypsy W Va 1b 37.98 R
Calif, State of, Sacramento Calif Mt Lowe Calif
1b 47.02, 47.10 R; 1rs 72.10 R
San Luis Obispo Calif 1q 75.78 R
Paso Robles Calif 1q 75.78 R
Indio Calif 1b 47.02 R
Cambria Calif 1b 47.02, 47.10 R
El Centro Calif 1b 75.78 R
Boulder Park Calif 1b 47.02, 47.10 R

SPECIAL EMERGENCY

Jackson, D & E Vtny Hosp Twin Falls Idaho
1b 47.50; 2m 47.50 M
Provincetown, Town of, Mass 6m 31.34 G
Moore, Donald E, Decorah Ia 5m 47.50 M
Miller, W T & Farmer, HT, Box 436 Richmond Va
Heinrico Va 1b 47.50; 5m 47.50 M
Philadelphia, City of, Pa 3b 47.46, 47.54, 47.62 R
Cole, Elbert C, Kiowa Colo 1b 47.54; 1m 47.54 M
Flexible Pipe Cleaning Co Los Nietos Cal 6p 35.02 M
West, Dr Jas R 820 Seaberry Av Milford Del
1b 47.46; 1m 47.46 M
Grant, Dr W R 3165 Tenn St Cartersville Ga
1b 47.46; 1m 47.46 M
Moore & Lindsay, Drs Belvidere Ill 1b 47.58 M
Hoffert E J 1002 Franklin Av Fremont Ohio
1b 47.54; 2m 47.54 M
Henley, Dr Claud A Fairview Terr Jacksonville Ill
1b 47.54; 1m 47.54 M
Wells, Dr Robt J 605 Mitchell Benton Ill
1b 47.54; 3m 47.54 M
Brennan & Lackey, Drs 361 6th St Chino Calif 1b
47.66; 2m 47.66 M
Michigan, State of, Lansing Mich
1b 47.66; 20m 47.66 M
Ager, Robt J O'Niel Nev 1b 37.90 M
Dapper, Dr Robt R Manning Ia
1b 159.51; 3m 159.51 G

POWER UTILITY

Ark Pr & Lt Co Pine Bluff Ark Smackover Ark
1b 37.70 L
Sunny Slope Water Co Pasadena Calif
1b 48.06; 8m 48.06 M
Miss Gas Co Meridian Miss Lownes Cty 1b 48.06 M
Amerida Petroleum Corp Tulsa Okla Lea N Mex
1b 33.18 G
Standard Oil & Gas Co Chicago Ill Corpus Christi
Tex 1b 153.23 R
Owensboro-Ashland Cty Owensboro Ky Webster Ky
1b 49.06; 10m 49.06 M
Central Maine Pwr Co Augusta Me Skowhegan Me
1 lb 47.98; m 47.98 M
Pacific G & E Co San Francisco Calif Corcoran Calif
1b 153.71 L
Fresno Calif 2b 153.71 L
Dinuba Calif 1b 153.71 L
Niobrara Elec Mem Assn Hay Springs Neb 1b 47.78;
8m 47.78 G
Central Ariz Lt & Pr Co Phoenix Ariz
1r 956.75; 1q 956.75; 958.25 R
Mingus Mtn Ariz 1rs 1.985 R
Shaw Butte Ariz 1qr 1.945; 1lr 958.25, 1.985 R
Abbeville, City of, S C Dept of Water & Light
1b 47.70 M
Raft River EC Inc Malta Idaho
1q 74.50; 1b 48.06; 15m 48.06 G
Morton Pr & Lt Co Morton Texas 1b 37.66; 6m 37.66
Anaheim, City of, Calif Dept of Pr & Wtr 1b 47.94;
6m 47.94 M
Durham, City of, N C Dept of Wtr
1b 47.94; 6m 47.94 M
Flat River Pump 1b 47.78 L
Coos-Curry EC Inc Box 456 Coquille Ore Gold Beach
Ore 1b 36.72 F
N Cent Miss EPA Olive Branch Miss 1b 48.30 R
Cumberland Vly EC Mercersburg Pa
1b 37.58, 72.75; 20m 48.54 R
New Mac EC Inc Neosho Mo 1b 158.13; 1m
158.13 M
Ohio Pr Co 606 2nd St SE Canton Ohio Dennison
Ohio 1b 37.70 L

S Cent Ark ECC Arkadelphia Ark
1b 47.90; 12m 47.90 M
Cook EC Chicago Ill 1b 134.85 X
Kans Pr & Lt 808 Kans Av Topeka Kans Hiawatha
Kans 1b 37.62 G

PIPELINES

Mfgrs Lt & Heat Co Pittsburgh Pa E of Bethlehem Pa
2b 456.15 L
Freemansburg Pa 1q 457.85 L
Mid-Valley Pipeline Co Longview Tex
1b 158.43, 153.05 M
Phillips Petroleum Co Bartlesville Okla 1m 158.43 M
Bowes City Texas 1b 158.31; 1m 158.31 M
Phillips Pipeline Co Bartlesville Okla
1b 158.31; 1r 75.46; 1q 72.90; 1m 158.31 M
Placid Oil Co Cotton Valley La 1b 49.14 G
Sohio Petroleum Co Lake Charles La 1b 33.30 M
Nance Exploration Co Houston Tex 2m 1.652 X
Westhoma Oil Co Hooker Okla
1b 30.70; 25m 30.70 M
Amer Liberty Oil Co Highland Pk Vlg Dallas Tex
Matagorda Island Tex 1b 33.34 G
Rockport Tex 1b 33.34; 4tb 33.34; 10m 33.34 G
Humble Oil & Ref Co Box 2180 Houston Tex Stanton Tex 1b 48.86 L
Service Pipeline Co Box 1979 Tulsa 2 Okla Stamford
Tex 1b 49.14 R
Haskell Tex 1b 49.14 R
Rochester Tex 1b 49.14 R

FOREST PRODUCTS

Southern Package Corp Hazlehurst Miss
1b 49.34; 15m 49.34 K
Amer Forest Prods Corp Lakeview Ore
2b 49.46; 15m 49.46 G
Warner Mt Logging Co Lakeview Ore
1b 153.29; 10m 153.29 M
J I Morgan Inc New Meadows Idaho
1b 49.83; 10m 49.83 L

SPECIAL INDUSTRIAL

Edgerton, Germeshausen & Grier, Inc 160 Brookline
Av Boston Mass 26tb 152.87; 32m 152.87 M
Black Rock Mining Corp Bishop Calif 1b 39 G
White Mtn Calif 1r 72.76; 1q 72.76 G
Cobb Canning Co Inc Cobb Wis
1b 152.93; 5m 152.93 M
W H Shields Constr Co Eugene Ore
1b 43.02; 1m 43.02 X

(Continued on page 32)

NEW APPLICATIONS

(Continued from page 31)

Dayton Builders Concrete Co Dayton Ohio
1b 152.87; 1m 152.87 R
Taylor Bros Inc Evansville Ind 1m 43.06 M
Jas E Wright Jr Box 188 Indio Calif 1m 49.86 G
Claremont Constr Co Los Alamos N Mex
1b 49.86; 10m 49.86 M
San Angelo Tex 1b 49.98 G
Kermit Tex 1b 49.98 G
Hobbs N Mex 1b 49.98 G
McCamey Tex 1b 49.98 G
Monahans Tex 1b 49.98 G
Sundown Tex 1b 49.98 G
Post Tex 1b 49.98 G
Diefenderfer & Bro Reading Pa 1b 49.90; m 49.90 M
Green Thumb Ldscp & Nsry Atlanta Ga
1b 30.58; 5m 30.58 M
Hastings Potato Grs Assn Hastings Fla
1b 43.06; 15m 43.06 C
Reynolds Tobacco Co Winston-Salem N C Forsyth N C 1b 152.87; 15m 152.87 M
Heidrich & Sons Orlando Fla 1b 154.57; 6m 154.57 G
Continental Supply Co Dallas Tex Midland Tex
1b 49.98, 1r 72.54, 75.42 G
Odessa Tex 1b 49.98 1r 72.54, 75.42G
Lamesa Tex 1b 49.98, 1r 72.54, 75.42 G
Central Paving Co Box 42 Dallas Ore 1b 154.49 F
Independence Ore 1b 154.49; 4m 154.49 F
A S Wikstrom Inc Box 217 Skaneateles N Y
1tb 49.98; 10m 49.98 M
Triangle Certified Concrete Inc Inyokern Calif
1b 43.14; 10m 43.14 M
Oil City Welding Wks Railroad Av Beaumont Tex Lake Charles La 1b 43.02; 10m 43.02 M
Reyes & DeLeon Packing Co Box 287 Guadalupe Calif 1b 43.02; 5m 43.02 M
Cons Vultee Aircraft Corp San Diego Cal 6p 46.37 X
Jack Lane & Ken Onyon Burlingame Cal 1b 157.17 X
Allis Chalmers Mfg Springfield Ill
1b 154.49; 1m 154.49 M
Ole Hanson & Sons Inc Pleasantville N J 1b 30.62 G
Construction Serv Co Box 311 Bound Brook N J Bridgeton Twp N J 1b 49.86; 12m 49.86 M
Union Ice Co 354 Pine St San Francisco Calif Watsonville Jct Calif 2b 154.57; 6m 154.57 L
Knoxville Sangrave Material Co Inc Knoxville Tenn
1b 49.90; 16m 49.90 R
Halliburton Oil Well Cementing Co Duncan Okla Eunice N Mex 1b 49.74 G

LOW-POWER INDUSTRIAL

Westinghouse Radio Sta Inc Washington D C
4p 42.98 M
Douglas Aircraft Co Inc Santa Monica Calif 2p 154 D
Manitowoc Shipbuilding Co Manitowoc Wis
30p 154.57 M
Cincinnati & Suburban Bell Tel Co Cincinnati 2 Ohio
12p 154.47 M
N J Bell Telephone Co 540 Broad Newark N J
20p 42.98 M
Borton Corp Providence R I 1p 154.57 X

RELAY PRESS

Globe Newspaper Co Inc Boston 7 Mass Roxbury Mass 1b 173.22; 10p 173.22; 20m 173.22 M

MOTION PICTURE

Nichols, Francis D Bayonne N J 1b 49.70; 4m 49.70 M

COASTAL & FIXED

Admirality Alaska Gold Mining Funter Bay Alaska
6b 5.652, 5.622, 2.474, 2.512, 3.190, 2.450 Xa

RAILROADS

Chicago Great Western RR Co 309 W Jackson Blvd Chicago Ill
Clarion Iowa 1b 159.57, 160.17 X

TAXICABS

Fox Hills Taxi Inc Stapleton SI NY
1b 152.45; 9m 157.71 M
Diamond Cab Co Harlingen Tex
1b 152.45; 10m 157.71 B
Cent Cab & Trans Co Butte Mont
1b 152.45; 10m 157.71 M
Cleghorn Taxi Co Fitchburg Mass
1b 152.33; 6m 157.59 M
Morrisville Taxi Service Morrisville Pa
1b 152.33; 25m 157.59 B
Arctic Cab Co Anchorage Alaska
1b 152.27; 20m 157.53 M
Schneider, Francis W 111 Wash St Oconto Wis
1b 157.53; 1m 152.27 M
Airwave Taxi Service Williamston N C
1b 152.45; 10m 157.71 M
Veterans Cab 317 Cherokee St Levenworth Kans
1b 152.27; 15m 157.53 M
Brews Taxi Inc Niagara Falls N Y
1b 152.45; 40m 157.71 M
United Cab Service Champaign Ill
1b 157.39; 15m 157.65 M
Veterans Cab Co Purcell Okla
1b 152.27; 1m 157.53 B

(Concluded on page 33)

NEW APPLICATIONS

(Continued from page 32)

OK Cab Co Macon Ga 1b 152.33; 30m 157.59 L
Ace Cab Co Inc Arbutus Md
1b 152.27; 10m 157.53 LBM
1000 Cab Co Williston ND
1b 152.27; 10m 157.53 B
Mackeys Taxi Newton N J 1b 152.33; 1m 157.90 M
Veterans Cab Pontiac Ill 1b 152.45; 6m 157.71 M
Rocket Cab Co Encorse Mich 1b 152.39; 1m 157.65 M
Robin Hood Cab New Orleans La
1b 452.05 L
"285 Taxi" Warren Ark 1b 157.30; 10m 157.53 M
City Cab & Storage Co Columbus Ohio
1b 152.45; 25m 157.71 GX
Hurleys Cab Paris Ky 1m 152.45 M
Tras Safety Cab Co Virginia Minn
1b 157.53; 5m 152.27 M
City Cab Co Jacksonville Ala
1b 152.33; 5m 157.59 M
Bus Station Cab Co Piedmont Ala
1b 157.65; 10m 152.39 M
City Taxi Co Kearney Nebr 1b 157.65; 10m 157.65 M
Sammy's Cabs Iron Mountain Mich Dickinson Mich
1b 152.27; 5m 157.53 R
Center & Springs Sts Co Eureka Sprgs Ark
1b 152.77; 27m 157.53 M
Shepards Taxi Service Franklin N H
1b 152.39; 1m 157.65 T
Earles Taxi Dunellen N J 1b 152.27; 1m 157.53 M
Century Cab Hollywood Fla 1b 152.39; 15m 157.65 L
Suburban Cab Co Harrisburg Pa
1b 152.33; 10m 157.59 L
Snyder's Cab Fremont Ohio
1b 152.39; 6m 157.65 M
Rizzo, John L Massapequa N Y 1b 152.45 L
Black & Yellow Cab Inc Riverdale Md
1b 152.45; 35m 157.71 GLM
Hennessey Taxi Serv Elizabeth N J
1b 152.27; 10m 157.53 L
Independent Cab Galesburg Ill
1b 152.33; 6m 157.59 M
Capitol Cabs Providence R I 1b 152.45; 6m 157.71 M
Joliet Checker Cab Joliet Ill
1b 152.45; 10m 157.71 M
ABC Taxi Laredo Tex 1b 152.27; 15m 157.53 M
Toms Taxi Del Rio Tex 1b 152.27; 15m 157.53 M
City & Safety Cab Co Toccoa Ga
1b 152.33; 12m 157.59 M
Friendly Cab Co Lebanon Tenn
1b 152.45; 10m 157.71 R
Yellow Cab Delano Calif 1b 152.45; 10m 157.71 M

AUTO EMERGENCY

Cornwall, E M 602 Lee Av Manassas Va
1b 47.58; 10m 47.58 M
The Automobile Club of Philadelphia 235 23rd St Philadelphia 3 Pa 1b 453.85; 25m 453.85 L
Mac's All Car Serv Lansing Mich
1b 35.70; 5m 35.70 M
G & W Garage Lawndale Calif 1b 35.70; 3m 35.70 M
Daugherty's Super Service Flushing N Y
1b 35.70; 6m 35.70 M
Carolina Motor Club Charlotte N C
1b 35.70; 10m 35.70 M

BLIND MONITORS

(Continued from page 28)

task it is to monitor critically the radiated programmes. This programme supervision locates and identifies any technical faults in the modulation chain between microphone and transmitter, as well as in the transmitter itself. Over and above its own work, this department makes everyone concerned with the programmes at the studio centres more painstaking. On account of its valuable observations, which make it possible to attain the highest degree of reliability in operation, the department has come to play an important part in the activities of the NWDR, and an ever increasing interest in it is being shown by the other broadcasting organizations in the Western Zone of Germany as well as by foreign broadcasting authorities.

When this department came into being in 1948, the monitoring was done by

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BLIND MONITORS

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engineers, as it was thought that only technically qualified personnel could do this task justice. It was, however, soon apparent that long hours of monitoring are extremely tiring and that, in the case of the less interesting transmissions, concentration soon fell off. In this way, momentary faults were often missed. In order to keep up the receptiveness of the monitors, their working hours were decreased, and among the additional staff which had to be engaged for this reason was a blind person. A comparison of faults registered soon showed that the blind operator was capable of a much higher degree of sustained concentration than were his seeing colleagues.

Since then the seeing monitors have been gradually replaced by blind personnel — particularly by war-blind. In this way was developed the technical programme supervisory department as it is today, where at present 12 blind persons are employed. Thus, the department has become socially one of the most important within the NWDR. The selection of the blind is made, in collaboration with the social welfare authorities, by means of a suitability test.

The monitoring rooms of the technical programme supervisory department have been constructed with broadcast studio acoustics. In sound-proof cubicles, the blind sit in front of loudspeaker units which have a wide frequency range. Telephones connected with the broadcasting center and the transmitting station are placed conveniently on the table, as is also a blind-typewriter for registering faults. A switching panel makes it possible to compare the programme leaving the studio center with the same programme as received. The apparatus is maintained by a supervisory engineer who can, by glancing through the large windows in the sound-proofed doors, make sure of the correct functioning of the installation. He assists and advises the blind in all technical questions.

In examining the reasons why the blind are so especially well suited for this newly-created occupation of broadcast monitor, it is relevant to hear a word from the monitor himself. Herr Errich Bollmann says about his job: "I am of the opinion that monitoring in broadcasting is suitable work for a blind person, since he himself is particularly well-equipped for it. For myself, the most important things are that I am able to work independently and without any outside help, and perhaps even more that my blindness is of no importance in this work. This means much and doubtlessly

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BLIND MONITORS

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increases my — and my colleagues — liking for the job. Since in this job hearing is the most important thing, and since this has necessarily come to play a big role in my life, I feel myself more reliable in the execution of my work. Although it cannot be said that a blind person has better hearing than one who can see, it must be agreed that the hearing of the former is better-trained and sharper and, as a result of practice, a blind person is able to assimulate acoustic impressions more rapidly. An additional advantage in our job is that we are able to work undisturbed, since we have no visual distraction.

"Naturally, there are difficulties in our job. Although a materially safeguarded existence in the well-equipped rooms of the transmission supervisory department gives us an inner tranquillity for carrying out our task well, it is very strenuous to do so for more than six hours. The constant sitting still in front of the loudspeaker is most certainly physical work, which can become a strain. Taken all round, I think I can say that although strenuous, the work can well be done by blind persons, both from mental and physical considerations, and over considerable periods."

Another blind monitor, Herr Jurgen Collasius, says in this connection: "Of the five senses, the eye and the ear are the most used. Of these two, the eye is perferred because it transmits impressions more quickly and accurately. A seeing person uses the eye even when the ear could replace it. Who among the sighted, for example, would think during the daytime of judging the speed of a passing car by the sound impression rather than the visual impression received, although he receives them both equally? In this case he permits himself so to speak, the luxury of neglecting the sound. On the other hand, a non-seeing person is forced to make full use of his ear, as he must try to replace the lack of one sense by the others. Therefore, one difference between the seeing and the non-seeing lies in the fact that the latter make complete use of every acoustical possibility, whereas the former do so only partially.

"A blind person, therefore, must have his ear receptive in every situation and at all times, as it forms his most important link with the outside world. He must differentiate quickly between the many sounds heard, and recognize their origins. This constant receptiveness, as well as analysis and recognition, requires the highest degree of concentration. This

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BLIND MONITORS

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can be attained only through practice. A blind person must always try to increase this faculty in order to offset as much as possible the lack of sight. A seeing person is not obliged to do this, therefore he does not worry particularly about the practice and development of this faculty. On the contrary, he even finds the eye a hindrance, as its impressions always come into the foreground and distract him.

"Hearing thus trained and practiced, and the consequent facility of concentration, are the main requirements in the monitoring service. The constant use of both faculties in everyday life enables the sightless to give more detailed attention over long periods of monitoring. Excessive loudness and the intrusion of extraneous noises are bad for monitoring, and have a dulling effect since they are prejudicial to delicate impressions. The cubicles of the department are such that it would be possible to monitor for years without any deterioration of the work.

"In every type of work, he who does it must find a certain satisfaction. This grows out of the meaning and usefulness of the work for the worker himself and for the community. The individual identifies himself with the work he produces and establishes his social effectiveness according to its worth. Monitoring can be satisfying in this respect only if the monitor is made aware of the results of his work. Monitoring must not become purely routine work, and the observations must not serve only as statistics to be filed. The monitors' experience must be made full use of, and they should be invited to express opinions. In no case must the technical programme supervision appear as a kind of radio police; this would have an unpleasant effect on collaboration with other departments. Monitoring gives the sightless the feeling of being a useful and complete member of the organization. The effect of this feeling forms the basis of his approach to life.

"In conclusion, it can be said that, whereas in general the lack of sight reduces the output of work, in the monitoring service it increases it."

Herr Gerhard Ziervogel, who was blinded in the war, says in a few sentences: "After working for nearly two years I still do my work with the same freshness and readiness. Because I am sightless, I have no distraction through external influences during my period of work, so that I can devote a greater degree of concentration to the broadcasts. By my new occupation I have become a full member of the working community."

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BLIND MONITORS

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These observations by blind operators who have been doing this work for three years state the most essential facts of this new occupation for the blind.

Each department must, through the results of its work, justify its place in the organization. This is not very easy in the case of a supervisory department. The administration and programme staff had first to find the right approach to, and gain confidence in the ability of the monitors to do the work.

Carefully-kept statistics record, by means of graphs, the faults in the modulation chain to the transmitter and in the transmitter itself, and synopses of faults in programmes showed after a short while a tendency to decrease. In this way, a far-reaching stabilization in the operation of the modulation chain and the correct development of the service is being achieved. Thus, the technical programme supervisory department with its blind operators fulfills its task.

BEAM INTENSIFICATION

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the oscillograph[1]. The resultant increase in the intensity of the trace makes writing speeds up to 9,100 inches per microsecond easily visible. These high writing speeds are useful in studying rapidly-varying electrical surges, such as are caused by lightning discharges, and in learning more about the insulation breakdown the surges produce.

Insulation breakdown caused by lightning discharge often results in power outages and failure of electrical equipment. Thus, for development of insulation designs, as well as for routine tests on high-voltage components, most manufacturers of high-voltage equipment now employ surge generators to produce in the laboratory electrical surges having the same voltage and current magnitudes as those occurring on transmission lines as a result of natural lightning. During a thunderstorm, an electrical system may be subjected to surges rising to a million volts and a hundred thousand amperes for less than one microsecond.

For measurement of artificially-produced rapid changes in current or voltage, special high-voltage cathode-ray oscillographs are used, in which a cold-cathode discharge tube is the source of the electron beam. Part of the beam passes through a small hole in the center of the anode of the discharge tube into the main chamber of the oscillograph. Here the electrons pass through a beam

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[1]For further details, see "A Fifty-Fold Momentary Beam Intensification for a High-Voltage Cold-Cathode Oscillograph," by John H. Park, *J. Research NBS 47, 87,* (1951) RP 2231.

BEAM INTENSIFICATION

(Continued from page 37)

trap, focusing coils, and deflecting and sweep plates, finally striking a photographic film or fluorescent screen.

A pulse of increasing voltage applied to the sweep plates moves the electron beam horizontally across the film, providing a time axis. The voltage pulse to be studied, after being reduced in magnitude by a suitable divider, is applied to the deflection plates to deflect the beam at right angles to the time axis. This deflection, in combination with the sweep, leaves a trace on the film which is a plot of voltage against time for a particular surge. A corresponding plot of current against time can be obtained by using a shunt rather than the voltage divider.

In order to obtain a readable photographic record of the steeply-rising front of the surge, it is necessary to utilize a high-intensity electron beam for recording. Several methods have been used to increase the beam intensity, and thus the writing speed, of this type of oscillograph. For example, some research workers have used prefocusing coils around the discharge tube, and others have reshaped the electrodes or employed different gases in the discharge tube. None of these methods, however, has been entirely successful, and until now the normal writing speed of the instrument has been only about 200 ins. per microsecond. As part of a general program of basic instrumentation sponsored by the Office of Naval Research, the Office of Air Research, and the Atomic Energy Commission, the Bureau of Standards undertook to develop a more effective technique for intensifying the beam. A method has been found which increases the beam intensity over the steady-state value by as much as 50 times.

With this method, a momentary pulse having a peak value of about 2,000 volts is superimposed on the steady DC voltage, about 50 kv, applied normally to the discharge tube. The pulse must be of very short duration, down to about 5 microseconds, and it must produce a sudden increase in the voltage across the tube in ½ microsecond or less. This sudden change in voltage, even though it be only 2% of the steady voltage across the discharge tube, disrupts equilibrium conditions in the tube momentarily, and produces a greatly-intensified electron beam for about 2 microseconds.

The increased beam current lasts for such a short time that it does not increase appreciably the heat dissipation of the discharge tube, nor cause burning

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BEAM INTENSIFICATION

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at the cathode. However, careful synchronization with the start of the sweep is required.

Application Methods:

Two principal means for applying the pulse have been developed and are being used. In one method, a current pulse is passed through a resistor inserted between the anode of the discharge tube and the ground-return lead. This causes a similar voltage pulse across the tube, which results in a sharp increase in the intensity of the electron beam. Alternatively, the cathode is connected to one terminal of a small high-voltage capacitor, and the other terminal is connected to ground through a resistor. Because of the steady direct-current voltage on the cathode, this capacitor is charged to 50 kv. When a current pulse is passed through the resistor, the cathode voltage is changed immediately by the IR drop through the resistor. This produces a very rapid change in the intensity of the beam.

A method of synchronizing the start of the beam intensification with the start of the sweep has been devised by NBS and used successfully with sweep speeds up to 60 ins. per microsecond. These fast sweeps were used to obtain records of the voltage oscillations occurring when the deflecting plates were short-circuited after being charged to a high voltage. Although this procedure deflected the electron beam from the top to the bottom of the film record in about the shortest time possible, a readable trace was recorded on the film. This trace was found to correspond to a writing speed of 9,100 ins. per microsecond, or three-fourths the velocity of light.

It is probable that writing speeds greater than the velocity of light could be obtained with this technique, if the deflecting system of the oscillograph were designed with that objective in mind. Since the current in the discharge tube is maintained at a steady low value except for the very short time required to obtain the record, the problems of beam adjustment and cathode life are of minor importance. In addition to its application with the high-voltage oscillograph, the new method should prove to be a useful tool for research in atomic physics, or wherever an electron beam of momentary high density is required.

PATTERN FOR TV PROFIT

Watch next month for the details of "Pattern for TV Profit," a series for management and engineering executives, to start in the March issue.

PIPELINE RADIO

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gency maintenance for the equipment of both companies, and for special test work and installations. These repair facilities are based at the Company headquarters in Los Angeles.

Because of the steep grades and rough terrain on the approaches to the mountain top repeater stations, it has been necessary to obtain a 4-wheel drive station wagon for carrying supplies to these points on regular maintenance trips. This vehicle, shown in Fig. 12, is equipped with a 30-watt 2-way radio installation.

Fig. 13 is another view of the mobile field service truck, shown also on the front cover. The gasoline engine-driven generator is used to supply power for the test instruments when outside AC power is not available. The equipment on the truck includes a frequency monitor, a Motorola test set, a capacitor checker, a tube checker, a signal generator, multirange volt-ohmeter, vacuum-tube voltmeter, tool boxes and spare parts. This truck is also radio-equipped.

Figs. 14 and 15 show the completely-equipped and shielded maintenance room at the Los Angeles headquarters. Here, receivers can be tested without interference from electrical disturbance within the building, and transmitters can be operated without interference to others on the same channel. The room is surrounded entirely by two insulated layers of fine screening.

MAGNETIC AMPLIFIER

(Continued from page 14)

the slope of the loop from point 1 to point 3, Fig. 3B. That slope is not necessarily related to the permeability of the material. As a rule, however, materials of high permeability do have desirable characteristics in that region. Generally, the high-permeability permalloy type materials are used for applications requiring high sensitivity.

The shape of that very important section of the hysteresis loop is affected by many factors. Eddy currents or other sometimes unpredictable factors may cause bumps on the curve which destroy linearity of control or even cause amplifier instability. Normally, these troubles can be avoided by judicious selection of the core material and by heat treatment. For high-frequency work, cores of extremely thin materials are required. Such cores are now available commercially in thicknesses down to only one-eighth of one mil, or .000125 in.

Factors of Response:

The magnetic amplifier described cannot

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MAGNETIC AMPLIFIER

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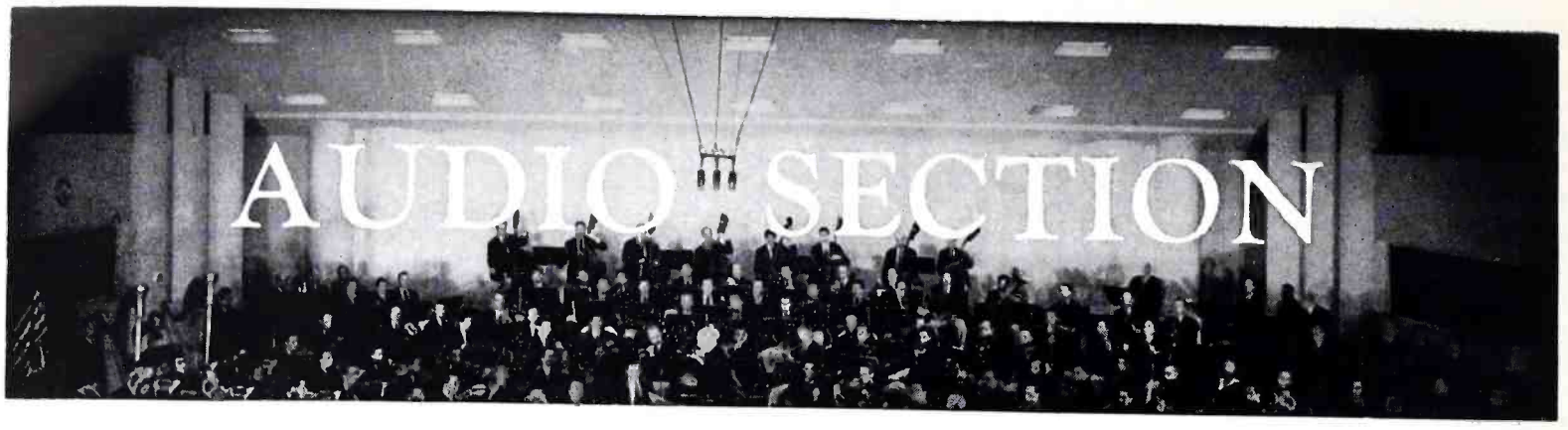
give instantaneous response to step changes in voltage applied to the control circuit. Some delay is caused by inductive lag in the control circuit, and by damping effected by other coupled circuits. Then, too, there is an inherent response lag, because the flux level must be set during the half-cycle prior to the conductive half-cycle. The delay associated with the L/R figure of the control circuit can be improved by adding series resistance. That is a waste of power, however. The best approach is to use as much positive feedback as is possible, and to minimize the number of turns required in the control windings.

For a typical simple magnetic amplifier, a delay of about 200 cycles of the carrier frequency can be expected for a 63% response with a power gain of 1 million. That figure can be improved significantly by the use of rate circuits in feedback networks. Because of a logarithmic delay-gain relationship, it is advantageous to employ several low-gain stages, rather than a single high-gain stage. For example, a gain of 1 million can be achieved in two stages with a resulting over-all response of only a few cycles of the carrier frequency. Also, since this delay is an inverse function of the carrier frequency, it is advantageous to employ a higher carrier frequency. Ten cycles of a 60-cycle carrier consume over 150 milliseconds. With a 10-kc. carrier, they take up only 1 millisecond. These are approaches employed which make possible the application of magnetic amplifiers to high-performance servo and other regulatory systems.

Conclusion:

The magnetic amplifier is not, at the present time, useful for all amplifier and control problems. However, it has become extremely valuable in many applications, and it is being put to new uses every day.

Present categories of application include instrument amplifiers, servo amplifiers, motor speed controls, voltage regulators, lighting intensity controls, battery charging controls, mechanical rectifiers and contact converters, computers, memory or information-storage systems, and special-purpose audio and video amplifiers. The magnetic amplifier is especially valuable in military applications, where long life and reliability are required under operating conditions of tremendous shock and vibration. It is in this field that the device is now finding widest acceptance. It is difficult to predict to what extent it will be useful in communication systems, but work is already being done in that field.



DESIGN OF CROSSOVER NETWORKS

PART 1 — PURPOSE OF CROSSOVER NETWORKS — TYPICAL CIRCUITS — CHARTS OF COMPONENT VALUES — OPTIMUM CROSSOVER POINTS — *By* SOL WHITE*

UNDOUBTEDLY, the crossover network is responsible for more arguments and confusion among designers and users of high fidelity equipment than any other system component. While a great deal has been written on the subject, much of the available information consists of loosely formed opinions and conclusions which tend only to add to the confusion. This article is intended to provide practical, helpful data on the subject, with capsule appraisals of the various factors involved in the selection of optimum circuit constants, as well as design charts which have been simplified as much as possible. The material presented here is the result of extensive objective and subjective research by University engineers.

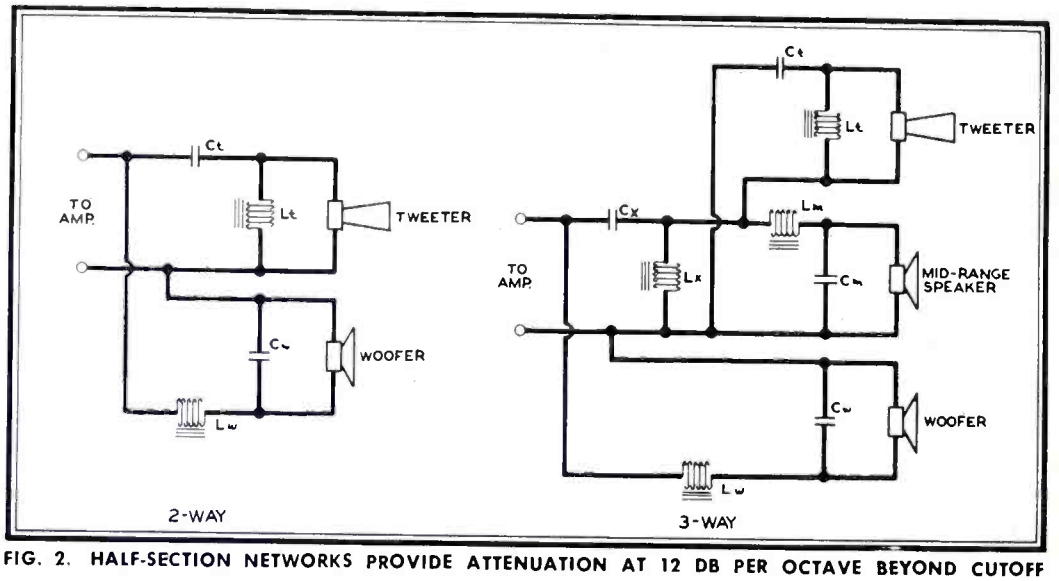


FIG. 2. HALF-SECTION NETWORKS PROVIDE ATTENUATION AT 12 DB PER OCTAVE BEYOND CUTOFF

Functions of Crossover Networks:

When two or more speakers are employed in a reproducing system, it is advantageous to feed to each speaker only those frequencies which it is designed to reproduce. Of course, speakers designed to handle various ranges could be simply connected in parallel, with no attempt made to limit the frequency range fed to each speaker. Such a practice may produce results acceptable to non-critical listeners, but the performance would be inferior by far to what can be obtained from the same speakers operated with a suitable dividing or crossover network. The advantages obtained by channelling the various frequency ranges to the proper speakers are summarized as follows:

1. Elimination of double sound-sources, with their attendent frequency cancellations. Such dead spots are caused by differences in path lengths between the listener's ear and two speakers which reproduce the same frequencies.

2. An increase of about 3 db in acoustic output, since high-frequency power is not dissipated as heat in the woofer voice coil, and low-frequency power is not wasted in the tweeter driver.

3. Prevention of damage to the tweeter diaphragm from excessive low-frequency power.

4. Greatly reduced intermodulation.

5. Prevention of cone breakup at high signal levels. Since the first breakup occurs at about 2 kc., cleaner high-level reproduction is obtained if frequencies in this region and above are diverted from a cone speaker to a tweeter.

6. An impression of spatial sound generation when the sources of lows and

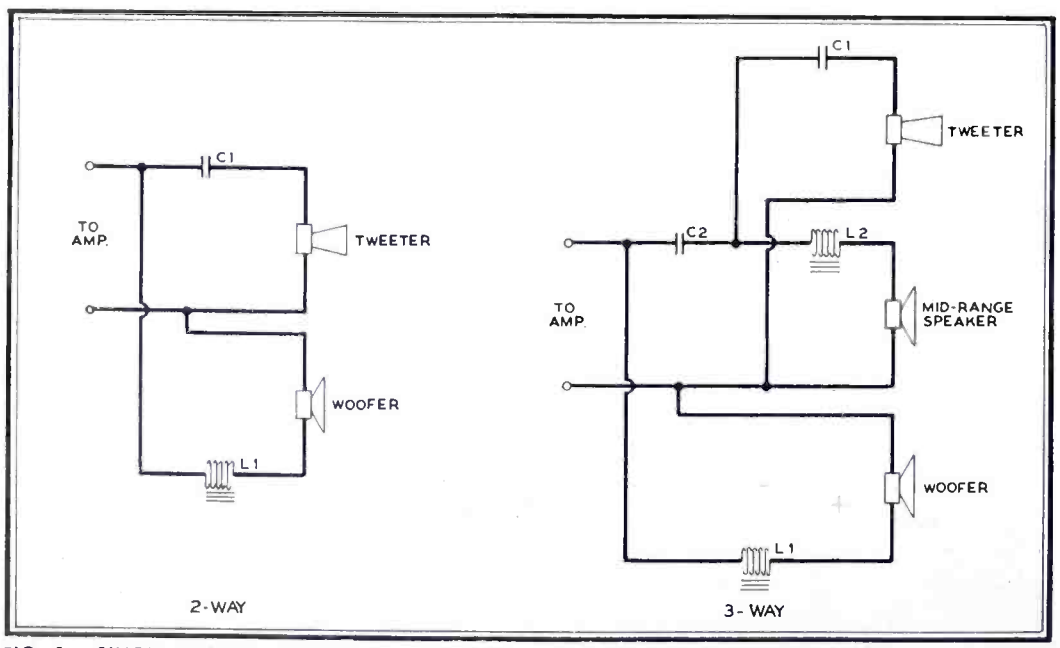


FIG. 1. SINGLE-ELEMENT QUARTER-SECTION PARALLEL NETWORKS FOR 2-WAY AND 3-WAY SYSTEMS

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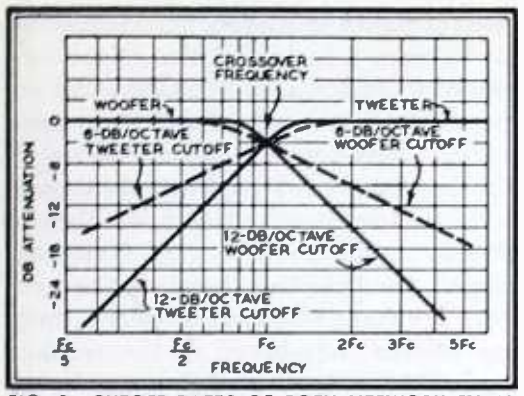

FIG. 3. CUTOFF RATES OF BOTH NETWORK TYPES

highs are separated physically. This is noticeable especially in 3-way systems. However, some listeners object to this separation, since it is not truly representative of conditions existing at the original source. For instance, a singer's voice is reproduced with the sibilants separated from the vowels. Also, the lower frequencies in a complex chord from a musical instrument are reproduced at one point, while the harmonics are generated at another point separated physically from the first. In spite of the departure from strict realism, there is generally a psychological reaction of pleasure to the spread of sound sources. However, this arrangement does not produce true stereophonic reproduction.

Crossover Network Circuits:

A crossover network for a coaxial or 2-way speaker system consists of low and high-pass filters, connected either in series or in parallel. The frequency at which the low-pass filter terminates transmission coincides with that at which the high-pass filter begins transmission. At this frequency, called the crossover frequency, equal power is supplied to each loudspeaker.

In the case of a 3-way speaker system, a band-pass filter, feeding a mid-range speaker, is added to fill in between the low and high-pass filters which are separated widely in their ranges of transmission. For instance, a low-pass filter may terminate at 600 cycles and the high-pass filter at 4,000 cycles. The range between, called the mid-frequency band, is covered by a band-pass filter. Thus, there are 2 crossover frequencies in a 3-way speaker system.

Two types of crossover network are in common use. One is the quarter-section single-element filter type, which provides a cutoff beyond the transmission band of 6 db per octave. Circuit diagrams for 2 and and 3-way systems are given in Fig. 1. The other type, utilizing half-section filters, has twice the number of filter elements and provides attenuation at 12 db per octave beyond the transmission cutoff frequency. The circuits of this type for 2 and 3-way systems appear in Fig. 2. Fig. 3 shows transmission and cutoff characteristics of both types. The cutoff rates given above are valid only for amplifiers with constant output voltage. When the networks are used with amplifiers having poor regulation, the attenuation rates are decreased.

These circuits are of parallel constant-resistance networks. The series configuration is not shown, in order to avoid confusion and because the series circuits have a disadvantage explained later.

Networks having cutoff slopes greater than 12 db per octave may have certain theoretical advantages. On the basis of listening tests, however, their complication and expense are not warranted, since perceptible distortion may be produced by them.

Single-Element Networks:

A chart for determining the values of L and C for the single filter-element network, Fig. 1, is given in Fig. 4. Selection is made on the basis that the reactance of C1 is equal to that of the tweeter voice-coil at its crossover frequency, and the reactance of L1 is equal to that of the woofer at its crossover frequency.

In the case of a 2-way system, these frequencies are the same. If both voice-coils are of the same impedance, then the input impedance of the network is equal to that of one speaker. But if the tweeter impedance is not the same as that of the woofer, then the input impedance is equal roughly to the average of the two voice coil impedances, and the network should be connected to the amplifier output tap closest to this mean value.

When a 3-way system is planned, the value of L1 is found for the woofer impedance at the low crossover frequency. Then, C1 and L2 are found for the tweeter and mid-range speaker impedances, respectively, at the high crossover frequency. Finally, C2 is found for an impedance halfway between that of the tweeter and the mid-range speaker, at the low crossover frequency. The input impedance of the network is then the mean between the woofer impedance and the value used for calculation of C2.

Fig. 4 can be used to find the values of L and C in the following way: First, find the diagonal lines corresponding to the desired crossover frequency and the voice-coil impedance concerned. Where these lines intersect on the chart, read the value of L corresponding to the height of the intersection, at the left side of the chart, or the value of C corresponding to the horizontal location of the intersection, at the bottom of the chart.

Two examples should make this procedure quite clear. Suppose that a 4-ohm

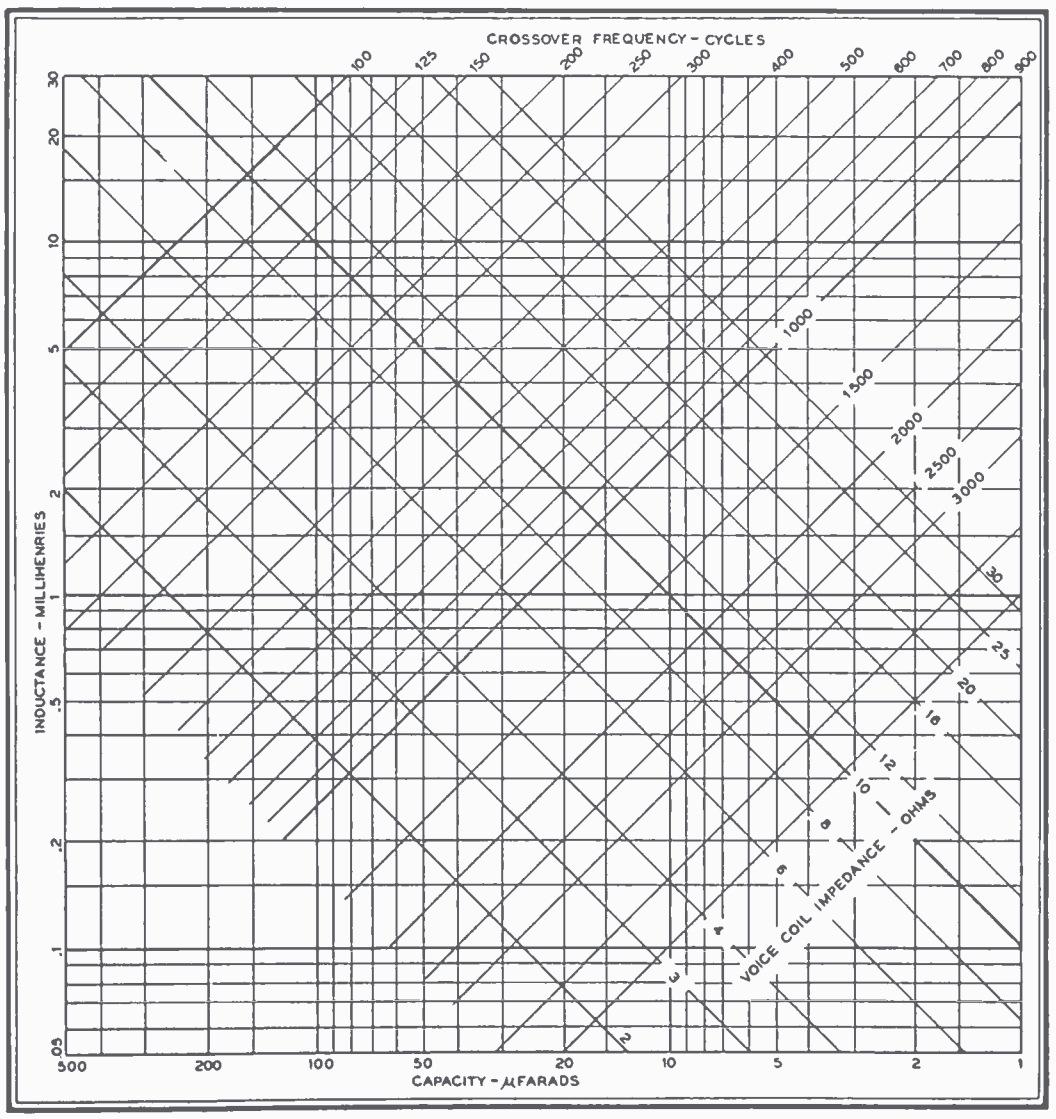

FIG. 4. CHART FOR DETERMINING COMPONENT VALUES OF QUARTER-SECTION CROSSOVER NETWORKS

SPOT NEWS NOTES

(Continued from page 9)

Latimer, who began his career with the Marconi Company in 1916, joining RCA when it was formed in 1919. Mr. Latimer has now been appointed vice president and chief technical consultant of RCA Communications.

Standard Ceramic Parts:

A 52-page catalog, detailing over 500 standard steatite parts, has been issued by Stupakoff Ceramic & Mfg. Company, Latrobe, Pa. Dimension drawings are given of coil forms, bushings, separators, standoff insulators, and similar items. A 9-page section on standards and testing is included.

Color-Code Chart:

A very elaborate wall chart is offered to engineers by the Centralab Division of Globe-Union, Inc., Milwaukee, Wisc. It shows the standard coding for transformers, battery cables, antenna and ground leads, telephone switchboard cable, RTMA and JAN mica, paper, and ceramic capacitors, resistors, speakers, and radio and TV chassis.

FM SET PROMOTION

FINAL plans for the pilot run of the FM receiver promotion campaign in North Carolina, jointly sponsored by RTMA and NARTB, were approved on December 27.

Promotional material prepared for this event includes 4-color window and counter displays, a set of 16 transcribed spot announcements, detailed plan books, and brochures for distributors and dealers. RTMA and NARTB will supply news releases to the local papers, and will carry out a mail campaign directed to officials of schools and civic organizations, county agents, and clergymen.

E. Z. Jones of WBBB, pioneer FM broadcaster in Burlington, N. C., and chairman of the FM promotion committee for his state, said that the North Carolina stations will carry 10 or more industry spots each day without charge, that free mention will be made of dealers who conduct FM demonstrations, that the stations will offer special FM program features, and will supply dealers and newspapers with advertising pieces and program logs. This was confirmed by Earl Gluck, WSOC Charlotte.

Similar test campaigns will be started in Wisconsin on February 4, and in Washington, D. C., on March 1. Additional information can be obtained from John H. Smith, Jr., FM director of the National Association of Radio and Television Broadcasters, 1771 N Street, N. W., Washington 6, D. C.

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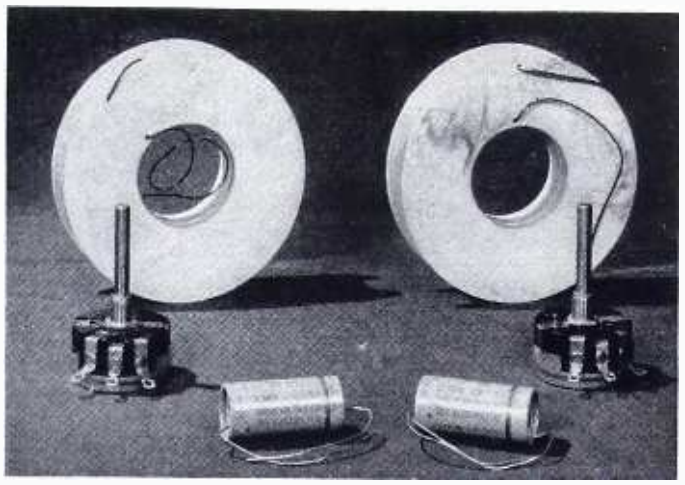

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RAPID ATTENUATION NETWORKS

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

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

SLOW ATTENUATION NETWORKS

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

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

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

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

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We now have the new design, **Dual Air-Coupler,** described in **Radio Communication** for October and in the Winter issue of **High-Fidelity,** in stock and ready for **immediate shipment.**

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Despite (or perhaps, because of) the author's 37 years of experience in this field, the text is written in an intense, positive manner that can be inspired only by tremendous enthusiasm and great authority. The reader profits therefrom.

"Foundations of Wireless," fifth edition, by M. G. Scroggie. Iliffe and Sons, London. 328 pages, price 12s 6d, postage 8d.

Serving only as an introduction to the fundamental concepts of electricity and radio, but as a very good one, Mr. Scroggie's book is lucidly and entertainingly written. Since no previous technical knowledge whatever is assumed of the reader, the book begins with the most elementary principles of electricity and radio, continues with the theory of tubes, transmitters, receivers, antennas, and power supplies, and ends with an introduction to transmission-line theory.

The fifth edition has been rewritten completely, with over 200 new illustrations. Of special value to the beginner is a section on symbols and graphs.

"Servicing TV in the Customer's Home," by Milton S. Kiver. Howard W. Sams and Company. 96 pages, liberally illustrated, $1.50.

This book should be of genuine value to television servicemen, since it is estimated that from 85 to 90% of TV service work can be done in the customer's home, and the margin of profit is greater than for shop repair work. Methods are described for diagnosing and rectifying typical troubles using only a VTVM, a capacitor test probe, and common sense. Four sections cover television receiver operation and layout, getting acquainted with strange receivers, judging set performance, and adjustment techniques without the use of instruments.

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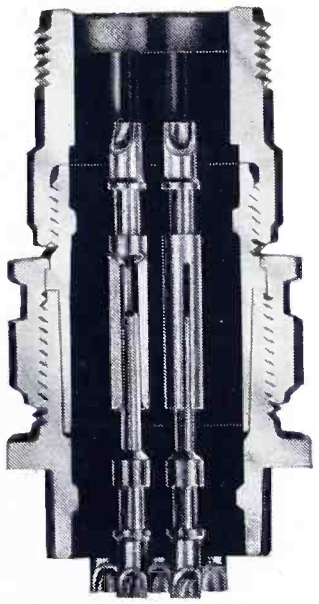

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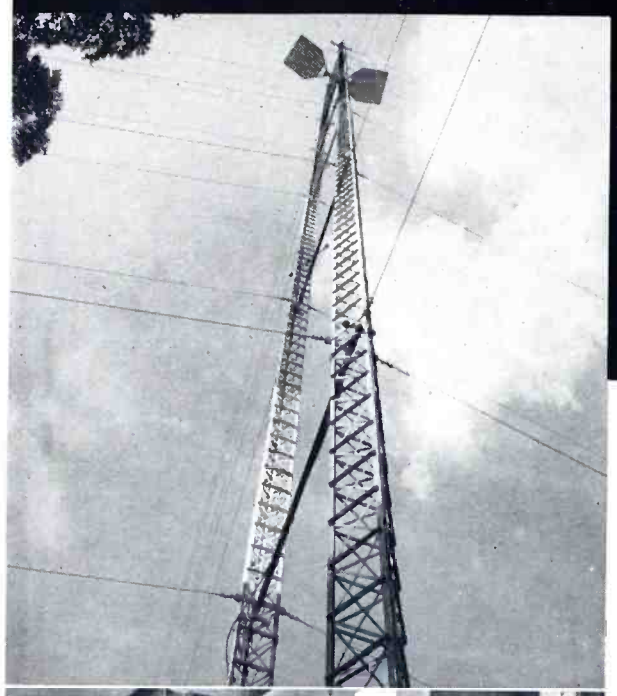

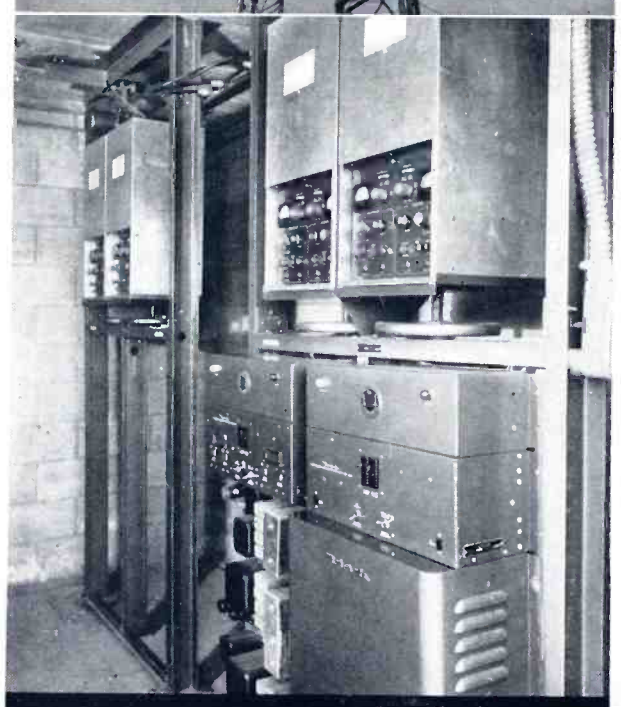

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