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FM-TV THE JOURNAL OF

RADIO COMMUNICATION

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D.C. AMPERES: 0-10, at 250 Millivolts
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gives **Customized Performance** for his location on every station!

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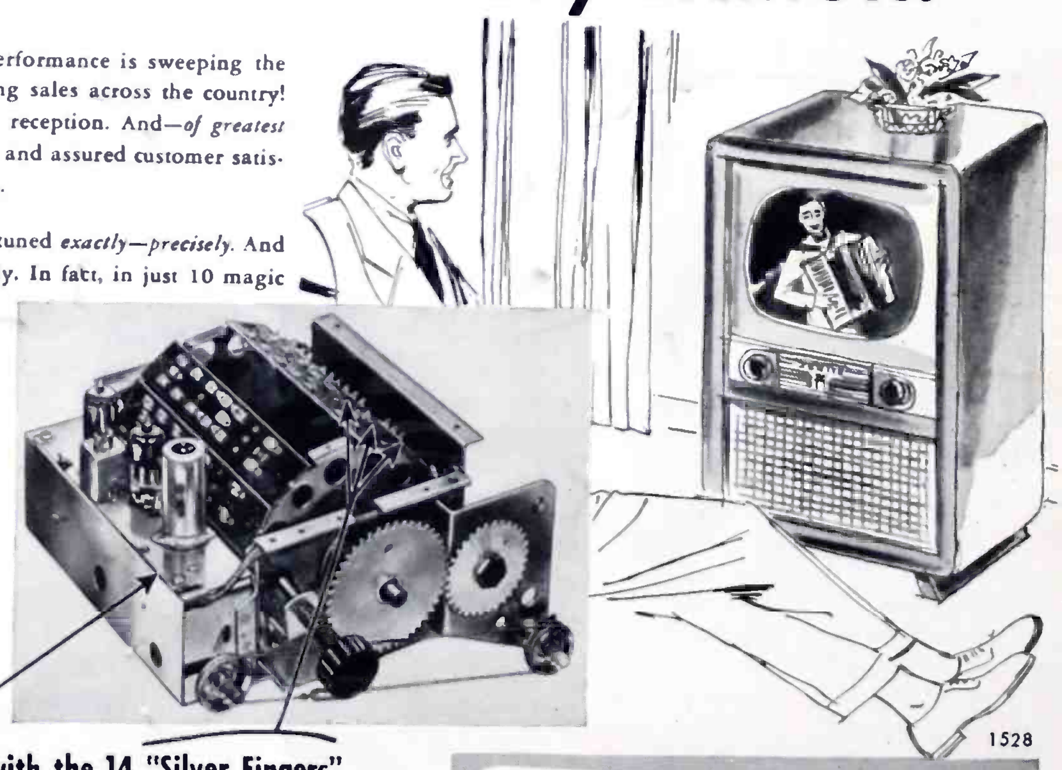
Yes—just 10 minutes! Customers want their sets tuned *exactly—precisely*. And you can do all that and more—quickly and easily. In fact, in just 10 magic minutes you'll tune the Fringe-Lock on your customer's Zenith to *his* distance from the station—and custom-compensate for *his* angle from the station.

Think of what Customized Performance means to a customer. Then better think of what it means to you in real profit-making potential.

All that for just 10 minutes installation time? RIGHT! It's Zenith Customized Performance—the Greatest Refinement in Television since Television began . . . and—**Only Zenith Has It!**



1528

The Miracle Zenith Turret Tuner with the 14 "Silver Fingers"

. . . a *Zenith Exclusive* on every 1952 model that really means something to television prospects. Thanks to a special "Bull's Eye Tuner Knob" built into Zenith's famous Turret Tuner—the tuner with the 14 "Silver Fingers"—every 1952 Zenith can be custom-tuned to the frequency of every individual station—for your customer's individual location.

And Customized Performance is permanent—yet it's simple! You can custom tune Zenith—any of your men can—with just a few minutes practice.

This profit-loaded feature ties in with Zenith's "Electronex" Tube, provision for UHF, Fringe Lock Circuit, and Dust-Proof Screen to give you the biggest selling combination in TV history.

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FM-TV RADIO COMMUNICATION

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

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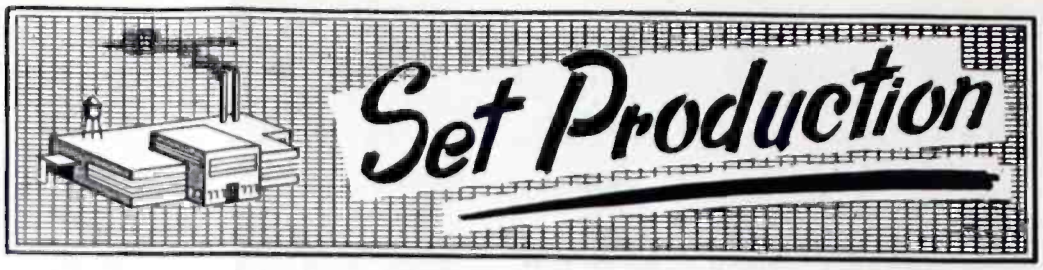
CPA AUDIT

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

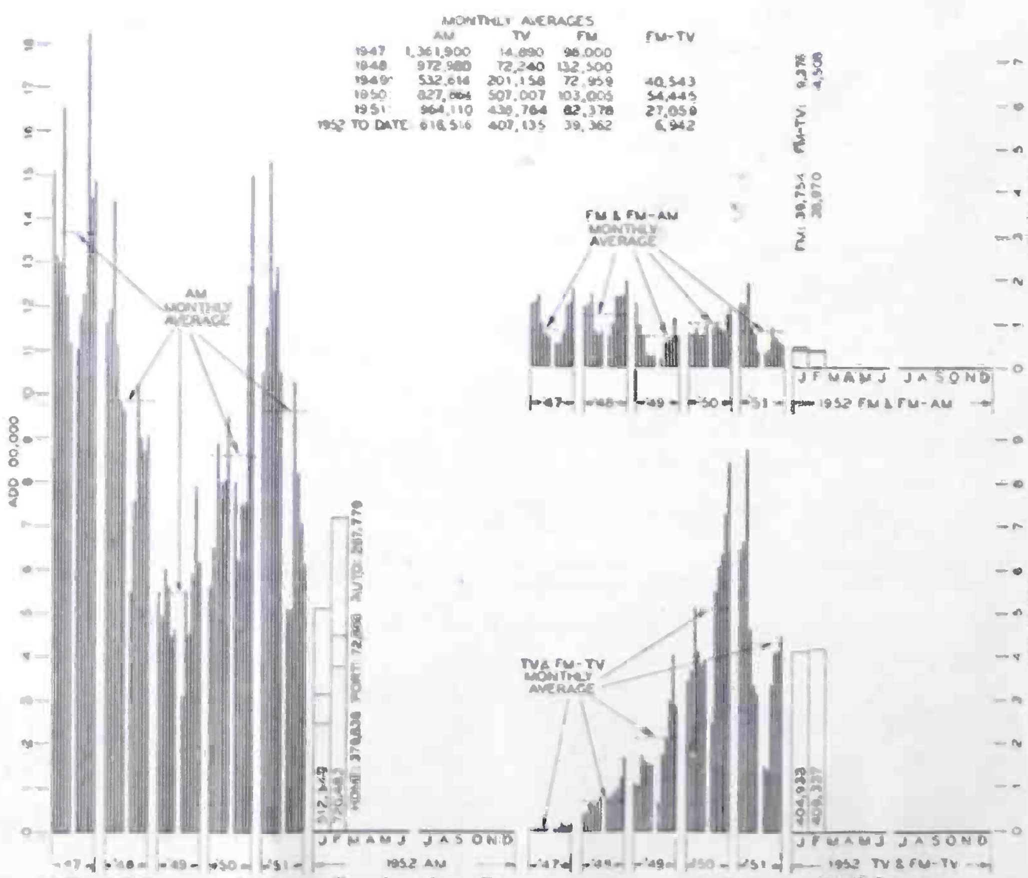


RTMA production figures show that TV sets inched up in February over January, while audio receivers went up 50%. TV prices hit a new low of $99.50 for 20-in. models, and the storm warnings were set for another period of overproduction. However, this situation should be relieved long before it develops to any serious proportions by the FCC's announcement that the TV freeze is finally over, and the expansion of television to the proportions of a nation-wide service is now under way. Dealers are complaining that some new designs are approaching marginal performance due to the fact that engineering effort is being directed toward price reduction rather than picture quality. The mechanical design is such that service work is made extremely difficult. In point of design and performance, some of the sets sold in chassis form are distinctly superior to factory-built cabinet models. Only a few are being made with FM broadcast circuits. Surprisingly, Admiral is combining AM broadcast tuning with TV.

The clock-radio idea, first offered as a point-of-sale gimmick, has taken hold in a big way. In February, 106,000 of these units were produced. That represents 25% of all home models. Auto radios accounted for more than 1/3 of the AM sets produced.

Most manufacturers are still entirely indifferent about FM. In fact, at the start of the NARTB-RTMA promotion on FM in Washington, the broadcasters found that no effort had been made by RTMA to do its part in making sets available or to line up the dealers. Only when president Harold Fellows wrote president Glen McDaniel to ask, in terms most diplomatic, that RTMA carry out its part of the program, did the latter rush into print with newspaper advertising headed "FM + AM = Complete Listening Pleasure. It is not clear that AM is necessary to complete listening pleasure in that area since, according to the advertisement, Washington has 4 FM-only stations, 3 FM-AM stations that operate only on FM at night, while programs of 6 networks are carried on FM-AM or FM only.

February FM set production of 38,970 was only 50% of the 1951 average. However, we understand that excellent new designs have been brought out by Crosley, Motorola, and Hallicrafters. These will undoubtedly swell the monthly totals. Eight companies are now producing FM chassis for custom installations, not included in RTMA figures.



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

AN IMPORTANT ANNOUNCEMENT

IMMEDIATELY after the end of the television freeze, RADIO COMMUNICATION concluded arrangements for the purchase of TeleVision Engineering.*

Thus, effective with the May issue, subscribers to each publication will receive copies of the combined magazine. Subsequently, we plan to publish these magazines separately. For the present, however, we believe that a single paper will serve our readers to best advantage. For advertisers, it adds 4,000 unduplicated ABC circulation at no increase in rates.

As we complete new plans under this arrangement, our editorial coverage will be expanded to include all aspects of television, from FCC allocations and standards to developments in transmitters, studio equipment, receivers, and components, as well as new techniques in design, installation, and operation.

We are prepared to pay generously for articles on TV subjects, according to the value of the material.

It is our purpose, in acquiring TV ENGINEERING, to take an active, constructive part in the expansion of television service to nation-wide proportions. To that end, comments and suggestions from our readers will be most welcome. You can be sure that such letters will receive thorough consideration at our editorial conferences.

* Rights to the titles "Radio Engineering" and "Communications" have also been acquired from Bryan Davis Publishing Company, Inc. by Radiocom, Inc.

Radio Communication
INCORPORATING
TeleVision Engineering

THIS MONTH'S COVER

The center of the recent tornado that did so much damage in Arkansas passed through Searcy, site of a microwave relay operated by the Texas-Illinois Natural Gas Pipline Company. Although one of the guy-wires on the tower was stretched 18 ins. when a house was blown on it, operation of the relay continued without interruption. A building near the tower simply disappeared. Power was supplied by an automatic engine-driven generator. It was not possible to get a photo of the antenna at Searcy, but another in the same system, of similar design, is shown on this month's cover.

SPOT NEWS NOTES

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

Television Thaw:

FCC Chairman Walker, addressing the broadcasters at the NARTB Convention at Hotel Hilton, Chicago, on April 2: "I wish I could say of our [TV allocations] decision that it will be a flawless masterpiece, the acme of perfection in . . . its several hundred pages. . . . Not all the parties in this proceeding will get everything they asked for. Instead, they will find that this document of ours represents the spirit of compromise. . . . Barring some last-minute snag, we are going to lift the freeze within the next two weeks. [that would be before April 16] . . . We will then probably allow three months for the filing of applications. That would bring us up to around the middle of July before we start processing. By that time we will probably have 1,000 or more applications on file. . . . Beside the work of examining and passing on uncontested applications, we will be swamped by hearing cases. We estimate that the applications will exceed the number of available assignments in virtually all of the larger cities, and many of the smaller cities. . . . It will apparently proceed at a snail's pace." Mr. Walker dwelt at length on the FCC's "hopelessly inadequate funds and staff." However, in view of the fact that lack of quantitative data and the complex nature of a national allocations plan has held up the thaw for nearly four years, television may benefit in the long run by the necessity for making haste slowly. More funds and a larger staff are no substitute for the missing element of technical experience.

Consulting Firm:

To handle consulting work and the design of pilot models independently of the manufacturing operations of the Radio Engineering Laboratories, Inc., the REL Company has been formed. Members of the new firm are Frank Gunther, James Day, C. R. Runyon, 3rd, and Joseph Behr. They will specialize in multiplex and microwave system engineering, and the design of special equipment for communication and control applications. Address is 36-40 37th Street, Long Island City 1, N. Y., and the telephone number Stillwell 6-2100.

Communication Equipment:

A new mobile radio communications department has been set up by Federal Telephone and Radio Corporation, with production facilities at Passaic, N. J. New designs have been engineered for vehicular and railroad services. J. J. McDevitt, Jr., is manager of the department, Ellis Jones is sales manager, and Glen Sellers the chief engineer.

Auxiliary AC Power:

Engine-driven generators, delivering 400 to 3,000 watts at 115 volts, 60 cycles, are described in a new bulletin from D. W. Onan & Sons, Inc., Minneapolis 14, Minn. They are portable types, with manual starting to be set up at any point where power failures occur. Other models are started automatically when commercial power is cut off. Recent blizzards and tornadoes have emphasized the value of auxiliary power for communication transmitters, receivers, and tower lights.

NARTB Convention:

Prevailing comment of those who attended the Chicago convention of the National Association of Radio and Tele-

(Continued on page 7)

SPOT NEWS NOTES

(Continued from page 6)

vision Broadcasters to those who didn't go: "You shoulda been there." With the engineering and management sessions running concurrently, the pace was fast, interest high, and the general spirit one of confidence. Neal McNaughten, ably assisted by Raymond Guy, Orrin Towner, Earl Johnson, James Ebel, and James McNary, assembled a most interesting 3-day program of papers and discussions on TV and audio subjects. Arthur Stringer assembled the largest group of equipment exhibits to be seen in the last five years. Broadcast-wise, manufacturers are coming to favor the NARTB convention over the IRE show at New York.

Missing Credit Line:

The paper by J. P. Schafer and L. E. Hunt entitled "Relationship of RF-IF to Baseband Amplitude Distortion in Microwave Repeater Systems," which appear in RADIO COMMUNICATION for February, 1952, was given at the 1951 National Electronics Conference. Our apologies for omitting this credit.

Edward L. Beaudry, Jr.:

Former president of Kay Electric is now president of Chase Resistors Company, manufacturing carbon film resistors under Western Electric patents. Plant is at 9 River Street, Morristown, N. J.

FM Broadcasting:

All during each succeeding year we are told that FM has died, and isn't it too bad. But each time NARTB holds its annual convention, the FM session is bigger and more enthusiastic. This year, most of the meeting was devoted to reports on the successful FM promotions in the Carolinas and at Washington, sponsored by NARTB and RTMA. Some 20 other areas have asked to be put on the campaign schedule. And this year the broadcasters actually talked about the greater coverage provided by FM as compared to AM!

New Magazine Offices:

Under the pressure of expanding activities at RADIO COMMUNICATION and HIGH-FIDELITY Magazines, we have outgrown what used to be quite adequate offices at the Savings Bank Building in Great Barrington. Our search for larger quarters finally led to our purchase of the Peter Adams property. This comprises a 15-room house on 14 acres of lawn, field, and woods.

The house is ideal for our purposes. It was built in 1890, in the days when rooms were large and ceilings high. The

(Continued on page 8)

SPOT NEWS NOTES

(Continued from page 7)

land runs up from the Monterey Road (State Highway No. 23 on the road maps) into forest-covered hills.

For the benefit of our friends who come up our way and have a chance to stop in for a visit: Route 7 is the main highway from New York City into the Berkshires and New England. As you drive north and enter Great Barrington, Route 7 is joined by Route 23. Just beyond the business section, Route 7 swings to the left going on to Tanglewood, site of the Berkshire Music Festival, and thence to Pittsfield. Route 23 runs straight east to Monterey and on toward Springfield and Boston. Our new home, which we shall call The Publishing House, is .8 mile from the point where the highways separate.

Soldering Flux:

Test samples of Lonco rosin flux are available without charge from London Chemical Company, 325 W. 32nd Street, Chicago 16. Intended to speed soldering operations 10 to 30% even on materials that have become oxidized in storage, this flux is described as non-corrosive and non-toxic, and as having withstood humidity, sulphur dioxide, and salt water spray tests for over 4 months without evidence of corrosion.

Battery Connectors:

Two bulletins on heavy-duty connectors, rated at 75 to 300 amperes, have been issued by Cannon Electric Company, Los Angeles 31. Also shown are switchboard and cord connectors with 1, 2, and 4 pins.

Pennsylvania Turnpike:

Although much has been written about the radio system that operates along the 320-mile Pennsylvania Turnpike, the details of the very clever and original engineering that makes it work have not been disclosed. This information will be presented, however, in the next issue of Radio Communication in an article by Douglas Lapp, who was in charge of the design and installation of the system, and Arden Hopple, chief communication engineer of the Turnpike Commission. Photographs taken exclusively for this article were made by Jean Schwartz.

Auxiliary Phone System:

A complete line of dial telephone instruments and automatic switching units, suitable for use in conjunction with multiplex point-to-point and radio relay systems, are illustrated in a bulletin from Automatic Electric Sales Corporation, 1033 W. Van Buren Street, Chicago 7.

(Concluded on page 9)

SPOT NEWS NOTES

(Continued from page 8)

Equipment illustrated ranges from installations of 10 telephones for 2 conversations at once to 200 telephones for any number of conversations at once.

Modulation Monitor:

The modulation monitor developed and manufactured by Doolittle Radio has been taken over by the electronics products division of James Knights Company, Sandwich, Ill., and is now being sold at the JK monitor. E. H. Aberdeen is director of sales for the new division. A detailed description of this instrument will be found in the "Mobile Radio Handbook."

Constant-Voltage Transformers:

Various capacities suitable for communication services are detailed in bulletin P-43 issued by Sola Electric Company, 4633 W. 16th Street, Chicago 50. Types range from small sizes with 3% regulation at 42 to 210 volt-amperes output for plate and filament supplies to those of 500 to 10,000 volt-amperes at 1% regulation for monitor receivers and communication transmitters.

Lines for Networks:

AT & T lines capable of carrying 15,000 cycles that were to be available after the war just haven't materialized, but the Company has been able to provide transcontinental relays for TV. Also, FM broadcasters report that rates quoted for 15,000-cycle lines are about one-half those at which 2.7-mc. service is available for carrying TV programs. And in some sections lines capable of handling 8,000 to 9,000 kc. are equipped with filters to cut the pass band to 5,000 cycles. It's all very puzzling.

MEETINGS and EVENTS

MAY 5-7, QUALITY ELECTRONICS CONFERENCE
Bureau of Standards, Washington, D. C.

MAY 8-10, RTCM SPRING MEETING
U. S. Merchant Marine Academy, Kings Point, Long Island, New York

MAY 12-14, AIRBORNE ELECTRONICS CONFERENCE
Hotel Biltmore, Dayton, Ohio

MAY 13, RADIO CLUB OF AMERICA
Engng. Societies Bldg., New York City

MAY 16-17, SOUTHWESTERN IRE CONFERENCE & SHOW
Rice Hotel, Houston, Texas

MAY 19-22, RADIO PARTS SHOW
Hotel Conrad Hilton, Chicago

MAY 23-24, AUDIO SHOW
Hotel Conrad Hilton, Chicago

JUNE 23-27, AIEE SUMMER GENERAL MEETING
Hotel Nicole, Minneapolis, Minn.

AUGUST 12-15, APCO CONFERENCE
Hotel Whitcomb, San Francisco, Calif.

AUGUST 27-29, WESTERN ELECTRONIC SHOW & CONVENTION
Municipal Auditorium, Long Beach, Calif.

OCTOBER 20-22, IRE-RTMA FALL MEETING
Syracuse, New York

Advancement in Emergency Communication

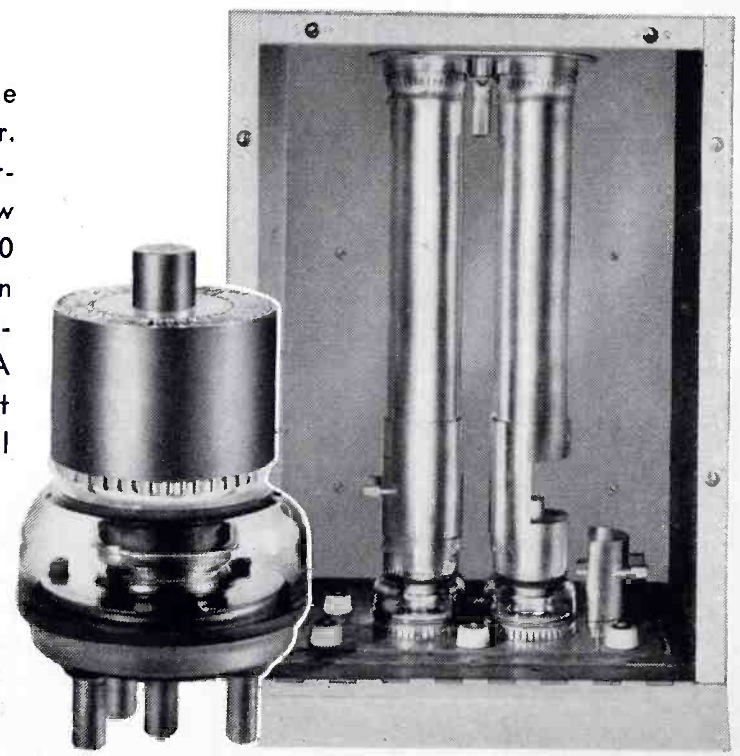
Eimac tubes fill key sockets In continuous service transmitters

REL type 757C transmitter

New and unique in civil emergency communication systems is the New York City Fire Department's five borough radio network planned to meet the threat of any emergency, including atomic attack. Transmitters designed by Radio Engineering Laboratories to give continuous operation are significant contributions to this electronic accomplishment.

Eimac's 2C39A triode is utilized in REL's type 757C point-to-point radio relay transmitter operating in continuous around the clock service at 900 mc. The 2C39A is used in two stages —as a tripler from 150 mc. to 450 mc. and as a doubler from 450 mc. to 900 mc. The 2C39A is a natural to serve in REL's 757C where it can perform as a frequency multiplier at ultra high frequencies with excellent operating efficiency. This compact, rugged, high-mu tube is designed for a variety of uses as a power amplifier, oscillator or frequency multiplier wherever dependability and durability are demanded.

Two Eimac 4X500A's give dependable performance in the REL type 715 emergency service transmitter. These external-anode tetrodes are in the power output stage of the final amplifier in each of the New York City Fire Department's eight main station 350 watt transmitters. Operating in the 150 mc. region the 4X500A's meet the challenge of 24-hour performance. Designed for application the 500 watt 4X500A has small size and low inductance leads which permit efficient operation at relatively large outputs well into VHF.



Power amplifier of REL's type 715

Write our application engineering department for the latest information and technical data about these and other Eimac tubes.

Follow the Leaders to Eimac Tubes

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313

BBC SCHEME for VHF BROADCASTING

SUMMARY OF THE INVESTIGATION LEADING TO THE ADOPTION OF FM AS A MEANS FOR IMPROVING AUDIO BROADCAST SERVICE IN ENGLAND*

THE purpose of this article is to outline briefly the technical reasons for the B.B.C. proposal to plan VHF broadcasting service on the basis of a chain of FM (frequency modulated) stations of various powers giving substantially complete national coverage with three programmes.

The use of very high frequencies in the band 88 to 100 mc. (about 3 metres wavelength) was envisaged before the war as a possible method of increasing the number of channels available for sound broadcasting. The number of medium-wave and long-wave channels available to the B.B.C. has become insufficient, and their quality inadequate, for the satisfactory national distribution of three programmes. Fading, increasing interference from foreign stations, and the necessity of synchronized working are severely limiting the range of existing stations, mainly as a consequence of the unsatisfactory operation of the Copenhagen Wavelength Plan in Europe.

Although the available medium waveband was slightly widened at the Atlantic City Conference by the inclusion of channels above 1,500 kc. (below 200 metres), such channels are not very useful because their range is small, and because many existing receivers are not designed to tune to them. In the future, the number of medium-wave channels available for British broadcasting is hardly likely to increase, and the situation may be expected to deteriorate further. It is therefore proposed to establish a broadcasting service within the VHF band allocated for sound broadcasting in the European Region.

Propagation conditions on these very high frequencies differ very considerably from those on the medium and low frequencies. The signal strength decreases rapidly with distance from the transmitter; and it is also more influenced by the contours of the terrain between transmitter and receiver, hills casting partial shadows similar to optical shadows. Fading may occur at times owing to changes in the weather and to the close proximity of aircraft, the extent of the fading depending on the distance from the transmitter and on the location of the receiving site. The service area of a VHF transmitter will therefore be to some extent patchy, owing to the existence of pockets of field strength lower than the average for the neighbourhood. It is thus not possible to give as precise an estimate for the range of a VHF transmitting station as for that of a medium-wave transmitter. It is possible to predict average ranges over terrains of known general contour, but listeners living in notably unfavourable positions within, for example, a first-class service area may get only a satisfactory second-class service; conversely, listeners living outside a first-class service area, but in favourable geographical positions, may still get a first-class service.

A VHF service suffers from some forms of electrical interference which do not much affect medium waves, and *vice versa*. Motor-car ignition systems, for instance, cause disturbances on VHF which may result in interference to the programme if the received field strength is weak and the motor car fairly near. On the other hand, most natural and man-made disturbances which cause interference on long and medium wavebands have little effect at VHF.

The receivers for these VHF transmissions may take the form of adaptors added to existing medium-wave sets, or special sets for the new frequency band. The listener will therefore have to pay for an adaptor for his receiver, or buy a new set, in order to take advantage of this new service. To make this additional outlay worthwhile to the listener, it is proposed to radiate the present three programmes in the VHF band, even in districts where adequate coverage on medium waves is available. It will thus be possible for the great majority of listeners ultimately to receive all three programmes with a straightforward VHF receiver. The sound quality provided by the new service will be normally much better than that of the existing medium-wave service, since the audio-frequency bandwidth will not have to be limited by the carrier frequency separation. In addition there will, in general, be much less background noise. The close frequency-spacing of transmitters operating in the medium wave-band has made it necessary to restrict the bandwidth of receivers, in order to avoid interference from adjacent channels which might otherwise prejudice programme quality. Moreover, excessive sharing with continental stations is liable to create various forms of background interference at night.

The propagation peculiarities, the possibility of interference from motor cars when the signal is weak, together with improved programme quality and low background noise are common to all VHF broadcasting systems. There is, however, a choice open in regard to the system of modulation to be used. Many new types of modulation have been proposed and tested during the past ten years, the main object being to minimise interference with the programme. Such improvement can be obtained only by taking certain technical precautions at the transmitting or receiving end, or both.

In a broadcasting system it is particularly important to keep the cost of the listener's receiver as low as possible. Bearing this in mind, only three systems merit consideration. The first is AM (amplitude modulation), the conventional system used in the medium and long wave-bands; the second is AML, *i.e.* amplitude modulation with a noise limiter incorporated in the receiver; the third is FM (frequency modulation). Pulse modulation systems have also been considered, but are not thought to offer sufficient advantages for broadcasting to merit further consideration.

Comparison of AM, AML, and FM:

The systems to be compared are therefor:

AM: conventional amplitude modulation.

AML: amplitude modulation with a noise limiter incorporated in a wideband receiver. The performance of this system depends on the receiver bandwidths; for the majority of the tests described in this article the bandwidth is the same as that of the FM receiver, namely ± 75 kc.

FM: frequency modulation, peak deviation ± 75 kc., pre-emphasis[1] time constant 50 microseconds.

In each of the three systems the quality of programme reproduction can be extremely high, being limited only by the audio-frequency stages of the receiver, including the loudspeaker. Programme quality, therefore, is not a point at issue, except possibly with AML.

The criterion by which the different systems of modulation can be judged and compared is the extent to which all forms of noise and interference are sup-

*This report was published in the B.B.C. Quarterly, Vol. VI, No. 3.

[1]Pre-emphasis is a method of getting relatively greater modulation at the higher audio-frequencies so as to offset the effect of noise, which in an FM system increases with frequency. The degree of pre-emphasis is expressed as the time constant of the electrical circuit giving the desired frequency characteristic.

pressed. There are two main types of noise — receiver hiss, and impulsive interference such as that caused by motor cars and some domestic appliances.

Taking AM as the basis for comparison, FM results in a considerable reduction of both hiss and impulsive interference. On the same basis, AML gives a reduction of impulsive interference, but not of hiss. The magnitude of these noise-level reductions and the conditions in which they apply are discussed later.

The advantage of FM over both AM and AML, in respect of noise suppression, can be used to obtain a larger service area, since a satisfactory service is possible at greater distances from the transmitter where the field strength is low. It may be mentioned in passing that it has also been suggested that this advantage can be exploited to permit a greater dynamic range of programme levels than is at present customary. The necessity of extending the service area is, however, paramount.

In order to realise the potential advantages of FM over the other systems of modulation, an efficient limiter must be incorporated in the receiver, for otherwise the advantage of FM will be lost in those parts of the service area where it is most needed, namely, where the field strength is low. Cheap types of receiver have been produced (for instance, in Germany) in which no limiter is incorporated, and the advantages of maximum coverage have therefore been lost. This may be justified, on the ground of cheapness, for those parts of the service area where the field strength is high, *i.e.* relatively close to the transmitter.

It is worthy of mention that, to achieve the full advantages of FM, careful (but not necessarily costly) receiver design is necessary. It is, however, necessary to distinguish between difficulties associated with the reception of VHF with any system of modulation, and those associated with a particular system of modulation. It is mainly on receiver design, handling difficulties, and cost, that the controversy over which system is superior has centred.

In the AML receiver, special noise suppression circuits are incorporated. Some of these, although performing their primary purpose efficiently, introduce attendant disadvantages. In some instances, efficient noise suppression is accompanied by perceptible audio-frequency distortion. These half-measures cannot be accepted for a new high-grade broadcasting service. However, the particular type of AML receiver used for the tests described in this article is the best available at the present time and gives very little perceptible deterioration of the sound quality.

A further word of explanation is necessary in connection with the use of pre-emphasis of the high-frequency components of the programme modulation, with corresponding de-emphasis in the receiver. Pre-emphasis has, in the past, been associated with FM, but it could be applied also to an AM system. Pre-emphasis is of particular advantage in FM because of the triangular noise spectrum[2] of this system. It is, however, necessary to reduce the general level of modulation somewhat in order to avoid overmodulation at the higher frequencies, so that the advantage obtained is less than might at first be expected. The advantage to be obtained by applying pre-emphasis to AM is less than for FM, and is in practice negligible. Unless otherwise stated, pre-emphasis and de-emphasis were used in the tests described with FM only.

Test on Noise Suppression:

Receiver Hiss: With 75-kc. deviation and 50 microseconds pre-emphasis and de-emphasis, provided that the input

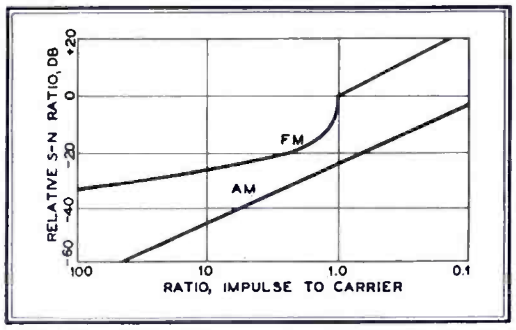


FIG. 1. RELATIVE PERFORMANCE OF FM AND AM SETS WITH REPEATED UNIFORM IMPULSE NOISE

level is sufficiently high to operate the limiter of an FM receiver, the level of receiver hiss with FM is 26 db lower than it is with AM or AML.

This is a result which can be justified theoretically, and it has also been checked by measurements. For the latter, the receiver was terminated in an ear simulating network of the performance specified by the International Telephone Consultative Committee (CCIF) followed by an rms meter. Corresponding subjective tests have also been carried out and show close agreement with objective measurements.

This result can be expressed in another way — in terms of the field strength necessary to provide a service in which the background receiver hiss is classed as *perceptible* but not by any means disturbing. With a simple dipole working into a well designed receiver with a low noise factor, it was found that the required field strength on AM or AML is 1,000 μV/m, whereas using FM the corresponding figure is 50 μV/m.

[2]For an explanation of the "triangular noise spectrum" referred to, see the sections on Noise, and Pre-emphasis and De-emphasis, "Mobile Radio Handbook," pages 110 to 114, published by Radio Communication Magazine.-Editor's Note.

It may be asked whether, in view of the fact that the present B.B.C. proposal is to provide at least a second-class service with an ambient field strength at 30 feet above ground level of 250 μV/m, the advantage of FM in suppressing receiver hiss can be usefully exploited.

First, it should be remembered that owing to the propagation conditions applying on these very high frequencies, considerable deviations of field strength may occur between points a relatively short distance apart, particularly if the country is hilly or built-up. Secondly, it is desirable that listeners should be able to receive these VHF transmissions so far as possible without the need to erect an out-door aerial, which may be expensive. Many listeners have been impressed by the fact that relatively simple aerials will give satisfactory reception of FM transmissions. The field strength indoors may be considerably less than the ambient value, particularly in difficult conditions — in a ground floor or basement flat or inside a steel framed building (where, incidentally, VHF reception will often give satisfactory results when medium-wave reception is unsatisfactory).

Thirdly, it should be remembered that a wide audio-frequency band (which at least some listeners will demand) increases the level of receiver hiss. Critical listeners are aware of receiver hiss if the signal-to-noise ratio is less than about 60 db. Fourthly, the field strength quoted above for satisfactory reception of FM and AM transmissions apply to a well-designed receiver. It is possible that some receivers having a relatively high noise factor will be manufactured; for instance, a relatively inefficient input radio-frequency amplifying stage, or none at all, may be used.

Taking all these factors into account, therefore, the suppression of receiver hiss is considered to be a desirable and important feature of a high-grade VHF broadcasting service.

Impulsive Noise: It is more difficult to be as precise about the relative performance of FM, AML, and AM in combating impulsive interference. To obtain optimum suppression, careful attention to the time constants of the circuits preceding the discriminator is necessary. Receivers which otherwise give a similar performance may behave very differently in the presence of impulsive interference. Furthermore, the degree of suppression of impulsive noise due to the use of FM depends upon the ratio of peak interference to peak carrier.

This effect is illustrated in Fig. 1, which applies to repeated uniform impluses, typical of, but more regular than the impulses caused by motor car ignition systems. When the peak noise to carrier ratio is less than unity the improvement of FM over AM is 25 db. At ratios exceeding unity, *i.e.* at signal levels below the *improvement threshold*, the advantage of FM over AM falls rapidly to a minimum and thereafter increases (FM always showing a substantial improvement over AM). The part of the curve below the improvement threshold is particularly important in the FM service under consideration, because it is in this range that car ignition interference begins to be annoying.

Experimental confirmation of this effect has been obtained. A typical result is shown in Fig. 2, which includes also the corresponding results for two typical AML receivers. The curves are for interference consisting of repeated uniform impulses and correspond, therefore, closely to the conditions assumed for the calculation illustrated in Fig. 1. For these measurements the receiver was terminated in a CCIF ear simulating network followed by an rms meter; results obtained in this way show good agreement with subjective assessments of the annoyance caused by interference. The performance of AML lies in general between that of FM and AM; it may approximate, however, to that of FM over a limited range of the ratio of peak noise to carrier.

In practice the most important source of impulsive interference is the ignition system of motor cars. The waveform here is far from the regularly repeated pulses on which the theory previously mentioned is based and to which quoted measurements apply. Subjective tests carried out using actual motor cars indicate that in practice the curves corresponding to Fig. 2 are considerably smoothed out; nevertheless, FM does show a marked improvement over both AM and AML.

Tests on Wrotham Transmissions:

During the laboratory experiments outlined above, field tests were carried out with low-power transmissions on AM and FM simultaneously from Alexandra Palace. The results of the experiments, the data from which were limited by the short range of the transmitters, were so promising that it was decided to carry out full-scale tests with high-power transmissions. After due survey, a site at Wrotham, Kent, was chosen. On this site two transmitters were installed with a carrier power of approximately 20 kw.; one of these transmitters was frequency modulated on 91.4 mc., and the other amplitude modulated on 93.8 mc. The outputs were fed simultaneously into a slot aerial array[3] with a gain of 8 db. The effective power of the horizontally polarised radiation from this aerial, the centre of which is 1,100 ft. above sea level, is approximately 150 kw.

A comprehensive series of field-strength measurements was made on these transmissions in order to check theoretical computations.

In July, 1950, the two transmitters began a series of modulated test transmissions on a regular time schedule. A listening survey was started, with the assistance of listeners provided mainly with specially designed VHF sets capable of receiving AM, AML, and FM. These specially designed sets were made to a specification believed to be typical of a reasonably, but not abnormally good receiver. The team taking part in these tests consisted of both technical and non-technical listeners, living in parts of the country within the projected service area of the Wrotham transmitter. Each listener was asked to answer a standard questionnaire, designed to give in condensed form his opinion of the three possible settings of the receiver. The completed questionnaires were analysed, and served as an excellent check on the results obtained by technical observers, both under laboratory conditions and in the field. Further listening tests with a mobile laboratory were made in the area covered by the 0.1-mV/m contour.

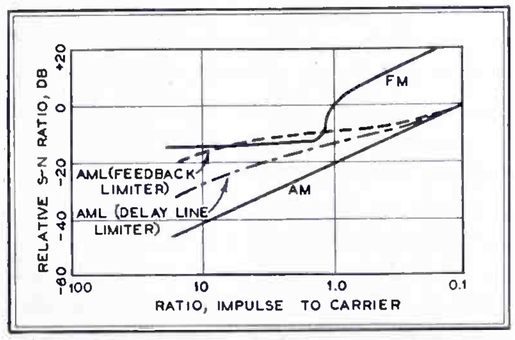


FIG. 2. IMPULSIVE INTERFERENCE SUPPRESSION PERFORMANCE OF FM, AML, AND AM RECEIVERS

Results of Tests:

With FM transmission, the first and second-class service areas were as defined below, the limits being set mainly by the level of impulsive interference from motor cars. Owing to the wide range of interference levels from different types of cars, and the varied reception conditions, it is extremely difficult to specify a minimum *standard* of reception for the service area.

To allow for difficult, but by no means extreme, conditions it has been assumed that the listener's receiving aerial is within 30 to 60 ft. from a busy road, on which the traffic may be continuous. Two types of service area were defined:

A. First-Class Service Area: Impulsive interference from 50% of cars is *imperceptible;* of the remainder, occasional cars may give rise to interference graded as *slightly disturbing*. In view of the difficult reception conditions assumed, this is considered a reasonable standard to adopt.

B. Second-Class Service Area: The average level of impulsive interference from at least 50% of cars is never graded as worse than *perceptible;* occasional cars may give rise to interference graded as *disturbing*.

The results obtained from the listening tests may be roughly summarised as follows:

1. Within a range of approximately thirty miles from the transmitter no general preference is expressed for either system; reception conditions were excellent with AM, AML, and FM. Where any preference was stated it was for FM, because of the absence of receiver hiss. Listeners were impressed by the comparatively simple, and therefore inexpensive, aerial systems which gave satisfactory reception with FM. This means that it will be possible for a very large proportion of listeners to any one station to use an indoor aerial for FM, which would not be practicable for AM. This constitutes a very marked saving in cost to listeners, which can be set against any difference in the cost of the receiver itself.

2. Beyond a range of thrity miles the majority of listeners expressed a distinct preference for FM.

3. Many listeners did not notice any marked difference between AML and AM. An improvement in favour of AML was, however, noticeable in areas subject to heavy impulsive interference.

4. Fading at times was reported on AM, AML, and FM at distances in excess of 40 miles, and this has been taken into account in assessing the service areas; in some cases the fading was associated with the presence of aircraft.

TABLE 1

SYSTEM	FIRST-CLASS SERVICE AREA Field Strength m/Vm	Approx. Range Miles	SECOND-CLASS SERVICE AREA Field Strength m/Vm	Approx. Range Miles
FM	1	45	0.25	60
AML	3	35	1	50
AM	10	25	3	35

Table 1 shows the approximate field strengths which represent the lower limit of a first or second-class service area, and the corresponding ranges. It is obvious that the coverage provided by the FM transmissions is greatly superior to that provided by AML or AM.

FM for the United Kingdom:

From the foregoing laboratory experiments and listening tests on the Wrotham transmissions, it has been estimated that the use of FM ensures a first-class service within the area of the 1-mV/m contour, and a second-class service up to the limit of the 0.25-mV/m contour, assuming average conditions of

(Continued on page 26)

[3]"High-Power VHF Slot Antenna" by G. D. Monteath, Radio Communication, Feb. 1952.

PATTERN FOR TV PROFIT

By ROY F. ALLISON, *in collaboration with* A.B. CHAMBERLAIN, RODNEY D. CHIPP, RAYMOND F. GUY, THOMAS E. HOWARD, *and* FRANK L. MARX

PART 2 — IMPORTANCE OF CORRECT LAYOUT FOR OPERATING EFFICIENCY & TO ACCOMMODATE FUTURE EXPANSION — MINIMUM SPACE REQUIREMENTS

LAYOUT is one of the key factors in successful television station planning. Only by a thorough study of all possible locations for the television plant; consideration of the relative merits of new construction or alteration of existing facilities, bearing in mind the programming facilities to be provided for; and the correct evaluation of the possibilities for future expansion, can the most efficient arrangement of the station's facilities be determined.

Future Expansion:

In Part 1, the determination of transmitter and studio location was discussed in general terms, with particular emphasis on antenna siting. One aspect of this problem which was not covered in detail was that of provision for expansion.

Television is notable for its phenomenal growth. This is true not only for the industry as a whole but in individual markets. Even with the freeze on new station authorizations, which continued in effect for nearly four years, the industry has continued growing at a tremendous rate. Television broadcasters have, for the most part, begun to operate at a profit. Well over 15 million receivers are in the hands of the public and, with the end of the freeze, set production will undoubtedly soar astronomically (providing that materials are available). Thus, it would be unwise to buy or construct a building to house a proposed TV plant that did not lend itself easily and efficiently to future expansion. At the same time, the necessity for maximum utilization of all available space should be kept in mind constantly, for a typical TV station requires at least 3 times as much usable space as a comparable radio station. Many TV broadcasters have found that this figure is not high enough, and recommend from 4 to 6 times the total space that would be allotted to a radio broadcast station of equivalent size. Because space is not cheap, it is mandatory to plan facilities so that none is wasted.

There are two general methods of building expansion — horizontal and vertical additions. The horizontal television plant, consisting of one or two stories, is preferable for production reasons and can be expanded easily. However, it is more expensive per unit area and requires more land. A vertical or multistory building has a lower first cost and can be built on a smaller lot, but does not, in general, lend itself to efficient TV operation. In addition, it is more difficult to expand vertically without interruption of service. Finally, because vertical expansion must result in some decentralization of facilities, it is likely that the operating cost of a vertically-planned station will be higher than that of one with similar horizontally-planned and better-integrated facilities.

Of course, there is a crossover point at which it becomes more practical to expand vertically, since further horizontal extension of a layout that covered a large area already might introduce more traffic problems than a vertical extension. However, it seems certain that such a point would be reached only by a very large station.

Transmitter and Studio Location:

It has been pointed out that great economies can sometimes be effected, in both initial investment and operating expense, when the transmitter and studio can be accommodated at a single location. This advantage may be offset, of course, by other considerations, especially in the cases of Types 3 and 4 stations. For instance, it may be found that the best location for the transmitter and antenna is at some relatively inaccessible place, unsuitable for the studio and offices of the station.

Types 1 and 2 stations. The location of a Type 1 or 2 station need not be affected greatly by the consideration of accessibility, since relatively few persons will be employed, and no live-talent originations will be scheduled. Relatively little space is required for the equipment of a Type 1 or 2 station — probably 1,000 to 1,500 square feet would be ample for all technical equipment, including an announce booth and an engineering workshop. Offices might require another 500 square feet. Such a small area might be available in a presently-owned building within the urban area to be served by the station. If the antenna can be located close by, such an arrangement may be quite desirable. If live-talent studio facilities are to be added eventually, they can be provided for in some other part of the city, and the original quarters could be utilized then as the master-control location.

On the other hand, if it is impossible or undesirable to have the transmitter and antenna within the city, it will probably not be advisable to locate the studio there. Unless the antenna must be installed in a location very difficult of access, the studio of a Type 1 or 2 station should be at the same place. Then as before, it can be employed as a master control in case of expansion, with the signal from the future live-talent studios brought to the location by a microwave or wire link; in case of further expansion, with multiple remote studios and associated master control, it can still be used as the transmitter and transmitter control building.

When the antenna for a Type 1 or 2 station must be situated in an extremely remote or inaccessible position, it is probably best to have the original studio facilities outside but close to the urban area. Then, when the time for expansion is at hand, the building can be enlarged horizontally to accommodate the necessary live-talent studios, and to provide space for prop-storage, dressing rooms, set construction, film and art departments, photographic lab and dark room, offices, and other requirements which are incidental to the presentation of live studio programs. It is estimated that a station with a single live-talent studio requires about 5 times the area of the studio for auxiliary space. For a 3-

studio station, about 3 times the total studio area is taken up by necessary adjuncts. This tremendous space requirement is the primary reason for the recommendation that the original studio should be located outside the heart of the urban area, where land will be more readily available for horizontal expansion.

Types 3 and 4 stations. The situation is slightly different for Types 3 and 4 stations. With these, less emphasis is placed on the economy achieved by locating the studio and transmitter together, because the savings in initial cost and operating expense are smaller parts of the overall financial outlays, and other considerations assume greater relative importance. For instance, it is extremely important for a station operating on a larger budget to obtain the maximum coverage it is possible to achieve with the transmitting system at its disposal. For this reason, it is almost always imperative to locate the transmitter and antenna where they can provide such coverage, regardless of other considerations. Also, the relative importance of the location for the studios increases with the size of the station.

If the factors of convenience and prestige only were to be taken into account when deciding on a location for the studios, then the best place for them would probably be at the center of the city. However, other problems must be recognized. Space in the amount required for a TV station is likely to be quite expensive in a downtown area. Ground-floor access to the studios is desirable so that very large objects can be brought in and out easily; if this is not available, an extra-large freight elevator is usually required. And last, but not least important, is the problem of expansibility. If an urban location is chosen for the studios, the space can seldom be expanded directly (remote studios must be added) or, if additional space *can* be made available at the same location, it is not likely to be at the same level. All in all, if the city to be served is not extremely large, it is usually found best to install the studios at some point outside the center, where plenty of room is available.

The importance of providing adequate room for expansion, and of planning the original layout to accommodate this expansion efficiently, is dependent normally on two basic factors:

1) Versatility and extensiveness of the original facilities, and

2) Present and probable future size of the maximum market that can be served by the station.

Obviously, a very small station should be more concerned with the possibilities for expansion in the near future than one beginning operation with extensive facilities for live remote and studio originations. And there will be more opportunity for expansion of a station in a thickly-populated area of New England, for example, than one in a town on the plains of Nebraska.

Time may be a factor in decisions to begin operation in a small way. Detailed planning and large-building construction take considerable time, especially where live-talent studios are being provided. Equipment installation may also require some time. Naturally, there will be a good deal of pressure to get on the air quickly once a CP is granted. The owner may not want to wait for the completion of extensive programming facilities to begin operation, and for this reason may go on the air at first with minimum facilities. This practice may be followed widely with the end of the freeze, particularly in cities of medium and large size.

General Considerations:

It is not the purpose of this section to discuss the technical aspects of TV station equipment in detail. However, in order to be able to plan facilities and station layout to best advantage, a general knowledge of standard equipment, its purpose, and how it is used is essential.

Since facilities for test pattern, station identification, and recorded tone signals must be provided for even in the network-only station, some means for video and audio switching must be available. Thus, even in the Type 1 station layout, a control position is required. Equipment must also be provided for monitoring and adjustment of the incoming network signal, the output of the monoscopes (fixed video generators which furnish test and station identification patterns) or flying spot scanner (a device which produces video from transparencies), and for the audio signals which must accompany these program sources.

The control facilities required for the Type 1 station would probably consist of the following items: audio-video control and switching units; a master monitor; and controls for stabilizing amplifiers, which could be rack-mounted or could be included in a control console. Some 500-watt transmitters have transmitter control consoles, and all these functions can be taken care of at this position. Others are not provided with such a console initially; the required control facilities are built up in individual sections to form a console. However, a console may not be absolutely required for a Type 1 station; the equipment could be rack-mounted, at the expense of some convenience. Monoscopes, power supplies, audio and video auxiliary equipment, test equipment, a sync generator, and transmitter monitoring equipment could be located in four or five 19-inch racks. Turntables would be situated convenient to the operator, so that one technician could operate this type of station most of the time. Space requirements for the Type 1 station would be very small. However, it would appear wise to provide room for an announce booth and for film projection facilities.

Each film camera and each live pickup camera requires a camera control unit to adjust the brightness, contrast, focus, shading and other properties of that particular camera signal. For a Type 2 station, then, five functions are required in the control console — 2 film camera controls, a master monitor, audio-video switching and control, and remote projector and stabilizing amplifier controls. Alternatively, the film camera controls can be operated separately by the projector operator. An announce booth is usually considered necessary for this type of station.

When a remote-pickup unit is added, the audio-video controls and switching equipment for the field cameras and microphone are included in the mobile unit. The only additional equipment required at the station is a microwave relay antenna and receiver or, if telephone company lines are to be used, the facilities for channeling the received signals to the audio-video switching part of the control console.

There is usually a distinction made between control equipments for individual program sources, such as live-talent studios, film projection rooms, and field pickup units, and the *master control*. The master control is fed a single signal from each studio control room, from the film control room, and the incoming signals from remote-pickup units, from the network line, and possibly from remote studios. It feeds the desired signal to the transmitter or transmitter control console, and can feed the same or another signal to one or more outgoing lines, at the same time controlling the characteristics of each signal. Thus, it selects and controls the signal that is actually broadcast by the station.

In many cases it is possible that the film control, the control for one live studio, and the transmitter control may be located in the same room. This conserves operating personnel, of course. But if the film projection room and each studio have their own control rooms, the flexibility of operation is increased considerably, in 2 ways:

1) It is much easier to carry on rehearsals in the studios and to preview film. Many stations have found it undesirable to combine control of 2 studios and film with master control, and have

had to modify facilities, at considerable expense, after such an attempt. Master-control combined with more than one studio control is not recommended.

2) A separate master control room makes it practical to broadcast one scene or program while feeding another station origination to a network. This consideration is important only for large stations.

No matter whether a separate studio control room or a combined studio control and master control is used, it should be so located that a clear view of all the studio area can be obtained. Also, the announce booth should be situated so that the announcer has a clear view of the studio and the control room. Where one room is used for a master control and for studio and film control, then it should be located in the center of these program sources, for it is important that the studio, film projectors, and announce booth be visible from the control position. If the transmitter is at the same location but in a different room, then it is desirable that this be visible also if it is possible to make it so conveniently.

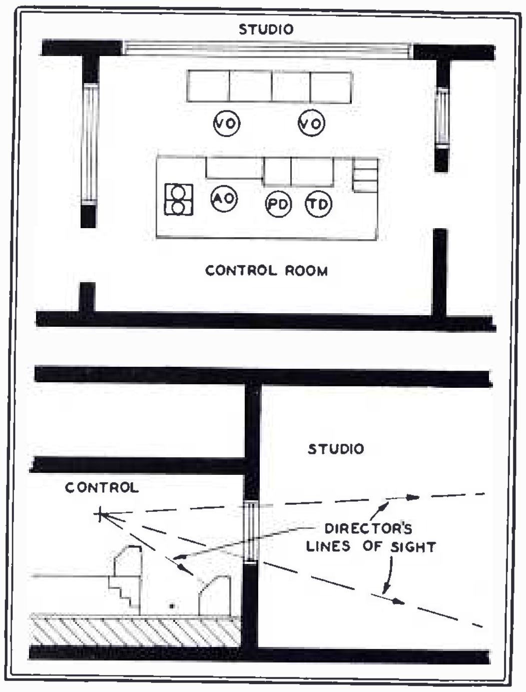


FIG. 1. A POPULAR CONTROL-ROOM ARRANGEMENT

Equipment in studio control rooms (or the studio control equipment in a master control room which is used also for studio control) can be arranged in various ways, depending on requirements and space limitations. Usually, the control room floor is slightly higher than the studio floor in order to provide a better viewing angle into the studio. If the studio is fairly large, the window between it and the control room can be made long enough, in many instances, so that all the control equipment can be placed end to end along the window. This equipment will consist of audio and video control and switching units, monitors, and possibly a separate director's console. With this arrangement, the audio and video operators and the technical director (who performs the actual switching and mixing functions for the cameras) can sit side by side in front of the control room window. The number of video operators required will depend on the number of cameras used and the complexity of equipment.

An alternative arrangement preferred by many designers is that shown in Fig. 1. Here, the video operator(s) and sometimes the audio operator sit side-by-side directly in front of the control-room window. The technical director and the program director (if both are used — sometimes a technical director handles both jobs, especially in a 2-camera set-up), and the audio operator in some cases, work on a raised platform slightly to the rear. This arrangement has the advantage that the directors have even better views of the studio, and can see the pictures on the camera control units and video monitors as well. If the program director is provided with a console having both preview and line monitors, the platform arrangement can be dispensed with if there is room for him at the control-room window. In any case, he must have a clear view of the studio and also be able to see the pictures picked up by each camera. Those who control the movements of the cameras and the microphones should have unobstructed views. Therefore, the position of the audio operator should be chosen carefully also.

Studio Requirements:

At least one fairly large studio is necessary in order to carry on uninterrupted multiple-set shows. A large studio is particularly important if only one is available, so that back-to-back live shows can be programmed if necessary. Suggested *minimum* size for a single studio ranges from 40 by 50 ft. to 50 by 80 ft. Most stations, at least in the larger cities, find that at least two studios would be preferable. The second studio would not have to be quite so large — 30 by 40 ft. is usually sufficient, and many stations get along with much less space.

Ceiling height cannot conveniently be less than 20 or 22 ft. to provide room for the ceiling grid lighting system. Besides operating inconvenience, low ceilings are disadvantageous in other ways. For instance, shadows cast by a microphone or a microphone boom that is too close to the ceiling lights may produce, on a camera monitor, some very distressing results. A height of 15 ft. is probably the absolute minimum for practical operation. Very high ceilings, which permit "flying" sets, are advantageous from an operational point of view but entail increased construction and air-conditioning costs, as well as difficulties in acoustic control.

Because of such requirements, live studios are usually planned for 2-story height. Medium-size stations find that a compact and efficient arrangement for 2 studios consists of a ground-floor master-control and film-projection room with a studio on either side. Control rooms for the studios are then located directly above the master control and film rooms. Alternatively, the studio control rooms can be built on the first-floor level, with the master control and film rooms above. The latter arrangement is probably best from the standpoint of the program director's viewing angle, since his platform would not have to be so much elevated in order to see the whole studio.

Studios must be well-treated acoustically. It is generally found most satisfactory to treat walls and ceilings with thick layers of sound-absorbent material. Television studios should be much deader than those used for radio broadcasting. Having the studio itself as acoustically dead as possible helps minimize the noise of scenery changes, camera dollying, and other activity unavoidable in the production of live shows. Also, since microphones are generally farther from the performers than in radio broadcasting, a very dead studio is necessary to eliminate excessive reverberation pickup. It is found that the sets themselves provide the liveness required for the audio pickup.

The problem is complicated by the necessity of using a hard, smooth floor

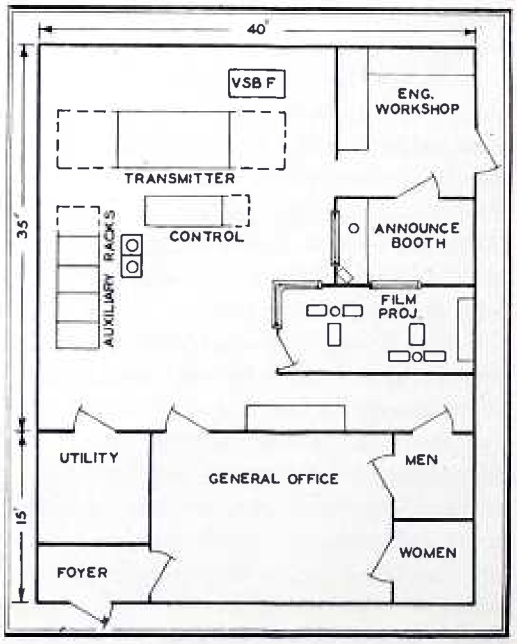


FIG. 2. A MINIMUM-TYPE STATION FLOOR PLAN

for camera and microphone boom movement. This requirement cannot be overemphasized. Hardness is necessary because sets and other heavy equipment will be dragged over the floor very often. A mirror-like smoothness is essential because the slightest bump or irregularity will show up to a disturbing degree on camera dolly shots, in which the "on-air" camera is moved.

Doors entering the studio from other parts of the building should be double, with a sound-lock between. Proper treatment of doors and windows can provide marked improvements in the reduction of extraneous noise. If the studio is located in a building where excessive vibration is caused by heavy machinery, such as printing presses, it must have extensive treatment for isolation. In some cases, severe vibration may make the use of the building impractical for studio construction.

Studio design, construction, and lighting will be covered in detail in a subsequent chapter.

Air Conditioning:

Because of the great amounts of heat dissipated by studio lighting equipment, which may be 100 kw. or more, an air-conditioning system is highly desirable if not absolutely essential. Often, in order to reduce noise, special duct construction is required in the studio. Because air velocity must be limited, large ducts are required to handle the necessary volume. Required capacity of the studio air conditioning system will depend on the size, of course, the amount of lighting equipment utilized, and the frequency and length of use of the studio. Simple forced exterior-air cooling has been employed by some stations. This sort of system works well during cold seasons, but is usually inadequate in the summer months.

Control rooms require some means of forced-air cooling also, since from 4 to 8 kw. may be dissipated by the control equipment, and the room is generally small and tight. The basic unit of air conditioning system capacity is the *ton*, which is the amount of cooling provided by one ton of ice melting over a period of 24 hours. From 5 to 8 tons of conditioned air at about 2,000 cubic feet per minute, or about 5,000 cubic feet per minute of 100% exterior air, depending on climatic conditions, are typical control-room requirements. This figure may be increased if the transmitter is located in the control room, although the transmitter is usually provided with its own ventilation system, and the equipment racks may be also.

Two types of air-conditioning systems are in general use. *Unit* air-conditioners are small equipments used for individual rooms. A *master* air-conditioning system is installed at one fairly central location, and is of such capacity as to handle all requirements of the station.

A master system is often set up on a *diversity* basis. Such a system can be controlled so as to have most effect where it is most needed at any time. This permits the use of a system with somewhat less capacity than the sum of the maximum capacities of all the areas it is to serve, since it is quite unlikely that all would require maximum cooling at any one time. Thus, a master system is normally less expensive than individual units, but leads to complications when the station's facilities are expanded.

Since such large air-conditioning units must be employed, they must be allotted adequate space in the initial plans.

The Traffic Problem:

There are other factors of good station layout which, if kept in mind in the planning stage, help to produce a more efficient arrangement of space. One of the major problems is traffic flow of people and materials, or *circulation*. Close scheduling is necessary in order to utilize to best advantage the space and equipment of the TV station. All areas of the station with which they are directly concerned must be accessible quickly and easily to all members of the station's operating, production, maintenance, and talent personnel. Congestion and traffic jams must be avoided.

Scenery, tables, chairs, lamps, pictures, and many other items must often be provided for only one set. There may be many sets of comparable complexity for a single TV show. Thus, the importance of providing for free traffic flow between studios and prop rooms is apparent. For this reason, separate wide corridors are often provided between the studios, carpenter shop, and prop room.

People concerned with a TV production fall into 5 categories requiring access to various sections of the station, as follows:

1) *Administration and office personnel.* Only the offices and the public lobby, with the exception of key persons.

2) *Sponsors and agency personnel.* Clients' viewing booths and administrative space only.

3) *Technicians and production personnel.* Control rooms, studios, shops, transmitter room, film projection and editing room, graphic arts and photo lab, prop room.

4) *Talent.* Studios, rehearsal and dressing rooms.

5) *Public.* Public lobby only, except for audience shows.

For most efficient operation, technicians and production personnel should have an entrance separate from the main entrance used by office personnel, sponsors, and the public, and talent should have a separate entrance leading directly from the street or parking lot to the dressing rooms. Shops and prop-storage rooms should be on one side of a horizontally-planned layout and should be directly accessible to the street. Dressing rooms, make-up and costume rooms, and rehearsal rooms should then be on the other side of the building. Many stations find it advantageous to provide a room roughly 15 by 20 ft. as a general-purpose room, which can be used for viewing, rehearsals, and conferences.

The remote-pickup truck should be stored in a garage near the technical or engineering workshop. The carpentry shop and prop-storage room should be connected to the studios by wide corridors equipped with sound locks, so that large sets and props can be shuttled back and forth efficiently. Also, it is a good idea to provide some means for moving very large objects (such as an automobile or a horse!) into the studios.

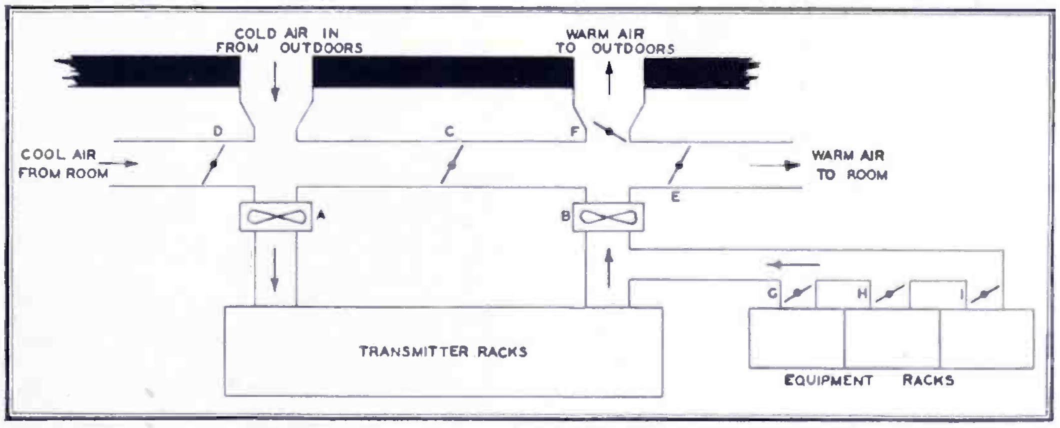


FIG. 3. HOW A TRANSMITTER VENTILATING SYSTEM CAN BE USED TO PROVIDE HEAT FOR A ROOM

An audience to a studio show is a problem in many instances, simply because it takes up space normally required for production. However, audience-participation shows are becoming more and more popular, and are held in high esteem by sponsors and agencies. In very small studios, it is virtually impossible to make provision for an audience. However, 200 to 250 people could be accommodated on folding chairs in a studio 60 by 80 ft. Such a studio would be classified as "limited-audience" in most city regulations, and as such would be subject to less stringent fire regulations than larger *auditorium* studios.

Typical Layouts:

Fig. 2 shows what is probably the minimum area required for a TV station.

(Continued on page 27)

Control and Sensing Resistors Made With

TEMPERATURE - SENSITIVE PAINTS

NEW NEGATIVE-TEMPERATURE-COEFFICIENT RESISTANCE PAINTS PROVIDE INCREASED CONTROL VERSATILITY AND ECONOMY — *By* ROBERT F. BRADLEY*

A new family of resistor-paint compositions, developed by Micro-Circuits Company, promises to increase greatly the versatility of resistors as control and sensing elements. The paints are applied as liquids at consistencies suitable for application by silk-screen, brush, or spray stencilling, by hand brushing, or by dipping. Some compositions may be air-dried, others require baking, and some can be dried by either method.

Fig. 1 shows some of the many variations in shape and size of bases to which these paints are applicable. Standard terminals or pigtail leads can be employed with or without strips of silver conducting paint. When silver paint is employed at the ends of the resistors, terminals can be eliminated in many cases because solder connections can be made directly to the silver-painted areas.

Characteristics:

The various compositions are characterized generally by large negative temperature coefficients of resistance over all or most of their operating temperature ranges. Unlike those of most devices used widely for the same purposes, the coefficients can be adjusted, by variations in composition, from nearly zero to the maximum value. In some cases the maximum value is higher than that attainable with thermistors or related devices.

Another important characteristic of the paints is that compositions having a given temperature coefficient of resistance can also be adjusted in nominal resistivity from a few ohms to many megohms per unit area. Because of this, the shapes and sizes of such resistors are determined entirely by the requirements of the associated equipment, within practical limits. Thus, an element need not be made excessively long with respect to its width in order to obtain a high resistance, as is necessary with other temperature-sensitive materials. An element the size and shape of a pea could have a resistance of .1 ohm. ten megohms, or any intermediate value. On the other hand, there appears to be no reason why a large area such as a section of the fuselage of a plane, the door of a refrigerator, or the entire wall of a room could not be made a single element of extremely large wattage dissipation.

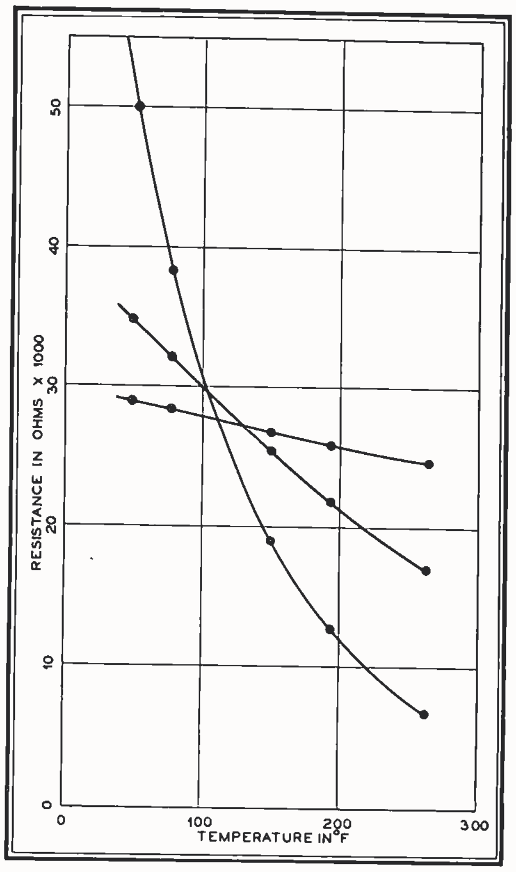


FIG. 2. HOW THE COEFFICIENT CAN BE VARIED

Characteristic curves of some of the compositions developed to date are shown in Figs. 2 through 6. The numerical values of resistance shown in the curves are for illustrative purposes only, since resistors in much higher or lower ranges could have been produced with curves of the same shape.

Fig. 2 is a group of curves which illustrate the possibility of varying the temperature coefficient of resistance while retaining a given type of curve. Resistors of this type will find wide application for measurement and control.

Fig. 3 illustrates how, by varying the composition, the general shape of the curves in Fig. 2 can be modified to provide a relatively smooth variation throughout the temperature range or to exhibit a definite inverse knee at some temperature. At temperatures below the knee the coefficient is large, while at temperatures higher than those around

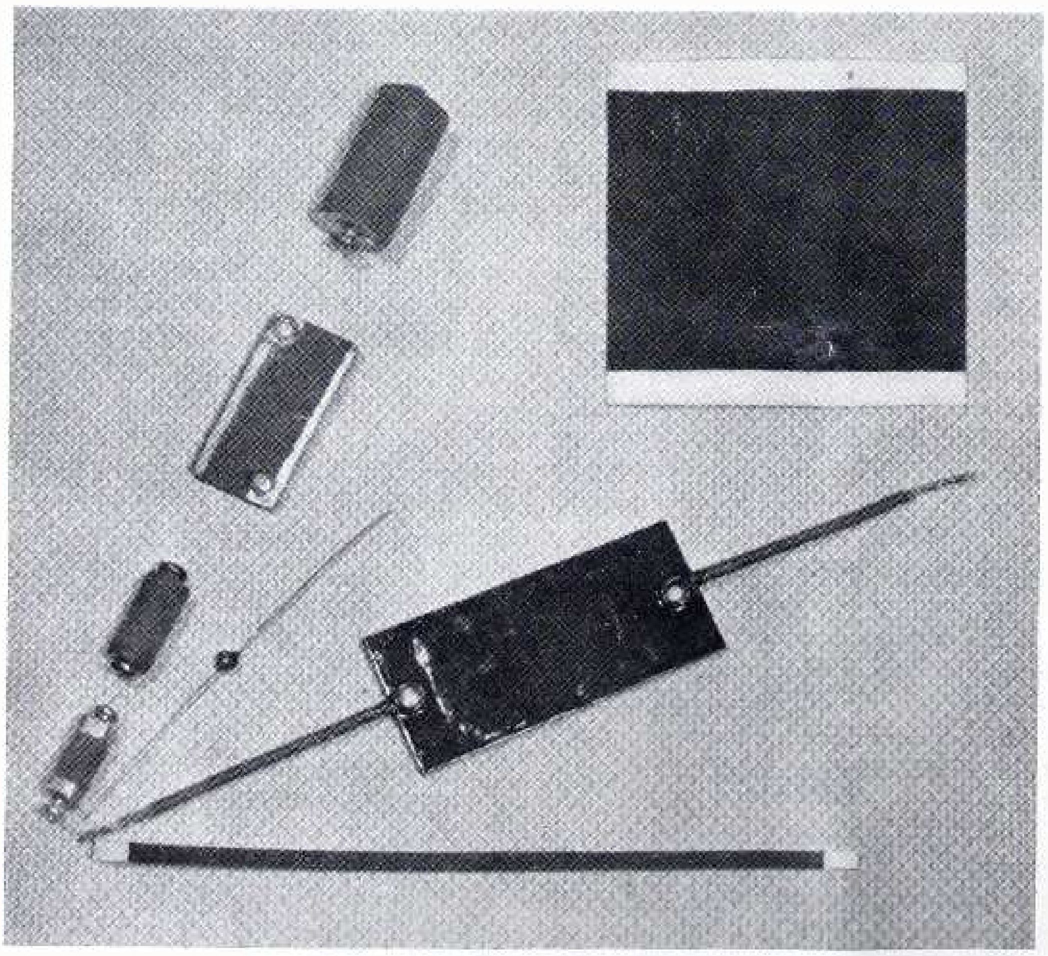
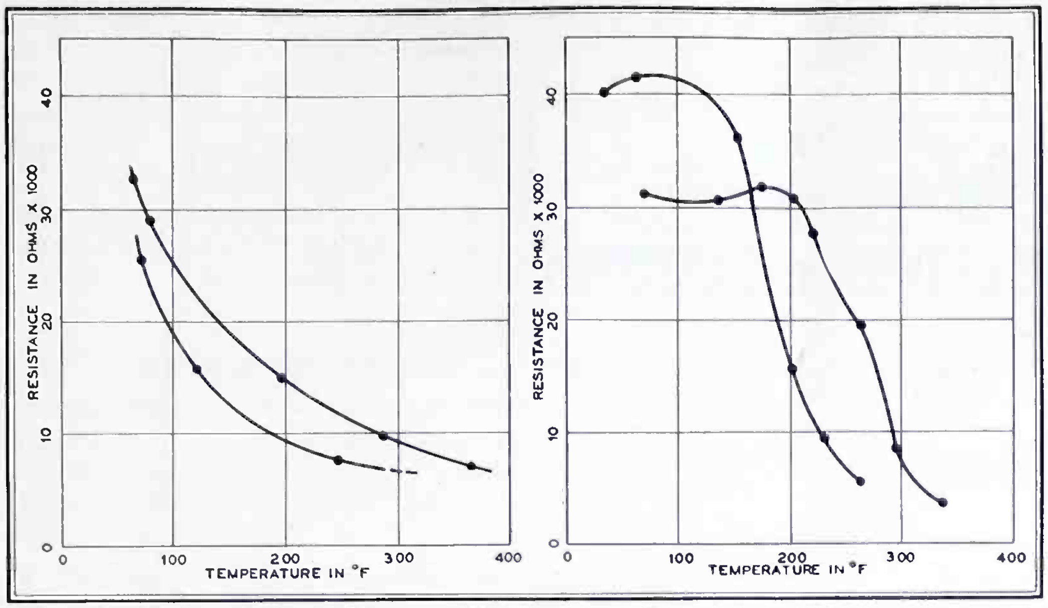


FIG. 1. SOME OF THE VARIOUS POSSIBLE SHAPES FOR THESE TEMPERATURE-SENSITIVE RESISTORS

*President, Micro-Circuits Company, New Buffalo, Michigan.



FIGS. 3 AND 5. THE SHAPE OF THE RESISTANCE CURVE IS CONTROLLABLE AS WELL AS THE SLOPE

the knee the coefficient is relatively small. The use of one type or the other will depend upon whether a continuous or relatively abrupt change in characteristics is desired.

A form of resistance hysteresis which is apparent in varying degree with some compositions is shown in Fig. 4. Where this effect exists, the curve plotted for rising temperature lies above that for falling temperature in nearly every case.

Characteristic curves of several members of another group are plotted in Fig. 5. Here, the resistance changes very little at low temperatures, but drops suddenly after a critical temperature is reached.

Fig. 6 shows the curves of still another type of composition, in which a rather

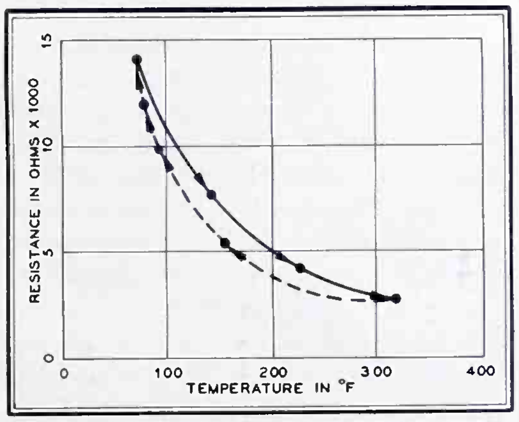


FIG. 4. A HYSTERESIS-TYPE RESISTANCE CURVE

abrupt peak in resistance occurs before the rapid drop in resistance.

The temperature range over which these compositions have been tested is roughly from 0 to 500° F. Extension in both directions appears to be feasible.

Relative Costs:

Manufacturing cost will vary widely, depending on the required resistance tolerance, the shape, and the size of the unit. In no case analyzed to date has the cost even approached that of equivalent ceramic elements of the thermistor type. Although there are noble metal compounds in the paints, and silver paints are used largely as terminals, the cost of the finished components is not increased significantly by their presence. It has been a common observation in printed-circuit work that all the silver in a complex circuit rarely costs more than a few cents.

Of course, the low cost of a single part of a control or measuring circuit does not tell the entire story. In applications where an element which can control a great amount of power permits the substitution of less delicate and expensive meters, or eliminates intermediate devices such as vacuum tube amplifiers and relays, the reduction of cost and weight may be multiplied many times. Also, it may be feasible to use an extremely small element with a special characteristic, such as a very high resistance, which cannot be obtained with conventional devices.

Typical Applications:

It is expected that these resistors will provide answers to problems where no answer or a too-expensive answer existed before. For example, there are many circuits in which some type of low-cost temperature compensation would be desirable, or in which vacuum-tube life is reduced by frequent high inrush currents to cold heaters. Another possible type of filament-control circuit is one in which the filaments are held at a stand-by temperature through a dropping resistor compounded of the new material. When an associated circuit is turned on, heat from it would reduce the resistance of the dropping resistor to a low value, automatically permitting full filament current to flow.

Another valuable circuit would be one in which a heat-sensitive resistor provides direct and stepless control of a simple magnetic actuator operating the fuel valve in an oil heater, or the flow of coolant in a transmitter tube or in an aircraft engine.

Indicating and warning devices, to indicate that trouble is developing in some circuit or machine, would be simple and inexpensive to construct. Such a device might consist of a simple circuit having a buzzer or light in series with a heat-sensitive resistor of proper size, and a power source. With the resistor in contact with the cooling water system of a transmitting tube, ignitron rectifier, or other device, the buzzer would hum or the light would glow dimly for normal operation. Any tendency toward overheating would result in louder humming or an increase in brightness of the light. A positive relay control could be incorporated in the same system.

In some applications, a large dissipating element would offer many advantages in simplicity and economy. It could provide stepless, automatic control of large motors without auxiliary amplifiers, relays, or other associated equipment. It would add very little weight to the structural member or surface to which it was applied. Although it has not been done to date, it is obvious that the fabrication of extremely unusual resistor shapes is possible. For example, a resistor element in the form of part of a cylinder could be cemented to the side of a pipe carrying heated or cooled materials in process. It could control an AC or DC meter, valve, motor, or relay from any steady power source.

Another good example of the ease with which the shape can be suited to the

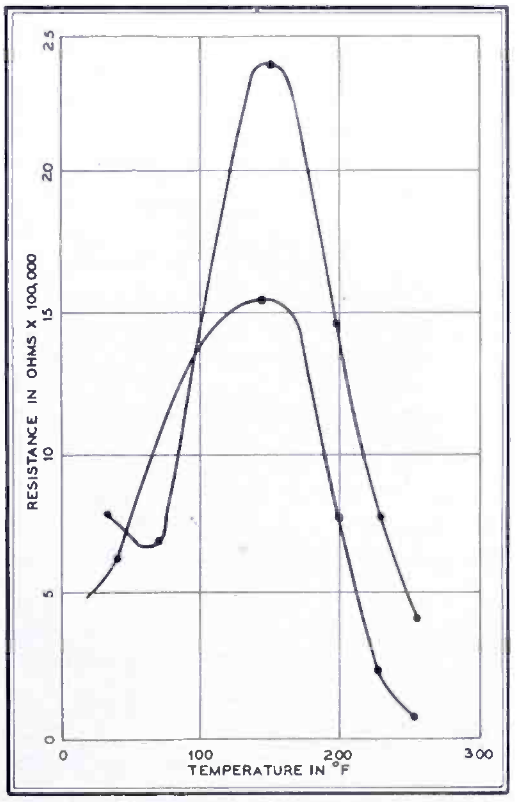


FIG. 6. SOME PEAKED CHARACTERISTIC CURVES

application is in the case of instruments, such as the hot-wire anemometer used for measuring wind velocity.

The applications of these paints appear to be unlimited, since they are extremely versatile and useful wherever control or compensation is or can be related to temperature changes.

NEWS AND FORECASTS

QUARTERLY REVIEW

By **JEREMIAH COURTNEY***

REVIEWING FCC developments in the mobile sector during the first quarter of 1952, there is little question that the principal change during the period was Wayne Coy's resignation as Chairman. Heralded as an unexpected development, actually his resignation was foreshadowed last December, in RADIO COMMUNICATION Magazine.

For those not blessed with photographic memories, the front cover of the December issue carried a full-page photo of the Chairman. The last time your publisher made a trip to Washington to get a similar picture was in January 1947. The resulting front-page likeness of Charles R. Denny, Jr., then FCC Chairman, was followed by his resignation a few months later. The same thing happened shortly after Paul Porter's photo was carried on the front cover about a year earlier. Three for three is not bad in any league. Furthermore, in each instance, the resignations were followed by very substantial salary increases in private business. So the appearance of an FCC Chairman's picture on the cover of RADIO COMMUNICATION can hardly be viewed as an omen of personal ill fortune.

Industrial Application Backlog: Probably the next most significant development during the first quarter was the sharp reduction in the time lag for processing applications in the industrial radio services. By the end of the quarter, an industrial radio service application, if it was prepared properly and did not require special study, could be expected to be granted within about a week of filing. Most of that week, furthermore, would be chargeable to Application Control activities.

The delay in processing such applications had formerly been on the order of two months, but was reduced to the extent indicated during the first quarter by the assignment of extra personnel to the Industrial Section. Time required for grants of comparable applications in the public safety and land transportation services, towards the end of the quarter, was one and two weeks, respectively.

Of course, if an application requires examination by the Antenna Survey Branch, that takes about three to four weeks, although when the application is returned for processing to the interested service group it is then considered immediately, so that the drags mentioned are not cumulative. What the Antenna Survey Branch delay will be, now that it has been moved to the Briggs Building, a couple of miles from Tempo T where safety and special service applications are received, processed, and granted, remains to be seen.

Miscellaneous Common Carriers: Speeding up of industrial service application processing, former sore spot in Safety and Special Services Bureau, has only served to accentuate the serious backlog that exists in the processing of miscellaneous common carrier applications. For a long period of time a new construction permit application for miscellaneous common carrier authority could be expected to average about three or four months, although towards the end of this quarter there was some indication that the delay might be reduced to something on the order of six weeks.

It is appreciated, of course, that processing a common carrier application requires more time than one for safety and special services because, in the common carrier field, the applicant receives the interference-free use of the frequencies assigned. This calls for a detailed engineering examination for many new applications. An unfortunate result is that an operator in the common carrier field is unable to order his equipment until the application is actually granted, since there is often no assurance that the frequencies requested will be made available in the area of the applicant's proposed operation. To the FCC processing delay there must be added the manufacturer's normal delay in delivery. Many of the people who would subscribe to common carrier service if they could get prompt service from a carrier entering the field are also eligible to construct and operate their own systems. Any disparity in the processing time of applications between common carrier and safety and special services therefore operates against the miscellaneous common carrier group.

New Renewal Application Form: The new short form of application for license renewal in the safety and special radio services is now available. This is reproduced here. Purpose of revising the form was to reduce FCC paper work and to speed up application processing by having the applicant prepare his own certificate which, when authenticated, evidences the renewal of the outstanding station license. The short form may be used only when requesting a renewal of an outstanding license, without modification, issued under the following parts of the Commission's Rules: Part 7, Rules Governing Stations on Land in the Maritime Services; Part 8, Stations on Shipboard in the Maritime Services; Part 9, Aeronautical Services; Part 10, Public Safety Radio Services; Part 11, Industrial Radio Services; Part 12, Amateur Radio Service; Part 14, Radio Stations in Alaska (Other than Amateur and Broadcast); Part 16, Land Transportation Radio Services; Part 19, the Citizens Radio Service; and Part 20, Disaster Communications Service.

Oil Industry Point-to-Point: Doug Anello, FCC industrial radio head, returned from a two-week inspection of radio use by oil companies in the lower Delta and West Texas area convinced that the oil industry has a high-priority need for point-to-point communications in that desolate territory. One of the principal purposes for which the oil industry uses radio in that area is for communication between drilling rigs and headquarters offices. The latter may vary from a pitched camp in the general area of the oil-well drilling activities to the company's home office in New Orleans.

Nine times out of ten there is no way of communicating except by radio. These drilling rigs are set up for periods of two, three, or four months in a good many cases, and microwave radio is obviously impracticable because of the temporary nature of the communication set-up.

Before the Atlantic City convention ruled out the portable classification for radio stations, this type of radio use would have been carried out on mobile frequencies under portable station authorizations. Now it is permitted on mobile frequencies on a secondary use

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

basis only. There is nothing secondary to the oil industry, however, when the crew of a drilling rig calls in an oil strike, or the immediate need for mud, cement, or other supplies. Seeing is believing, and it's encouraging when those who write and interpret FCC mobile rules take a look-see to obtain first-hand information.

Microwave Systems:

Speaking of communications for the oil industry, this observer has a feeling that the microwave field is just about to break open in that particular sector on a large scale. Not that it hasn't a good start already, but there were bugs in some of the first systems, and it has taken considerable engineering work to eliminate them. Now the radio men responsible for recommending microwave use to the companies' top brass are in the position of having made good on their promises. It is not an easy responsibility for a company official to recommend the high capital investment required for a microwave relay system, especially when he can hardly accept any responsibility for endorsing the initial engineering proposal because of his total unfamiliarity with the field. Up to a few years ago, even the Bell System was moving very cautiously in the microwave field, but it seemed to this observer that the verdict was in when that company decided on microwave relays for transcontinental operation.

On this general subject, RCA has recently prepared a very attractive booklet entitled "What is Microwave." Liberally interspersed with pictures, it explains in simple language how microwave relays work, and how they are useful to industry. Precisely because the decision to put in a microwave system must percolate up to top-level operating officials, this booklet will serve an extremely useful purpose.

March 15 Blues:

The first quarter of every year always brings up the question of the rate at which to depreciate radio equipment. Back in 1947, Gene Goebel of Motorola got a ruling from the Bureau of Internal Revenue on this point for the taxicab companies when they were first confronted with this question. Principal paragraph of the ruling is quoted below. It appears as sound today as then:

"On the basis of the information submitted, a normal life of five years or a depreciation rate of 20 per cent applied to the cost of the equipment less the estimated salvage value, is acceptable to the Bureau. It is to be understood, however, that this depreciation rate is subject to such change at the end of any taxable year as subsequent experience may indicate is necessary, in order to spread the cost of the assets over their remaining useful lives."

As a matter of administrative convenience, a base station, at least in the taxi field, is generally lumped with mobile units in single radio account, all depreciated at 20% per annum, although a slightly longer life — 7 or 8 years — might be justified for base-station equipment. Because of FCC Rule changes (narrower and narrower channels) and the general dynamic nature of the mobile radio art, no salvage value should be attributed to equipment at end of its five-year life. In all cases, however, actual retirement and salvage sale practices will ultimately govern the depreciation rate to be applied, although this may not be known now.

FCC Form 405-A-1
March, 1952

United States of America
FEDERAL COMMUNICATIONS COMMISSION
APPLICATION FOR RENEWAL OF RADIO LICENSE (SHORT FORM)
(Use only in accordance with instructions on reverse side)

Form Approved
Budget Bureau No. 52-R131

1. Name of licensee
John Doe Company

2. Mailing address (number, street, city, and state)
1000 - 1st Street
Chicago, Illinois

3. Transmitter location
1000 - 1st Street
Chicago, Illinois

4.(a) Nature of Service Special Industrial
(b) Class of Station Base
(c) Call Sign KEB541
(d) File No. 16345-D4-L-G
(e) License term ending June 1, 1952

5. Applicant certifies that there have been no changes in ownership or control, either by transfer of stock ownership, changes in partnerships, or other changes of the licensee organization, and the facts relating to the licensee organization, the station equipment and station location as contained in the applicant's most recent application embodying this information are unchanged, except as reported herewith.

6. If for renewal of amateur station and/or amateur operator license, I certify that I have satisfied minimum requirements of rules for renewal of amateur operator license.

7. Applicant waives any claim to the use of any particular frequency or of the ether as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests renewal of station license in accordance with this application.

Dated this 30 day of March, 19 52
By John Doe
(Designate by checkmark below appropriate classification)
☐ Individual Applicant
☐ Member of Applicant Partnership
☒ Officer of Applicant Corporation or Association
☐ Official of Governmental Entity Competent under the Jurisdiction to Sign for the Applicant

Subscribed and sworn to before me
This 30 day of March, 19 52
/s/ Mary Doe
Notary Public
(SEAL)
My commission expires 7-1-54

FCC Form 405-A-2

NOTICE OF RENEWAL OF RADIO LICENSE
Field Office Record

1. Name of licensee
John Doe Company

2. Mailing address (number, street, city, and state)
1000- 1st Street
Chicago, Illinois

3. Transmitter location
1000 - 1st Street
Chicago, Illinois

4.(a) Nature of Service Special Industrial
(b) Class of Station Base
(c) Call Sign KEB541
(d) File No. 16345-D4-L-G
(e) License term ending June 1, 1952

THIS SPACE FOR COMMISSION USE ONLY

The license for the reference radio station (and/or amateur operator license) has been renewed on the same conditions and in accordance with the same provisions for the term ending:

T. J. Slowie
Secretary

FCC Form 405-A-3

United States of America
FEDERAL COMMUNICATIONS COMMISSION

CERTIFICATE OF RENEWAL OF RADIO LICENSE

1. Name of licensee
John Doe Company

2. Mailing address (number, street, city, and state)
1000 - 1st Street
Chicago, Illinois

3. Transmitter location
1000 - 1st Street
Chicago, Illinois

4.(a) Nature of Service Special Industrial
(b) Class of Station Base
(c) Call Sign KEB541
(d) File No. 16345-D4-L-G
(e) License term ending June 1, 1952

NOT VALID UNLESS POSTED WITH LICENSE

THIS SPACE FOR COMMISSION USE ONLY

This authorization shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term hereof, nor in any other manner than authorized therein. Neither the license nor the right granted herein shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. This authorization is subject to the right of use or control by the Government of the United States conferred by Section 606 of the Communications Act of 1934, as amended.

This certificate, when properly authenticated, serves as a renewal of the reference radio station license (and/or amateur operator license, if applicable) on the same conditions and in accordance with the same provisions for the term ending:

By direction of the
FEDERAL COMMUNICATIONS COMMISSION

T. J. Slowie
Secretary

SAMPLE SHORT-FORM APPLICATION FOR LICENSE RENEWAL IN SAFETY OR SPECIAL RADIO SERVICE

NEW YORK'S FIRE RADIO SYSTEM

PART 1: A CITY-WIDE COMMUNICATION SYSTEM ENGINEERED AROUND THE USE OF ADJACENT-CHANNEL OPERATION — *By* LIEUT. SAMUEL HARMATUK*

THE FM radio communication system recently installed for the New York City Fire Department is probably the most extensive and complete of its kind anywhere in the world. To communication engineers, it is of particular interest because its highly successful performance demonstrates that adjacent-channel operation can be a practical reality. To municipal officials, the details of planning and installation are of special importance because the specifications were worked out in strict accordance with fire department methods, practices, and requirements.

Problems of System Planning:

Fire protection presents many unusual problems in New York because the five boroughs of the city, comprising 299 square miles, are broken up in a most irregular manner by 578 miles of waterfront. Further complications result from the extreme density of population, and the proximity of New York City to other populous urban centers. These conditions presented many problems in planning a communication system to serve Fire Department needs not only for routine and emergency activities, but for situations of catastrophic proportions, such as an attack by atom bombs.

From the standpoint of fire-fighting, the five boroughs are organized in a semi-autonomous manner for practical reasons. First of all, only the borough of the Bronx is on the mainland. The boroughs of Brooklyn and Queens are on Long Island, while the boroughs of Richmond and Manhattan are islands themselves. This isolation by waterways poses a cable maintenance problem for the fire alarm telegraph system. Second, the fire density is such that a borough constitutes the approximate maximum of physical territory that can be protected efficiently with conventional signal equipment by a single central agency. Third, the types of occupancy are, in some measure, peculiar to the individual boroughs.

Now, coming to considerations of radio communication, it is obvious that the system engineer is confronted by elements of severe interference from man-made static, other radio services, diathermy, and induction heating equipment in an area of extreme density of population with the concomitant factor of high fire incidence.

The fact that cities immediately adjacent lie in the radio shadows of New York City does not lessen but, rather, complicates the matter of interference. Further, the paradoxical requirements that a radio system for New York provide both maximum borough autonomy and city-wide operation under central control are not compatible with the usual concept of a municipal system operated from a single point, under a single agency.

Thus it becomes evident that, in New York, the answer lies in a plan comprising several systems integrated into a flexible method of overall operation. It is not surprising that two years were required to make the preliminary survey, to work out the system plan, prepare detailed specifications in accordance with fire department practices, and to complete the steps leading to the final contract award for suitable equipment and its installation.

Study and Survey:

Preliminary investigation showed that operation on 30 to 40 mc. would not be practical because of noise in the dense metropolitan area, and that skip interference would cause trouble — not so much because we would be subject to the occasional transmissions from smaller communities, but because they would be swamped by our heavy traffic. Since the 70-mc. segment is too close to the television channels, the answer seemed to lie in the 152 to 162-mc. band. That would keep us reasonably clear of interference from industrial equipment, and provide propagation characteristics better suited to operation on streets lined with tall buildings, since good coverage can be obtained by virtue of dispersion of signals by reflection. Tests showed a marked improvement in penetration at the higher band as compared to the lower frequencies.

Over 300 street-level field strength measurements were made at various locations throughout the City, using a Stoddart field intensity meter. These measurements were made with a standard vertical dipole, moved through at least 3 wave fronts to minimize false readings due to local reflections. We also made tests with a coaxial dipole, a ground plane antenna, 3-element coaxial with parasitic elements, and a 3-element coaxial with driven elements. Results were in extremely close agreement with the theoretical values. AM noise measurements indicated that levels of 1,000 microvolts per meter were fairly common, with high values exceeding 10,000 and dropping to a low of 1 microvolt per meter measured on a Sunday afternoon in an outlying rural area of Richmond. It was concluded that signal levels below 30 microvolts per meter would be inadequate to provide a desirable quality of voice communication.

In the extremely noisy areas, we found that signal levels below 75 microvolts per meter yielded only marginal results, even with receivers of 1 microvolt sensitivity. It was concluded that a signal level of 100 microvolts should be the measure of acceptability with some outlying areas in Richmond and Queens falling somewhat below that level, when a 250-watt transmitter and an antenna of 3 driven elements at a height of 300 ft. above sea level were used to cover the entire city. This value of 100 microvolts per meter may appear unnecessarily high. However, it should be noted that one of the requirements set up for this system was for mixing and rebroadcasting mobile transmissions when necessary to appraise directing officers of field conditions. Any deterioration of intelligibility due to poor signals would be fatal, therefore, to the operation of the system.

Adjacent-Channel Operation:

One of the limiting factors in the design of the system which we encountered at the start of our work (1948) was the selectivity of receivers then available, for measurements indicated an attenuation capability of not more than 85 db at 60 kc. from center frequency. This meant operation on alternate channels. An equally serious fault of receivers current at that time was their susceptability to desensitization in the presence of strong signals close to the desired frequency. The seriousness of this consideration is indicated by the fact that measurements of spurious radiation from local television transmitters showed field strengths as high as 8,000 microvolts per meter at a radius of 3 miles, and at only 70 kc. from what is now our City-wide Fire Department frequency.

At that time, it appeared impossible to break our system down into more than two sub-systems, because of the difficulty of obtaining channel assignments.

*Radio Supervisor, Bureau of Fire Alarm Telegraph, New York Fire Department, Municipal Building, New York City.

The prospect of handling message traffic for mobile units in more than 500 vehicles, 11 fire boats, and other miscellaneous fire apparatus was not a bright one.

The various equipment manufacturers were greatly interested in our project because of its magnitude, and gave us whole-hearted cooperation through the loan of equipment and the assistance of their engineering personnel. As we proceeded with our tests, new models were developed which showed a trend toward improved selectivity, desensitization, and intermodulation characteristics. In fact, it appeared that 3 sub-systems would be practical. Plans were crystallized along that line with a view toward putting the boroughs of Brooklyn and Queens on one pair of frequencies, with Manhattan, Bronx, and Richmond on another pair, and using the third for the city-wide system to cover all five boroughs and the fire boats.

While the trend toward improvement was quite evident, the time required to deliver the new models was uncertain, and we were torn between the desire to install equipment then available, because it was needed urgently, and the almost certain knowledge that it would be obsolete long before the end of its normal life.

Fortunately, we did not have to make this Hobson's choice. In the spring of 1949, the Department obtained a pilot model of a Motorola unit having a selectivity of 100 db at 30 kc. off center frequency, with greatly improved desensitization and intermodulation characteristics. The following description of one of our field tests will illustrate the difference in performance between one of those receivers and another that showed a selectivity of 100 db at 38 kc. and a sensitivity of approximately .5 microvolt:

A 30-watt fixed station on the desired frequency of 154.43 mc. was set up at the Brooklyn central station, approximately 7 miles from the Queens central station where we had a 250-watt transmitter on the adjacent channel of 154.37 mc., giving a separation of 60 kc. Both receiver models were installed in a car which we drove toward the transmitter on the undesired frequency. The receivers performed equally well until we were within .5 mile of the station on the undesired frequency. At that point, the second receiver began to show signs of serious desensitization, and could no longer bring in the desired station. The first receiver, however, continued to bring in the desired signals, although the field strength of the desired station had become marginal, up to a point within 150 ft. of the undesired transmitter. This test illustrated quite graphically the difference in susceptibility to interference in the areas where interference blanked out reception of the desired station.

A second type of test was run with two 250-watt transmitters on 154.37 and 154.43 mc. respectively. Their antennas were separated by a physical distance of 1,700 ft. The receivers were tuned to 154.31 mc. Thus, the intermodulation product of the transmitters fell on the frequency to which the receiver was adjusted. The radius of the interference area for the first receiver was approximately .5 mile, and .25 mile for the second, giving an area ratio of 4 to 1. This test was conducted with the squelch controls wide open to rule out threshold levels.

When the highly satisfactory results of these tests were presented to the FCC, the Commission agreed to the assignment of 2 pairs of adjacent channels for our fixed stations, and a block of 4 adjacent channels for the mobile units. These are

FIXED	MOBILE
154.19 mc.	153.89 mc.
154.25	153.95
154.37	154.01
145.43	154.07

The manner in which we distributed these channels in the 5 boroughs will be explained subsequently.

The use of these blocks of frequencies is desirable for several reasons. First of all, the physical locations of the transmitters can be controlled at least to a limited degree. Then, since most of the intermodulation products fall on our own system frequencies, they can be made to fall on the frequencies of the more distant transmitters, thereby minimizing or eliminating such interference.

Another advantage lies in the fact that, in most instances, any interference due to frequency drift is contained within our own system, putting the remedy under our own control. To accomplish this, we have a General Radio secondary frequency standard. In contrast, interference caused by frequency drift in other systems must be identified before efforts can be made to correct it. Prompt cooperation is sometimes difficult to obtain, and one service, no matter how closely it limits the drift of its own transmitters, may be subject to the effects of lax maintenance or inferior equipment in another system.

Finally, the desensitization of receivers can be minimized by the proper distri-

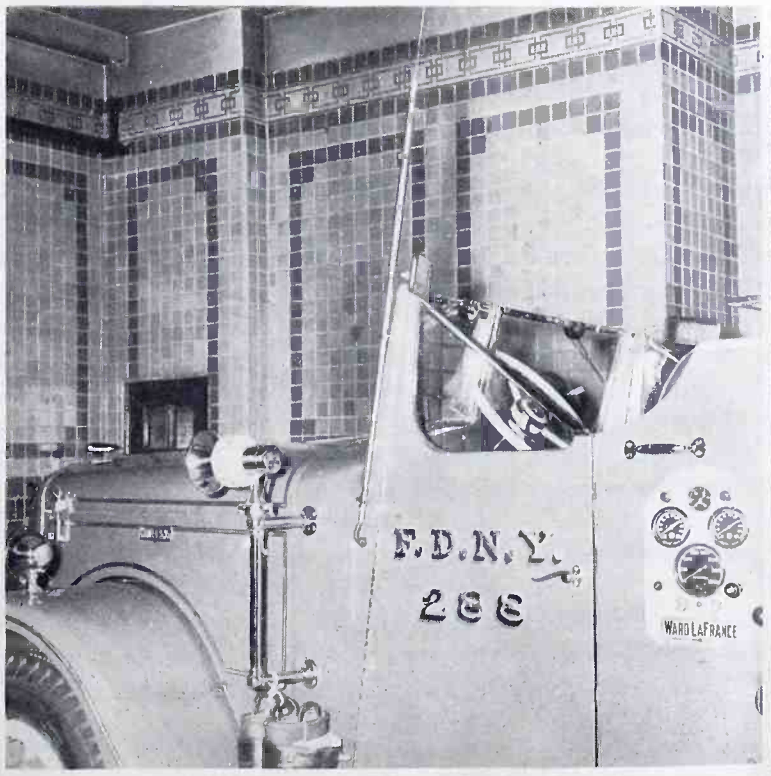

FIG. 1. TYPE OF QUARTER-WAVE DIPOLE USED ON ALL FIRE APPARATUS.

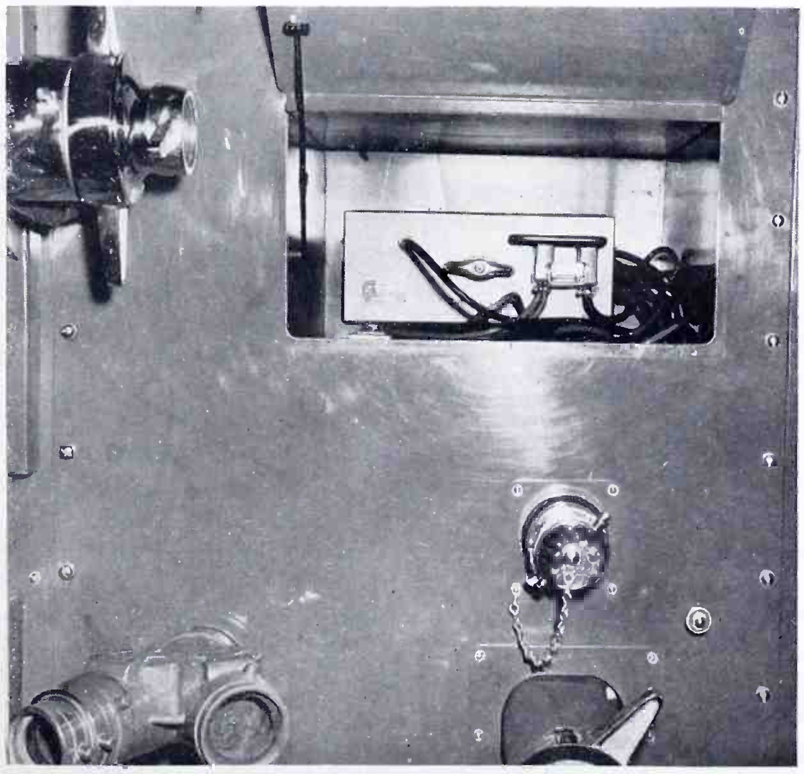

FIG. 2. TYPICAL INSTALLATION OF A 25-WATT MOTOROLA MOBILE UNIT

bution of frequencies within our own system, so that no receiver is subjected to strong signals from an adjacent-channel carrier.

Plan of Operating Frequencies:

The use of our assigned channels was set up on the following borough plan:

Fixed — 154.19 mc. Richmond
154.25 mc. Manhattan & Bronx
154.37 mc. Brooklyn & Queens
154.43 mc. City-wide
Mobile — 153.89 mc. City-wide
153.95 mc. Brooklyn & Queens
154.01 mc. Manhattan & Bronx
154.07 mc. Richmond

Richmond, on Staten Island, was assigned a separate frequency because it area covered by our communication system.

Physical Layout of the System:

Effective use of radio communication by a fire department requires direct contact at all times between the dispatching office at each central station and the fire-fighting forces. Thus, each central station must be the control point for its transmitter. Also, it must have speakers connected to such remote pickup receivers as are required at various locations to assure reception of transmission from mobile units.

The selection of transmitter sites involved the obvious considerations of accessibility, the availability of adequate for the old AM system to support the new FM antenna for the Manhattan-Bronx transmitter. It is located at Long Island City, providing broadside transmission toward the area to be covered. The effective propagation from that site appears to be the result of multipath reflections and dispersion through the narrow, canyon-like streets. At a distance of 1,700 ft. from that tower, the Fire Department's repair shop building was chosen as the site for a new 285-ft. tower to carry the antenna for the City-wide transmitter. Actually, two antennas were mounted on that tower, the second being for an alternate transmitter to operate under remote control on either the Manhattan-Bronx or the City-wide

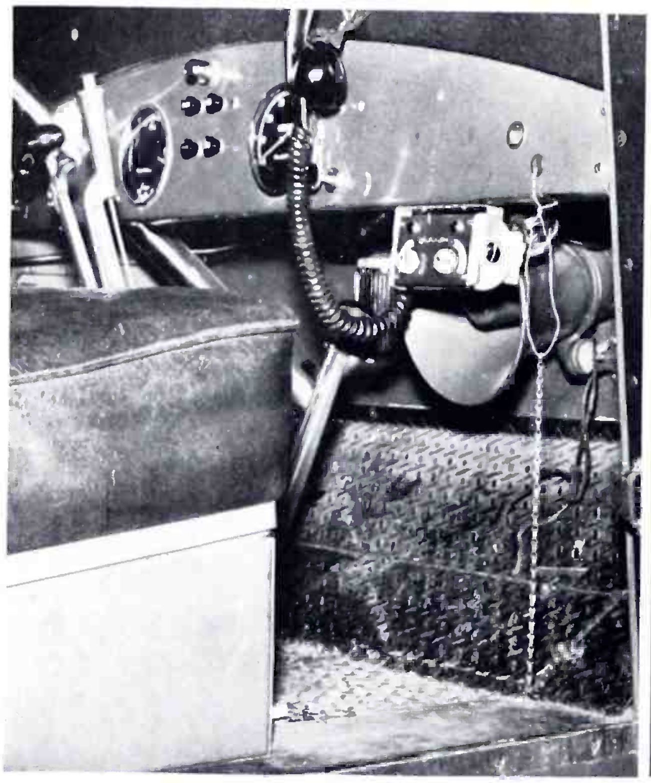

FIG. 1. TYPICAL INSTALLATION OF HANDSET, CONTROL BOX, AND RACON SPEAKER ON FIRE APPARATUS.

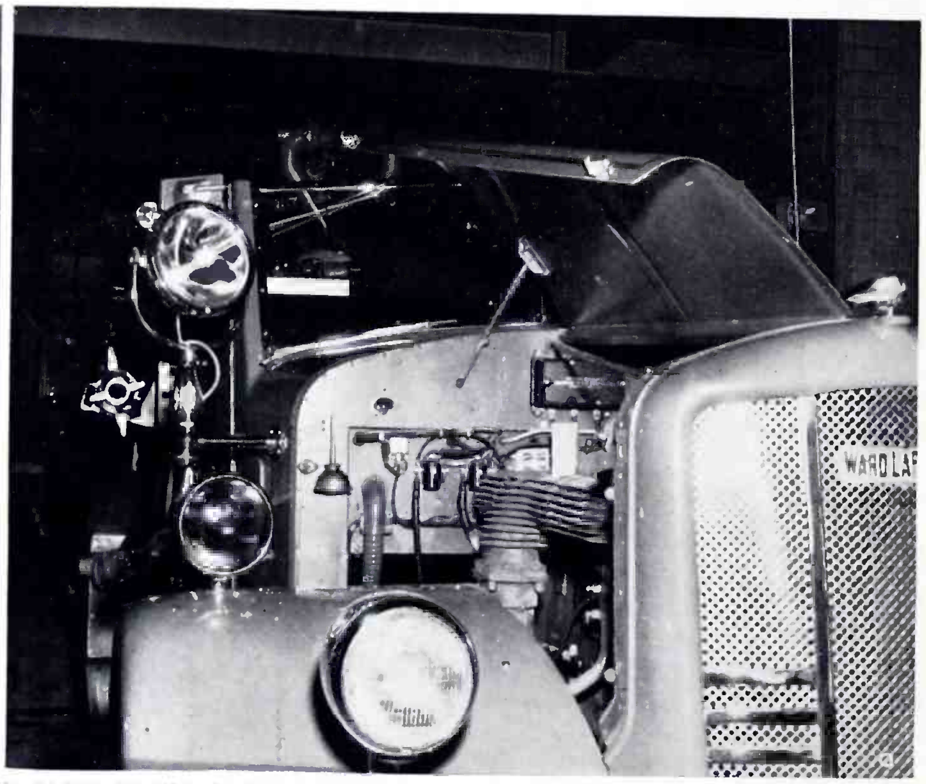

FIG 2. GREENFIELD IS USED TO PROTECT CABLES

is isolated from the other 4 boroughs, although it can draw additional fire-fighting equipment and personnel from either Manhattan or Brooklyn, depending upon the circumstances. It has a heavy fire traffic situation in the spring and fall because of brush fires. This fact, due to its suburban character, would seriously impair operating efficiency if the Richmond radio system were an adjunct to any other. Manhattan and the Bronx, although they are only connected by bridges, operate in fairly close conjunction from a fire-fighting standpoint. Brooklyn and Queens are contiguous entities. The City-wide frequency can be cut in at each fixed transmitter, merely by throwing a switch at the associated control console. Transmitters on the City-wide mobile frequency are used in command-level automobiles of the Department, and the fire boats, ambulances, and maintenance trucks. These are vehicles that, in the course of normal duties, may be in any part of the total

power supply, an independent emergency power supply and control facilities, and economic factors of rental or new construction. Then there is the matter of location and elevation as they affect the problems of interference. In an area such as the borough of Manhattan, a transmitting antenna must necessarily be high enough to avoid the sharp shadowing effects from tall buildings nearby. Yet while an antenna so located would assure local coverage it would be a source of interference to certain communities within a radius of 100 miles. If used also as a pickup antenna, it would bring in undesired signals all too readily.

After careful evaluation of all pertinent data, it was concluded that a height of 300 ft. above sea level would be the optimum elevation for all the transmitting antennas except in Richmond, where there are 400-ft. ridges, necessitating an antenna elevation of 460 ft.

The final plan worked out in this way: It was decided to use the tower erected

frequency. Also, the tower was designed to carry the extra wind-loading of 6 parabolic antennas for future radio links.

At Queens, a 200-ft. tower was specified for erection on a ridge 200 ft. from the Fire Alarm Central Station, while the Brooklyn Museum offered a support for the Brooklyn antenna. That location is about ¼ mile from the Central Station.

The Central Station in Richmond is 3 miles from the highest spot on Staten Island, the site chosen for that transmitter. Both a land line and a microwave link were provided between the Central Station and the transmitter. It was intended originally to use the link as a standby, but after the initial tests the link proved highly satisfactory, and it was put into regular service at once. At this time of writing, it has been in continuous operation for 3,500 hours.

Equipment Specifications:

While planning of the overall system

proceeded, detailed specifications were worked out. These specs occupied 132 pages, in addition to the Fire Department's standard printed form of proposals for bids. The contract, which covered both the furnishing and the installation of the complete 5-borough system, was awarded to Motorola after competitive bidding. Their mobile units, modified to meet our specs, were used for 660 installations on fire apparatus, sedans, fire boats, maintenance trucks, and other vehicles. The control consoles and fixed transmitters, designed in accordance with our special requirements, were produced by Radio Engineering Laboratories, as subcontractors.

Space does not permit publication of the complete specifications, but excerpts are given here with the thought that they may be useful to officials in other Fire Departments, for reference purposes. The work of preparing them, carried out under the direction of Deputy Chief Thomas P. O'Brien, in command of the Bureau of Fire Alarm Telegraph, was done in strict accordance with fire department practices and, in many respects, the requirements laid down are much more stringent than those generally prevailing in the field of radio communication.

Receiver Specifications:

The most interesting part of the specifications on mobile and pickup receivers concern the performance characteristics and the methods of checking their performance.

Type: The receivers shall be of the double-superheterodyne type, utilizing miniature tubes. Each frequency conversion shall be crystal controlled. At least two limiter stages shall precede the discriminator. These limiters shall be essentially saturated on noise excitation alone.

Sensitivity: Quieting-signal sensitivity test input shall be .8 microvolts or less for 20 db quieting (I. R. E. Standards on Railroad & Vehicular Communication Methods of Testing, 1949, Section 2.8). On useable sensitivity test input, receiver shall exhibit a minimum useable sensitivity of .8 microvolt or less (I. R. E. Sec. 216 and 4.1).

Selectivity: The receiver shall have selectivity characteristics such that an RF signal ±30 kc. from center frequency is attenuated at least 140 db when referred to the on-frequency signal level for 20 db quieting. The selectivity curve shall conform to the following values when referred to center frequency:

3 db	not less than	± 10 kc.
6 db	" "	± 15 kc.
10 db	" "	± 20 kc.
20 db	" "	± 22 kc.
40 db	not greater than	± 25 kc.
60 db	" "	± 26 kc.
80 db	" "	± 27 kc.
100 db	" "	± 28 kc.
110 db	" "	± 29 kc.
120 db	" "	± 29½ kc.

The curve shall be symmetrical within 1 kc. about center frequency.

Tests shall be made by using two signal generators (I. R. E. Sec. 4.2). The following represent minimum acceptable selectivity:

For 1, 10, and 1,000 microvolts standard input, attenuation at ±15 kc. shall be not more than 3 db. For 1 and 10 microvolts standard input, attenuation at ±35 kc., at least 80 db. For 1,000 microvolts standard input at ±30 kc., at least 40 db.

Desensitization: With two signal generators set up according to I. R. E. Sec. 3.3, and the interfering signal generator at +60, +120, and +240 kc., the desired-signal level in microvolts to produce at least 20 db quieting, and at least 12 db $S+N+D/N+D$ shall not exceed the value shown below:

DESIRED SIGNAL IN MICROVOLTS

UNDESIRED FREQ. VOLTS	UNDESIRED FREQ. AT +60 KC.	UNDESIRED FREQ. AT +120 KC.	UNDESIRED FREQ. AT +240 KC.
3	60	30	15
2	40	20	10
1	20	10	6
.4	8	5	3.5
.1	2	1.5	1.3
.06	1.4	1.2	.9

There shall be not more than 6 db desensitizing of the unit with an adjacent-channel signal of 37,000 microvolts impressed across the antenna terminals. In actual tests, this performance is bettered by a ratio of ten times.

Audio Performance: With a signal of 1,000 cycles and deviation of ± 15 kc. at a level of 1,000 microvolts input to the antenna terminals, and the audio output level set at 1 watt, the audio output shall not drop more than .5 db when the input signal is reduced to 1 microvolt.

With a signal of 1,000 cycles and deviation of ± 15 kc. at a level of 1,000 microvolts input to the antenna terminals, the ratio $S+N+D/N+D$ shall not drop more than .5 db when the input signal is reduced to 1 microvolt.

Nuisance Interference: Two equal signals of not less than 68 db above the on-channel effective 20-db quieting signals level, impressed simultaneously across the receiver antenna terminals at frequencies displaced + 60 kc. and + 120 kc. from the desired frequency, shall produce a nuisance interference signal which quiets the receiver not more than 20 db.

Following is the test procedure: Two Measurements model 80 generators shall be connected by suitable connectors and identical cables to the antenna input circuit, and an output meter connected to the loudspeaker voice coil.

1. With both generators connected to the receiver, a record shall be made of the desired-frequency signal level required from each individual generator to produce 20-db quieting. These are the parallel-generator effective sensitivities.

2. Generator No. 1 shall be set at the desired frequency plus 120 kc., and generator No. 2 at the desired frequency plus 60 kc., both with 5,000 microvolts output. At precisely the desired frequency a spurious response will be noted. Exact frequency setting of generator No. 2 can be obtained by discriminator zero-balance indication.

3. Maintaining equal signal ratios of actual power output level to desired-frequency 20-db quieting level, as determined in (1.) above, the RF power output of the two generators shall be reduced simultaneously to that level which results in a 20-db noise-quieting nuisance interference signal. This signal ratio shall be noted in db.

Reception Interference: Two equal signals not less than 85 db above the on-channel effective 20-db quieting signal level, impressed simultaneously across the receiver antenna terminals at frequencies displaced + 60 kc. and + 120 kc. from the desired frequency, shall produce reception interference no greater than that normally experienced from a 10-microvolt or 20 times 20-db quieting-level on-channel signal (whichever is greater) in an unsaturated IF stage.

Following is the test procedure: Using one signal generator only, the input frequency shall be adjusted to discriminator zero balance, and the output level set to 10 microvolts or 20 times 20-db quieting, whichever is greater. At this point, the IF grid meter reading shall be read. This stage must not be saturated.

With two generators connected to the receiver, adjust the signal ratio to give the same IF reading as obtained above. This level should be noted.

Intermodulation: Three FM signal generators in parallel, with standard deviation, shall be connected with appropriate terminations to the receiver input.

The receiver shall exhibit a minimum of 68 db attenuation of two equal signals displaced + 60 kc. and + 120 kc., as measured by a value of 6 db $S+N+D/N+D$ when referred to the useable-sensitivity input level.

The receiver shall exhibit a minimum of 85 db attenuation of two equal signals displaced + 60 kc. and + 120 kc., as measured by a value of 6 db $S+N+D/N+D$ when referred to an input level of 10 microvolts.

(To be continued next month)

VHF IN BRITAIN

(Continued from page 13)

reception. In conditions better than average, that is in areas comparatively remote from a busy highway, lower values of field strength would be sufficient.

In view of the close accord between the predicted and measured field-strength contours of the Wrotham transmissions, it was decided to draw up a preliminary scheme for an FM broadcasting system to cover the major part of the United Kingdom, on the basis of three programmes (Home, Light, Third) for each service area. For certain areas this entailed some considerable overlapping because of the need to provide regional programmes appropriate to the areas concerned. A population survey based on this plan is set forth in Table 2.

In VHF broadcasting, it is not practicable to achieve as close synchronisation between two stations nominally operating on the same frequency as is possible on medium frequencies, and the frequency difference under conditions of interference may give rise to an audible beat note. If, however, the frequency spacing between nominally common-channel stations is made greater than the maximum audible frequency, *i.e.* greater than about 12 kc., the beat note is not heard, and interference occurs only when one or both signals are modulated; with FM, it then takes the form of a rasping noise. Laboratory experiments have been carried out to compare the impressions of a number of listeners regarding the amount of interference which occurs with common-channel FM stations having carrier-frequency differences both within and above the audible range, and also to ascertain the ratio of wanted-to-unwanted signals required to provide protection against interference in these two conditions.

TABLE 2

	1931 Census	FIRST-CLASS SERVICE substantially interference-free	SECOND-CLASS SERVICE (or better) motor car interference tolerable
England	37,359,000	33,285,000 (89.0%)	36,724.000 (98.3%)
Wales	2,593,000	2,078,000 (80.0%)	2,438,000 (94.0%)
Scotland	4,843,000	3,883,000 (80.2%)	4,014,000 (82.9%)
N. Ireland	1,280,000	943,000 (73.7%)	1,064,000 (83.2%)
	46,075,000	40,189,000 (87.2%)	44,240,000 (96.0%)

It should be noted that if AM were to be chosen for the VHF scheme, the number of broadcasting stations required would be approximately three to four times as many as those required if FM were chosen, for the same grade of service. This would involve heavy capital expenditure on technical equipment, buildings, and the necessary high-grade lines. Moreover, there would be difficulty in obtaining agreement to the erection of such a large number of high masts. In addition, the running costs would be very seriously increased.

Common-Channel Interference:

In planning a national VHF broadcasting service within the frequency band available, common-channel working may be necessary, whichever system of modulation is used, since it may not be possible to assign a separate frequency to each transmitter. Moreover, channel sharing by agreement will no doubt be necessary with stations in western Europe. Common-channel stations would be spaced geographically as far apart as possible so that interference would occur only when the tropospheric conditions favoured long-distance transmission; this will be for a comparatively small proportion of the total time. Long-distance field-strength measurements of transmissions from experimental VHF pulse transmitters, extending over a period of some two years, have provided valuable, though as yet incomplete, information on the values of field strength likely under extreme trophospheric conditions.

As a result of these experiments, it was found that the level of interference does not depend significantly upon whether the programmes used to modulate the wanted and unwanted stations are the same or not. Moreover, there is no change in the degree of interference if the frequency difference between the two carriers is increased from a low audio frequency to about 5 kc. There is, however, a reduction of interference by about 6 db if the frequency spacing is increased to 15 kc.

The allocation of frequencies to the various transmitters forming part of the provisional national scheme will be so planned that interference will not occur for any listener within the service area for more than 5% of the time on the worst days in the year, *i.e.* when propagation conditions are conducive to long-distance transmission. Some slight relaxation of the ratio of the wanted to interfering field strength that would otherwise have been necessary to avoid interference in any circumstances may therefore be permitted. The conception of *tolerable interference* has accordingly been introduced, which refers to the grade of interference that would be tolerated by all but the most discriminating listeners.

Table 3 shows the required ratio, expressed in decibels, of the wanted to the interfering carrier for various degrees of suppression of common-channel interference, using FM.

TABLE 3

Beat frequency between carriers	No perceptible interference	Just perceptible interference	Tolerable interference
5 kc.	30 db	25 db	19 db
15 kc.	24 db	19 db	13 db

Adjacent Channel Interference:

The proposed channel spacing for FM stations operating as part of a national distribution scheme is 200 kc., and it is necessary to consider what degree of interference may be experienced from a station operating in the channel adjacent to that to which the receiver is tuned.

This will depend to a considerable extent on the details of receiver design, but in typical cases, for a wanted signal of 1 mV/m, the adjacent channel signal must be from 10 to 20 db less for interference to be quite inaudible. For weaker signals, of the order of 0.1 mV/m, the adjacent channel signal need be only from 0 to 10 db below the desired signal. On this basis it will not prove difficult to plan a national scheme, the geographical situation of the stations being so chosen that adjacent-channel interference is avoided.

FM Receivers:

As mentioned earlier in this article, the adoption of a VHF service would mean that listeners would have to buy new receivers or else fit adaptors if they are to take advantage of the service. In a first-class service area, *i.e.* where the field strength equals or exceeds 1 mV/m on FM, experience in the U. S. A. and Germany, as well as in this country, indicates that inexpensive receivers can provide good service. In second-class service areas more expensive receivers are necessary.

Two essential requirements for a good FM broadcast receiver are:

1. That it should be provided with a limiter set to operate efficiently at the minimum signal strength for which the receiver is designed.

2. That oscillator drift (a difficulty inherent in any VHF receiver) should be reduced to reasonable limits.

Requirement No. 1 is of the greatest importance, for unless the limiter does become fully operative, the principal advantage of FM — that of noise suppression — is partially or wholly lost. Requirement No. 2 is met, in the more expensive class of receivers, by the provision of quartz stabilised oscillators or by the provision of automatic frequency control. In the cheaper sets, some form of thermal element may be incorporated to prevent drift as the receiver warms.

Experience of British-made FM receivers has not been extensive. Most of

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VHF IN BRITAIN

(Continued from page 26)

the listening tests on the Wrotham transmissions were carried out with receivers built to a B. B. C. specification. These receivers are fitted with automatic frequency control and incorporate the latest type of limiter for AM reception, which can be switched in or out of circuit at will. Other receivers used for the laboratory and field tests included one make with a crystal controlled superheterodyne oscillator and another of relatively simple design,[4] which was developed in the B. B. C. Research Department laboratories. Two models of this receiver were made, one being a (6 + 1)-valve receiver with external loudspeaker, and the other a 6-valve car receiver.

From the experience which has been gained with teams of listeners, both technical and lay, the conclusion is drawn that the tuning of an FM receiver need not be difficult, and that in receivers not provided with automatic frequency control little trouble is experienced with oscillator drift after the first few minutes of switching on. The degradation of quality due to incorrect tuning is comparable with that encountered in conventional medium-wave and long-wave receivers when maladjusted.

[4] "A Simple F.M. Receiver for the 90-Mc. Broadcast Band," by J. G. Spencer, *Wireless World*, *Nov. and Dec.*, 1951.

TV PROFIT

(Continued from page 17)

Space is provided for the addition of a transmitter of 5 to 10 kw. output.

It has been stated that a separate ventilating system is usually provided for transmitters of 5 kw. and over, and that this same system is often used to cool equipment racks. In a small station, such as a Type 1 or 2 installation, this system can be used to heat the building (or part of it) in the winter. A typical system of this sort is is diagrammed in Fig. 3. Fan A draws in exterior air which is piped to the bottom of the transmitter racks. Fan B takes air from the top of the transmitter and the other equipment racks, and exhausts it outdoors. Valve C provides a bypass for some of this air, and is therefore a control for the average temperature of the circulating air, Valves D, E, and F operate in conjunction, with valves D and E opening as valve F closes, to regulate the amount of heated air which is circulated through the room. Valves G, H, and I control the air drawn through the individual equipment racks, since some generate more heat than others.

Editor's Note: *Part 2 will be concluded in the following issue.*

TV FREEZE ENDED APRIL 14

Announcement that the TV freeze had ended came from the FCC just as the last form of this issue was ready for press. The Final Report and plan for nation-wide service occupied 716 pages of text, maps, and charts. This, of course, is the basic work of the Commission, from which many months of hearings will proceed after an initial 75-day application period.

Applications for non-commercial educational stations and for all stations in Alaska, Hawaii, Puerto Rico, and the Virgin Islands will be processed starting July 1. Next will come applications resulting from changes in channel assignments to 30 of the VHF stations now on the air.

Then the Commission will tackle applications from VHF-UHF cities located 40 miles or more from the nearest city where a TV station is already operating. In other words, the no-station areas will receive first consideration.

The table of assignments provides for 2,053 VHF and UHF stations in 1,291 communities. Minimum co-channel distances have been established for three zones. In northeast Zone 1, extending from Maine to Virginia, and west to Ohio, Illinois, and Wisconsin, these are 170 miles on VHF and 155 miles on UHF. In Zone 2, covering almost the remainder of the Country except for the southern area, the distances are 190 and 175 miles, while in Zone 3, a strip from Florida to Texas, they are 220 and 205 miles.

Copies of the Final Report are not available from the FCC. However, the Report will be published in the Federal Register, which can be ordered from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The price will probably be $1.00.

A complete summary of the new allocation plan and the standards is already under way for publication next month.

New FCC Applications

This list includes applications for mobile, point-to-point, control, and relay communication facilities filed with the FCC during January, 1952.

This listing, provided 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 operating power, 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	q Control station
b Base station	r Repeater or relay
m Mobile unit	s Fixed
mm Marine Mobile	t Temporary
p Portable unit	u Operational

w Watts

Make of equipment is indicated by one of these letters:

AA Aircraft Radio	M Motorola
A Hallicrafters	N Gen. Railway Signal
B Belmont-Raytheon	NN Ntl. Aero. Corp.
BB Northern Radio	O Farnsworth
C Comco	P Philco
D Doolittle	Q Collins
E W. Coast Electronics	R RCA
F Federal Tel. & Radio	S Railway R. & S.
G General Electric	SS Sonar
H Harvey	T Bendix
J Comm. Equipment	U Western Electric
K Kaar	W Westinghouse
L Link	WW Wilcox

X Miscellaneous

AERONAUTICAL & FIXED

Aeronautical Radio Inc 1523 L St NW Washington D C
 Winona Wis 1b 50w 130.9 WW
 Clinton Ia 1b 50w 130.5 WW
 McAlester Okla 1b 50w 130.5 WW
 Jackson Mich 1b 50w 131.3, 131.7 WW

Cordova Air Serv c/o Northern Elec Co
 314 Bell St Seattle 1 Wash
 Chisana Alaska 1b 8w 2.748, 2.922, 4.650, 5.042 5.310, 5.652, 5.622, 5.662, 6.590, 8.015 X

Northern Cons Airline Inc Anchorage Alaska
 Naknek Village Alaska 1b 30w 2.466, 2.922, 3.190, 5.167, 5.652, 5.622 X

FLIGHT TEST

Lockheed Aircraft Corp 1705 Victory pl
 Burbank Calif.
 Alamogordo New Mex 1m 10w 123.3 U

Lab for Electronics Inc 43 Leon St Boston Mass
 1b exp radar 45w 9080mc —; 1b exp radar 8w 122.8mc P

Westinghouse Radio Stations Inc 1625 K St NW
 Washington 6 DC 4m 8w 121.5, 123.3, 123.1 —

Raytheon Mfg Co Foundry Ave Waltham 54 Mass
 Medford Mass 1b 35w 235.4, 314.6, 382.6 G

AERO MOBILE UTILITY

Harris-McBurney Co 297 W Mich Ave Jackson Mich
 1m 6w 121.9 SS

V N Holderman & Sons Inc 890 Oakland Park Ave
 Columbus Ohio 4m 6w 121.9 SS

AIRDOME ADVISORY

Tulairco Inc Tulsa Okla 1b 10w 122.8 —
Buck's Flying Serv Bridgeton NJ 1b 4w 122.8 NN
E Hampton Airport E Hampton NY 1b 4w 122.8 NN
Walston Aviation Co E St Louis Mo 1b 4w 122.8 NN
E W Wiggins Airway Norwood Mass 1b 10w 122.8 T
Tyler Flying Serv Tyler Tex 1b 122.8 NN
Scholter Aviation Co Butler Pa 1b 4w 122-8 NN
C W See Baldwinsville NY 1b 4w 122.8 NN
Northern Cons Airline Anchorage Alaska
 Platinum Alaska 1b 100w — BB
Horace E Hibbard Auburn Cal 1b 12w 122.8 T
Wm F Zorn Monroe Mich 1b 4w 122.8 NN
Spring Valley Air Park Spring Valley NY
 1b 4w 122.8 NN
John W Thompson Pine Grove Pa 1b 4w 122.8 NN
Herbert H Erdman Hershey Pa 1b 4w 122.8 NN

CIVIL AIR PATROL

CAP Raceland Ky 1b 75w 4.585, 4.325 X
CAP Scarsdale NY 1b 275w 4.507, 4.585 10w 148.14
CAP Mich Wing Sqdn 638-4 Grp 8 Cadillac Mich
 3b 10w 148.14 X; 6m 35w 4.507, 4.585 X
CAP Mich Wing Sqdn 1 Grp 1 Flint Mich 2b 10w
 148.14; 1b 10w 148.14 150w 4.507 150w 4.585 X
CAP Mich Wing Sqdn 631-1 Grp 1 Flint Mich
 1b 10w 148.14 X
CAP Rush City Flight Pine-Chicago Sqdn Box 83
 Pine City Minn
 Rush City Minn 1b 10w 148.14 1w 5.5 T; 3m 10w 148.14 1w 5.5 T
Conley Flight Rte 1 Ben Hill Ga 1b 75w 4.325,
 4.585 X; 4m 75w 3m 6w 10m 25w 4m 15w 3m 40w 4.325, 4.585 X; 1b 1w 5.500 X; 5m 10w 148.14 X; 5m 1w 5.5 X; 1b 10w 148.14X
Dodge County Flight Beaver Dam Wis 1b 75w 4.507,
 4.585 1w 5.500 10w 148.14 X; 4m 1w 5.500 X; 1m 10w 148.14 X
CAP Austin Sqdn Austin Minn 3b 10w 148.14
 1w 5.5 75w 4.5075 AT; 1m 1w 5.5 X
CAP Minn Wing Minneapolis Minn 1b 150w 4.507,
 4.585 10w 148.14 75w 4.507, 4.585 —

(Continued on page 28)

NEW APPLICATIONS

(Continued from page 27)

CAP Binghampton Grp Harpursville NY 1b 28w 2.374, 4.507, 4.585, 5.500 X; 1b 1w 5.500 M; 4m 6w 4.507, 4.585 R; 5m 1w 5.500 M
CAP NY Wing Catskill NY 2b 150w 4.585, 4.507 X
CAP Palatka Sqdn Grp II Fla Wing Palatka Fla 1b 75w 4.325, 4.585 X

POLICE

City of Rochester N Y 1530 Highland av 2 tb 102w 24.55 Speedmeter
County Sheriff Eureka Kans 1b 124w 39.58; 10m 62w 39.58 G
Panola County Sheriff Batesville Miss 2m 120w 42.02, 42.18 L
City of Brookings Ore Box 256 2m 60w 39.78 M
Cumberland County Sheriff Portland Me 1b 120w 39.62 M; 10m 60w 4m 3w 39.62 M
Boro of Bedford Pa 1b 30w 155.49 R; 10m 30w 155.49 R
Wilbus S Menges Dighton Mass 1m 35w 44.74 L
Osage County Sheriff Lyndon Kans 1b 120w 39.58; 5m 120w 39.58 G
Clark County Sheriff Las Vegas Nev 1b 500w 45.10; 1b 3w 945 G
Nr Las Vegas Nev 1b 3w 958 G
Mesquite Nev 1b 124w 45.10 —
City of Sandersville Ga 1b 25w 155.43; 5m 25w 155.43 G
Musselshell County Sheriff Roundup Mont 1b 120w 39.82 M; 10m 60w 2m 3w 49.82 M
Culberson County Sheriff Van Horn Tex 3m 15w 42.9 G
Rooks County Sheriff Stockton Kans 1b 37.18; 6m 37.18 G
Kansas State Patrol 10th & Van Buren Topeka Kans
Dodge City Kans 1b 120w 44.98 M
Louisiana State Patrol Box 1791 Baton Rouge La
Nr La Place La 1r 120w 72.1 M
City of River Falls Wis 2m 30w 39.42 M
Arizona State Patrol 1739 W Jackson Phoenix Ariz 10tb 5w 24.55 —
Rankin County Sheriff Brandon Miss 5m 120w 42.02, 42.18 L
Boro of Butler NJ W Belleview Ave 1m 120w 37.1 M
Police Dept Bellows Falls Vt 1b 100w 39.1 15m 60w 39.1 M
Police Dept Pontiac Ill 1b 30w 155.25 4m 12w 155.25 M
Doniphan County Sheriff Troy Kans 1b 124w 39.58; 5m 124w 39.58 G
Monroe County Sheriff Albia Ia 1b 120w 37.10 6m 60w 37.10 M
Summit County Sheriff 2124 Broadway Akron Ohio 2tb .2w 2455 speed meter
Wayne County Sheriff Lyons NY 1b 60w 39.18 G 25m 60w 39.18 F
Calif State Police Patrol Sacramento Calif
Courtwright Tank Calif 1b 150w 42.34 G
Barstow Calif 1q 120w 74.1 G
Govt Peak Calif 1b 150w 42.34; 1r 120w 74.14 G
Roseville Calif 1b 150w 42.34 G
City of Glendale Wis 1b 150w 46.02 8m 100w 46.02 K
Town of Narrows Va 5m 62w 39.5 G
S C State Police Patrol Box 1357 Columbia S C
Nr E Kershaw S C 1b 30m 159.27 M
City of Live Oak George West Tex 1b 120w 37.26 5m 120w 37.26 M
Homer Greer (North Beach Patrol) 30732 Malibu Rd Malibu Calif 2m 10w 157.47 T
Butler County Sheriff David City Neb 2m 60w 42.30 M
Police Dept City Hall Talmadge Ohio 2p 10w 2455 speed meter
Clinton County Mut Aid Fire System
Plattsburgh NY 1b 60w 46.10; 10m 60w 46.10, 4622; 1q 60w 74.57; 1r 60w 7457 G
Town of Walterboro NC 1b 15w 155.19; 5m 15w 155.19 R
Brown County CD Council Aberdeen SD 1b 3-120w 46.8; 15m 3-120w 46.5 L
Parish of Calcasieu Court House Lake Charles La
Sulphur La 1b 120w 39.5 M
City of Elyria Ohio 131 Court St 1m .2w 2455 X
Angelina County Sheriff Lufkin Tex 1b 120w 37.18; 5m 120w 5m 40w 37.18 M
Worth County Sheriff Grant City Mo 1b 140w 155.73, 155.37; 5m 80w 155.73 M
Chief of Police Holbrook Ariz 2m 80w 39.18 M
City of Augusta Me 1b 13w 39.1; 12m 75w 39.1 R
City of Leland Miss 1b 120w 155.67, 5m 60w 155.67 M
Village of N St Paul Minn 1b 30w 156.75; 10m 30w 156.75 R
Div of Comm PO Sta D Box 183 Cincnnnati Ohio 1m 10w 2.455 X
Colorado State Police Patrol 1950 31st St Denver 5 Colo
Nr Genoa Colo 1b 150w 42.46 P
Cameron Parish Cameron La 1b 120w 39.5; 10m 120w 4m 3w 39.5 M
City of Anchorage Ky 1b 30w 155.61; 3m 30w 155.61 M
Warren County Sheriff Lake George NY 1b 120w 39.18; 65m 60w 39.18, 39.34, 39.02 M
City of Terrell Tex 1b 120w 37.26; 3m 120w 7m 40w 37.26 M
Jones County Sheriff Anamosa Ia 1b 120w 37.1 M
Haskell County Sheriff Sublette Kans 1m 140w 39.58 M
Pocahontas County Sheriff Pocahontas Ia 1b 150w 37.1L
City of Vassar Mich 1b 0-300w 39.1; 4m 0-300w 39.1 M
Kershaw County Sheriff Camden SC 1b 120w 158.73; 15m 60w 158.73 M
Village of Ruidoso NM 1b 54w 39.9; 1m 39.9; 2p 39.9 M
Willits Police Dept Willits Calif 1b 25w 155.61; 10m 25w 155.61 G
Town of Secaucus NJ 1b 120w 155.07; 12m 60w 155.07L

FIRE

Community Fire Prot Dist 8847 St Charles Pl Overland Mo
St Johns Mo 1b 120w 154.37; 20m 30w 154.37 M
Hauppauge Fire Dist Hauppauge LI NY 1b 120w 46.46; 4m 40w 46.34 2m 3w 46.46 M
Fire Dept 29 Arnold Westfield Mass 1b 120w 46.06; 5m 60w 5m 30w 7m 3w 46.06 M
Lake City Firemans Assn Lake City Fla 1b 24w 154.37; 5m 24w 154.37 M
County of Yolo Fire Dept Woodland Calif 1b 120w 154.37; 25m 30w 120w 10m 60w 154.37 L
Waterford Twp Fire Dept Waterford Mich 1b 60w 154.43 M
City of Chicago Fire Dept City Hall Chicago Ill 1b 500w 154.13; 10m 80w 153.95 M
City of West Palm Beach Fla 2b 50w 154.43 G
Town of Marshfield Mass 1b 120w 33.9 M; 2m 75w 33.9 G
City Fire Dept Stamford Conn 1b 115w 154.13; 20m 30w 154.13 G

FORESTRY

Alabama State Dept of Forestry 607 Monroe St Montgomery Ala
Centerville Ala 2b 30w 159.45 M
Sweet Water Ala 1b 30w 159.45 M
Bessemer Ala 1b 30w 159.45 M
Oak Grove Ala 1b 30w 159.45 M
Theodore Ala 1b 30w 159.45 M
Mt Wellings Ala 1b 30w 159.45 M
Selma Ala 1b 30w 159.45 M
Salem Ala 1b 30w 159.45 M
Texas State Dept of Forestry Box 460 Lufkin Tex
Daingerfield Tex 1b 30w 170.42 M
Gilmore Tex 1b 30w 170.42 M
Buna Tex 1b 30w 170.42 M
Salem Tex 1b 30w 170.42 M
Mauriceville Tex 1b 30w 170.42 M
Magnolia Tex 1b 30w 170.42 M
Smithland Tex 1b 30w 170.42 M
Missouri State Dept of Forestry Jefferson Mo
Lincoln Mo 1b 31.10, 31.30 M
New Hampshire State Dept of Forestry Concord NH
Bedford NH 1b — — M
Los Angeles Flood Control Dist Los Angeles Calif 1b 120w 159.27 M
Idaho State Dept of Forestry Boise Idaho
Kendrick Idaho 1b 30w 172.22 C
Kamish Idaho 1b 30w 172.22 C

Nr Coeur d'Alene Idaho 1b 120w 172.22 M
Sandpoint Idaho 1b 120w 172.22 M
Comm of Mass Dept of Forestry 15 Ashburton Pl Boston 8, Mass.
Brimfield, Mass. 1b 48w 31.34 H
Calif State Dept of Forestry Sacramento Calif 36tb 30w 159.27, 159.33, 159.39, 159.45, 170.42, 170.57, 172.37, 172.22 M
Texas State Dept of Forestry Walton Bldg Austin
Junction Tex 1b 40w 31.22 M
SC State Dept of Forestry Box 357 Columbia SC
Westville SC 1b 30w 159.27 M
Georgia State Dept of Forestry Waycross Ga
Ways Station Ga 1b 30w 159.39 M
Irwinton Ga 1b 30w 159.39 M
Trenton Ga 1b 30w 159.39 M
Roopville Ga 1b 30w 159.39 M
Americus Ga 1b 30w 159.39 M
Dublin Ga 1b 30w 159.39 M
Nr Dry Branch Ga 1b 39w 159.39 M

HIGHWAY MAINTENANCE

Town of Greece Hiway Dept Rochester NY 1b 120w 33.1; 20m 30w 33.1 M
Calif State Dept of Highways Sacramento Calif
Berkley Calif 1b 150w 47.02, 47.10 —
Los Angeles Calif 1b 150w 47.02, 47.10 —
Nr La Jolla Calif 1b 150w 47.02, 47.10 —
Redlands Calif 1b 150w 47.02, 47.10 —
Texas Highway Dept Box 1286 Houston Tex
Galveston Tex 1b 120w 47.18; 15m 120w 47.18 M
City Highway Dept Cedar Rapids Iowa 1b 60w 37.9, 25m 12w 37.9 M
Sandusky County Highway Dept Fremont Ohio 1b 70w 33.1; 25m 40w 33.1 G

SPECIAL EMERGENCY

C H Poitevint Dothan Ala 1b 60w 47.58; 2m 30w 47.58 M
La Grange Vet Clinic La Grange Ga 1b 12w 47.54; 1m 12w 47.54 M
Dr Wm A Elinburg Jr Laurenceville Ga 1b 12w 47.5; 1m 12w 47.5 M
Dr Leslie Green Trenton Mo 1b 40w 47.62; 2m 40w 47.62 M
John B Fleming Marshfield Wis 1b 120w 47.46; 1m 80w 47.46 M
Greene Animal Hosp Nashville Tenn 1b 120w 47.5; 3m 120w 47.5 M
E L Mayfield DVM Hopkins Mo 1b 30w 47.54; 2m 30w 47.54 M
E J Janson DVM Gravity Ia 1b 60w 47.62; 2m 30w 47.62 M
Dr Leslie L Parrett Plymouth Ind 1b 30w 47.46; 1m 12w 47.46 M
Flint Ambulance Serv Co Flint Mich 1b 50w 47.5; 5m 45w 47.5 G
Chester A Breecher DVM Storm Lake Ia 1b 30w 47.62; 2m 30w 47.62 M
J H Clements DVM Grinnell Ia 1b 60w 47.54; 2m 30w 47.54 M
Dr Russell L Dettiker Marshfield Wis 1b 120w 47.62; 2m 80w 47.62 M
S G Eddins Galax Va 1b 120w 47.5; 5m 60w 47.5 M
Dr R A Thompson Glencoe Minn 1b 60w 47.54; 1m 60w 47.54 M
John M Holmes DVM Cobleskill NY 1b 60w 47.54; —m 30w 47.54 M
Dr John M Nelson De Kalb Ill 1b 60w 47.66; 2m 30w 47.66 M
E H Pick Remsen Ia 1b 60w 47.66; 1m 30w 47.66 M
C W Potter DVM Homer NY 1b 60w 47.54; 1m 30w 47.54 M
P F Lordi MD Highland NY 1b 60w 47.5; 1m 30w 47.5 M
Dr N C Ralston Mt Pleasant Tex 1b 70w 47.5; 6m 70w 47.5 G
Warren B Rawlings Limerick Pa 2m 20w 35.7 C
Victor O Connell MD Bourbon Ind 1b 60w 47.62; 2m 12w 47.62 M
W R Grant Cartersvllle Ga 1b 12w 47.46; 1m 12w 47.46 M
John L Groh MD Lebanon Pa 1b 120w 159.57; 1m 120w 159.57 L
Bernard Zackon Oley Pa 1b 120w 47.5; 2m 60w 47.5 G

STATE GUARD

Texas State Guard Box 613 Refugio Tex 1tb 75w 27.26 X

POWER UTILITY

Northern Piedmont EC Culpepper Va
Criglersville Va 1b 115w 153.41 G
Cons Gas Utilities Corp Braniff Bldg Oklahoma City Okla
McAlester Okla 2b 30w 60w 153.47 M
Nodaway-Worth EC Inc Marysville Mo
Grant City Mo 1b 140w 153.54 M
City of Seattle Water Dept Seattle Wash
Cedar Falls Wash 1b 150w 48.42 G
Seattle Wash 2b 150w 48.42; 60m 62w 124w 48.42 G
City Water Dept Port Arthur Tex 1b 12w 153.41; 15m 10w 153.41 M
Pacific Gas & Elec Co 245 Market St San Francisco Calif
Santa Maria Calif 1b 120w 153.59 L
King City Calif 1b 120w 153.71 L
Fresno Calif 1q 1w 958 G

(Continued on page 30)

NEW APPLICATIONS

(Continued from page 29)

Newark Calif 1q 1w 954 G
San Jose Calif 1q 1w 958 G
Fowler Calif 1q 1w 954 G
Bucks Lake Dam Calif 1b 120w 153.65 L
Twin Lakes Calif 1b 120w 153.71 L
Calpella Calif 1b 120w 158.25 L
Ukiah Calif 1b 120w 158.25 L
Lindmore Irrig Dist Lindsay Calif
1b 30w 48.18; 15m 12w 48.18 M
Wis Pub Serv 600 N Adams Green Bay Wis
1b 70w 47.74 G
Brillon Wis 1b 40w 47.74 G
Oshkosh Wis 1b 70w 47.74 G
Merrill Wis 1b 70w 47.74 G
Waupaca Wis 1b 40w 47.74 G
Stettin Wis 1b 40w 47.74 G
Edgar Wis 1b 70w 47.74 G
Sheboygan 1b 70w 74.74 G
Stephenson Wis 1b 70w 47.74 G
10m 40w 47.74 G
Menominee & Marinette Lt & Traction Co
Menominee Mich 1b 70w 47.74; 10m 40w 47.74 G
Pub Utility Dist #1 of Clallom County Box 951
Port Angeles Wash 1b 150w 48.46 G
Forks Wash 1b 150w 48.46; 15m 150w 48.46 G
Monongahela Power Co 301 Adams Fairmont W Va
Elkins W Va 1b 90w 47.82 G
Nr Elkins W Va 1b 90w 72.06 L
Board of Water Supply Honolulu TH
1b 50w 47.82; 30m 50w 47.82 G
Niagara Mohawk Pr Corp 535 Washington St
Buffalo 3 NY
Brighton NY 1b 120w 47.82 M
Lockport NY 1b 140w 47.82 M
Maricopa County Mun Water Conservation Dist #1
Box 343 Rte 1 Peoria Ariz
Beardsley Ariz 1b 30w — C
Lake Pleasant Ariz 1b 30w —; 15m 30w — C
Newport Elec Co Newport RI
1b 70w 47.9; 20m 40w 47.9 G
Black Hills Pr & Lt Co Rapid City SD
Custer SD 1b 50w 75.86 G
Arizona Edison Co Inc Douglas Ariz 1b 153.53 R
Pub Utility Dist #1 of Grays Harbor County
Box 220 Aberdeen Wash
Montsano Wash 1b 120w 48.26 M
Elma Wash 1b 120w 48.26 M
Roosevelt Rural Pub Power Dist Mitchell Nev
1b 60w 48.5; 10m 30w 48.5 M
Tri-County Elec Assn Inc Plankington SD
Wessington Springs SD 1b 120w 48.26 M
Southwestern G & E Co Box 1106 Shreveport La
De Queen Ark 1b 60w 48.10 G
Dakota County EC Farmington Minn 1b 150w 37.7 R
Kansas G & E Co 201 W Market Wichita Kans
1b 30w 158.19 M
Nr Oatville Kans 1b 30w 158.19; 5m 25w
10m 30w 158.19 M
Cullman Utilities Board Inc Cullman Ala
1b 60w 153.41; 10m 10w 153.41 M
Virginia Elec & Pr Co 7th & Franklin Richmond Va
Buena Vista Va 1b 120w 48.14 M
Kinble Elec Coop Inc Junction Kans
1b 70w 47.78; 10m 70w 47.78 G
Dominguez Water Corp 21718 S Alameda St
Long Beach Calif 1b 120w 37.66; 20m 120w 37.66 G
New Hampshire Elec Coop Inc Plymouth NH
No Conway NH 1b 120w 47.9 M
Iowa Pub Serv 502 6th St Sioux City Ia
Charter Oak Ia 1b 120w 47.9 M
Sheldon Ia 1b 120w 47.9 M
Rock Valley Ia 1b 60w 47.9 M
Audubon Ia 1b 120w 47.9 M
Ida Grove Ia 1b 120w 47.9 M
Wisconsin Hydro Elec Co Amery Wis
1b 60w 47.82; 25m 30w 47.82 M
Colfax Wis 1b 60w 47.82 M
Cumberland Wis 1b 60w 47.82 M
Durand Wis 1b 60w 47.82 M
Chetak Wis 1b 12w 47.82 M
Trego 1b 12w 47.82 M
New Richmond Wis 1b 12w 47.82 M
Clear Lake 1b 12w 47.82 M
Consumers Pub Serv Brookfield Mo 1b 120w 47.74;
10m 60w 10m 120w 10m 30w 47.74 M
Missouri Western Gas Co Butler Mo
1b 120w 47.78; 12m 30w 47.78 M
Kansas Lt & Pr Co 808 Kans Ave Topeka Kans
Marysville Kans 1b 124w 37.62 G
Eureka Kans 1b 124w 37.62 G
Union Elec Pr Co 315 N 12 Blvd St Louis Mo
Cobden Ill 2r 10w 1975 R
Swanwich Ill 1b 75w 48.38; 2r 10w 1935 R
Merrimac Mo 2r 10w 1935 R
Wood River Ill 1b 10w 1935 R
St Louis Mo 2r 10w 1975 R
Waterloo Ia 2r 10w 1975 R
Electric Energy Inc Box 165 Joppa Ill
1b 10w 1935 R
Northwestern Pub Serv Co Huron SD
Nr Yankton SD 1b 150w 37.58 L
Nr Armour SD 1b 150w 37.58 L
Mitchell SD 1b 150w 37.58 L
Huron SD 1b 150w 37.58; 15m 120w 37.58 L
Boro of Butler NJ 1b 120w 37.66; 5m 60w 37.66 M
Montana-Dakota Utilities Co 831 2nd Ave S
Minneapolis Minn
Whitlash Mont 1b 124w 48.26 G
Nr Chester Mont 1b 124w 48.26 G

Lansing Bd of Water & Elec Light Commissioners
Lansing Mich 1b 24w 153.41 G; 20m 24w 153.41 G; 4m 24w 153.41 M

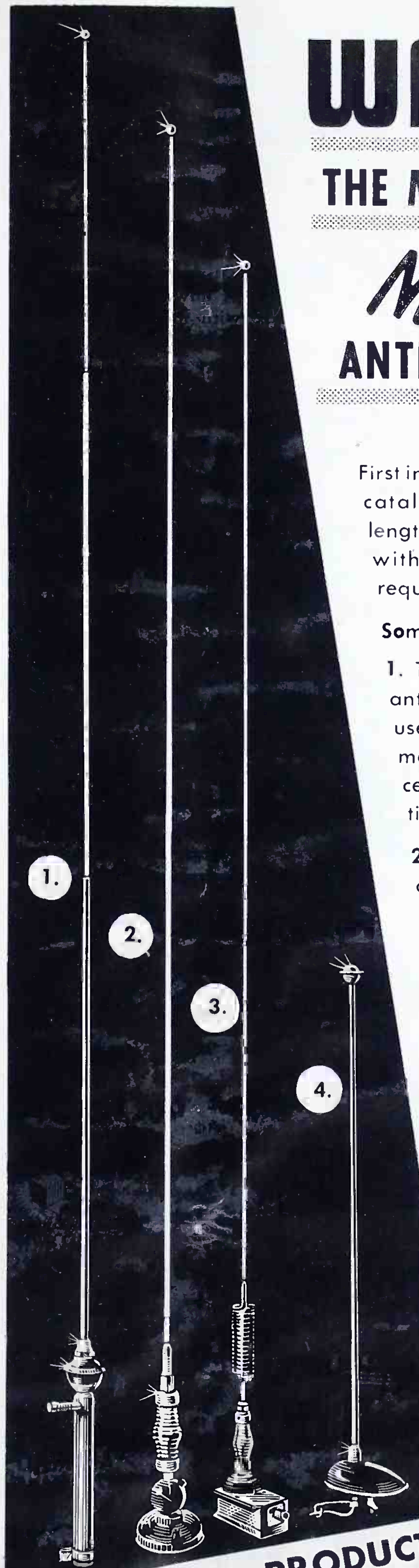
PIPELINE PETROLEUM

Seaboard Oil Co of Del Continental Bldg Dallas
Midland Tex 2b 50w 75.82 G
Sweetwater Tex 1b 70w 48.78 G
Tide Water Assoc Oil Co Mid Continent Div Box 731 Tulsa Okla
Drumright Okla 1b 60w 48.62; 8m 10w 8m 1w 48.62 M
Humble Oil & Refining Co Box 2180 Houston Tex
25tb 150w 48.86 L; 2tb 150w 48.86 M
5tb 150w 48.86 G
Nr Sandy Hook Miss 1b 150w 48.86 L
Dogdell Dist Camp Tex 1b 150w 48.86 L
Gen Petroleum Co Box 6652 Casper Wyo
Meeker Colo 1b 120w 49.02 M
Vernal Utah 1b 120w 49.02 M
Penrod Drilling Co Tex Eastern Bldg
Shreveport La 1tb 70w 49.14 G
Berry Asphalt Co Magnolia Ark 10m 60w 153.11 L
Barnes Exploration Co 118 E Nobles Midland Tex
6m 12w 1.614, 1.628, 1.652, 1.676, 1.700 R
Beaumont Petroleum Co Eldorado Kans
Winfield Kans 1b 60w 153.05; 1p 120w 153.05 M
Sinclair Pipeline Co Independence Kans
Cushing Okla 1r .15w 6805 M
Sand Springs Okla 3r .15w 6805, 6745, 6725 M
Ramona Okla 1b 600w 153.17 M; 3r .15w 6625, 6685, 6605 M
Drumwright Okla 1b 600w 153.17; 70m 60-120w 1-30w 153.17; 2r .15w 6625, 6685 M
Osage Okla 1r .15 6725 M
Independence Kans 2r .15w 6625, 6685; 1r .15w 6745; 1b .15 153.17 M
Cavey Kans 2r .15 6745, 6805 M
Tulsa Okla 1r .15 6605 M
Sohio Petroleum Co Box 1090 Lafayette La
10tb 120w 33.3 M
Carter Oil Co Box 801 Tulsa 2 Okla
Uintah County Utah 1b 120w 48.74 M
Duchesne County Utah 1b 120w, 1b 60w, 4tb 60w; 20m 60w, 48.74 M
Magnolia Petroleum Co Port Arthur Tex
1b 100w 1614, 1628, 1652, 1676, 1700, 2292, 25.02, 25.06, 25.10, 25.14, 25.18 A
G S Taylor Box 114 Snyder Tex 1b 500w 49.10; 4tb 150w 49.10; 10m 150w 49.10 R
Ketchum-Wham Drilling Co Cushing Okla 1b 60w 158.43; 5tb 60w 158.43; 10m 60w 158.43 L
The Ohio Oil Co Findlay Ohio 7tb 70w 48.82; 50m 70w 48.82 G
Midland Tex 1b 300w 48.82 G
Hobbs N Mex 1b 300w 48.82 G
Eldorado Tex 1b 70w 48.82 G
Iraan Tex 1b 300w 48.82 G
Platte Pipeline Co Independence Kans
50m 35w 153.05, 158.43 G
Grafton Ill 1b 60w 153.05, 158.43 G
Montgomery Mo 1b 60w 153.05, 158.43 G
Renick Mo 1b 60w 153.05, 158.43 G
Bosworth Mo 1b 60w 153.05, 158.43 G
Gower Mo 1b 60w 153.05, 158.43 G
Seneca Kans 1b 60w 153.05, 158.43 G
Marysville Kans 1b 60w 153.05, 158.43 G
Deshler Neb 1b 60w 153.05, 158.43 G
Campbell Neb 1b 60w 153.05, 158.43 G
Elwood Neb 1b 60w 153.05, 158.43 G
Wellfleet Neb 1b 60w 153.05, 158.43 G
Ogallala Neb 1b 60w 153.05, 158.43 G
Gurley Neb 1b 60w 153.05, 158.43 G
Big Horn Neb 1b 60w 153.05, 158.43 G
Ft Laramie Wyo 1b 60w 153.05, 158.43 G
Glendo Wyo 1b 60w 153.05, 158.43 G
Glenrock Wyo 1b 60w 153.05, 158.43 G
Panhandle Eastern Pipeline Kansas City Mo
1b 125w 48.7 M
East Ohio Gas Co 1405 E 6th St Cleveland Ohio
Macedonia Twp Ohio 1b 150w 48.62 L
Texas Co (Producing Dept) 135 E 42nd St New York
Nr Buras La 1b 120w 48.94 M
Service Pipeline Co Box 1979 Tulsa 2 Okla
Fullerton Station Tex 1b 60w 49.14 R
Monahans Tex 1b 60w 49.14 R
Benson & Martin 1501 Petroleum Bldg Oklahoma City Okla
Farmington N Mex 1b 70w 48.62; 5tb 70w 48.62; 10m 70w 48.62 G
Deep Well Productions Inc 139 S Beverly Dr
Beverly Hills Calif 1tb 60w 48.9; 5m 30w 48.9 M
Pure Oil Co Box 239 Houston Tex 2tb 150w 33.34 G
Trans-Penn Transit Corp Bradford Pa
Tamarack Pa 1b 120w 49.14 G
Hope Natural Gas 545 Wm Penn Pl Pittsburgh Pa
Nr Cressop W Va 1b 120w 48.7; 1sq 20w 457.75 L
Nr Kent W Va 1sq 20w 456.25 L
Nr McKeefrey W Va 1sq 20w 456.25 L

FOREST PRODUCTS

Park Logging Co Estacada Ore 1b 120w 153.17; 4m 60w 2m 3w 153.17 M
Buck Mt Logging Co Box 57 Shelton Wash
Quilcene Wash 1b 115w 153.11; 12m 24.8w 5m 105w 5m 30w 153.11 G
Ed Halloran Wallawa Ore 1b 50w 49.26; 10m 50w 49.26 G
Crown Zellerbach Corp 1400 Pub Serv Bldg
Portland Ore 1tb 115w 153.23 G
Murphy Lumber Co 619 Failing Bldg Portland Ore
Valley Junction Ore 1sq 150w 49.54 G

(Continued on page 32)



NEW APPLICATIONS

(Continued from page 31)

Saddle.Back Mt Ore 1b 150w 49.54; 25m 150w 49.54; 1sr 150w 72.02 G
Natl Forest Industries Communications 10 E 18th
Eugene Ore 6m 60w — R
Cal-Ida Lumber Co Auburn Calif 1b 120w 49.66 M
Brandy City Cal 1b 120w 49.66; 15m 30w 49.66 M
Long-Bell Lumber Co Longview Wash
Skamania County Wash 1b 30w 153.29 M

RELAY PRESS

Chicago Relay Serv Assoc Chicago Ill
1b 250w 173.32; 40m 30w 173.32 M

SPECIAL INDUSTRIAL

Louie J Macchese Phoenix Ariz
1b 120w 154.57; 10m 25w 154.57 G
Dowell Inc McCamey Tex 1q 10w 75.62 G
Nr McCamey Tex 1b 300w 43.18; 1r 10w 72.18 G
Arizona Cotton Co Casa Grande Ariz
1b 30w 154.57; 20m 30w 154.57 M
Frank Montgomery Midland Tex 1b 500w 49.9 M
Cornell University 302 Lincoln Hall Ithaca NY
2tb 40w 152.99; 10m 3w 152.99 M
Bell Aircraft Corp Box 1 Buffalo 5 NY
Nr Niagara Falls NY 2b 60w 120w 43.1; 16m 60w 43.1 M
Kenmore NY 1b 120w 43.1; 10m 60w 43.1 M
Middletown Sand & Gravel Middletown Ohio
1b 60w 49.9; 20m 30w; 20p 1w L
The Tide Co 1512 Center St Tacoma Wash
1b 20w 152.93; 10m 10w 152.93 K
Apache Maid & Lost Eden Ranches Rimrock Ariz
Nr Long Valley Ariz 1b 30w 43.06 M
Nr Rimrock Ariz 2b 30w 120w 43.06; 20m 30w 43.06 M
Geological Well Serv 230 White Bldg Abilene Tex
6m 150w 43.02, 4p 150w 43.02 R
Georgia Kaolin Co Dry Branch Ga
2tb 60w 154.49 L; 2tb 30w 154.49 M
United Airchaft Corp 364 Main E Hartford 8 Conn
Windsor Locks Conn 1b 50w 43.14; 1m 1w 43.14 L
Kasper Constr Co Manitowoc Wis 1b 30w 152.87; 6m 30w 4m 2w 152.87 M
MGM Constr Co Concord Calif
1b 150w 30.62; 7m 75w 30.62 M
Fountain Sand & Gravel Pueblo Colo
1b 140w 154.49; 25m 40w 154.49 M
Chas A Wright Agawam Mass 1b 60w 43.14; 8m 30w 43.14 M
Phillips Chemical Co Bartlesville Okla
Nr Exeter Tex 1b 12w 154.49; 10m 12w 154.49 M
Samuel Lesser Ritzville Wash
1b 120w 43.1; 3m 30w 43.1 C
Farnsworth Chambers Co Inc Box 74 Houston Tex
1tb 60w 43.02, 43.14; 2m 30w 43.02, 43.14; 10m 30w 2m 10w 43.02 M
Blackford Bros Constr Co Flint Mich
1b 60w 49.86; 8m 60w 49.86 M
St Louis Ship Building & Steel Co St Louis Mo
1b 30w 43.1; 15m 30w 43.1 M
Denoli Constr Co Box 125 Anchorage Alaska
1b 120w 152.87 M
Elmendorf Air Force Base Alaska
1b 10w 152.87; 10m 10w 153.87 M
A W Walker & Son Mt Sterling Ky 1b 120w 43.14 M
Nr Levee Ky 1b 120w 43.14 M
Frenchburg Ky 12m 10-120w 2-60w 43.14 M
Wantagh Rangers Wantagh NY
1b 15w 27.35; 6m 15w 27.35 SS
Central Mills Inc Dunbridge Ohio
1b 120w 43.14; 12m 60w 43.14 M
Cygnet Ohio 1b 120w 43.14; 10m 60w 43.14 M
Mission Paving Co Inc Mission Tex
1b 120w 49.9; 10m 120w 49.9 M
Brown & Root Inc Box 3 Houston Tex
Kingsville Tex 1b 120w 22.92 R
Alice Tex 1b 180w 22.92 R
Wixson & Crowe Inc Box 799 Reading Calif
E of Kalispell Mont 1b 60w M
Kalispell Mont 1b 60w 40-50 mc band; 15m 60w 40-50mc band M
GG Griffin Constr Co 4450 E Admiral Pl Tulsa Okla
1tb 50w 43.1 M
Lorenzo Pump & Supply Co Box 175 Lorenzo Tex
1b 70w 49.94; 10m 70w 49.94 G
Bud Inc Watsonville Calif
1b 124w 43.06; 20m 124w 43.06 G
S Jersey Constr Co Riverside NJ
1b 120w 49.98; 10m 60w 49.98 G
La Brea Securities Co Santa Maria Calif
1b 10w 43.18; 10m 10w 43.18 M
Rockfield Canning Co Rockfield Wis
1b 80w 43.18; 6m 30w 43.18 M
Jackson Wis 1b 30w 43.18; 4m 30w 43.18 M
Granville Wis 1b 30w 43.18; 4m 30w 43.18 M
Patrick Fruit Corp Sanford Fla
1b 70w 30.58; 7m 70w 30.58 G
Grandview Constr Corp 740 S Fulton Av Mt Vernon NY 9m 10-30w 154.47 M; 4m 3-6w 154.47 L; 1tb 120w 154.47 L
Fansler Excavating & Grading Co Coldwater Mich
1b 60w 49.94; 10m 30w 49.94 M
Ken Coal Co Beaver Dam Ky 1b 150w 152.93; 16m 24.8w 152.93 R
Kannal Coal Co Rte 1 New Waterford Ohio
Columbiana Ohio 1b 60w 43.10; 10m 30w 43.10 R
Rotary Engr & Mfg Co 701 S Pecos Midland Tex
Crane County Tex 1b 500w 43.06; 2m 95w 43.06; 1usr 120w 74.50 M
Durn Bros Inc 801 Mercantile Bldg Dallas Tex
Nr Houston Tex 1b 150w 30.62; 10m 150w 30.60 M
W E Graham Constr Co Box 268 Cleveland NC
21m 60w 30w w 49.86 M
Halliburton Oil Well Cementing Co Duncan Okla
5tb 70w 49.74 G
J H Fleming Stephensville Tex
Nr Stephensville Tex 2b 70w 49.9; 6m 70w 49.9 G
Northern Gravel Co Muscatine Ia 1b 60w 30.58; 20m 30w 30.58 M
Sherman Thomas Madera Calif 1b 150w 49.78; 13m 150w 49.98 G
Idaho Egg Producers Caldwell Idaho
1b 50w 49.98; 10m 30w 49.98 L
Williamson Well Serv Co Odessa Tex
1b 70w 30.58; 10m 70w 30.58 G
D W Falls Constr Co Albuquerque NM
1tb 60w 43.02; 43.14; 10m 30w 43.02 M
J Leonard Neal Kingman Ariz 10m 120w 43.02 M
Hall & Son Inc 1022 Santa Rosa Ave Santa Rosa Cal
6m 60w 43.14 M
Inland Steel Co Price Coal Mine Wheelwright Ky
1tb 24.8w 152.87 G; 2m 24.8w 152.87 G; 2m 4w 152.87 D
Metropolitan Paving Co Box 3686 NW Station
Oklahoma City Okla 1b 125w 43.02; 1tb 152w 43.02; 20m 125w 43.02 G
W G Moore & Son Phillipsburg Pa
Nr Houtzdale Pa 1b 60w 152.99; 6m 15w 152.99 R
J D Camp & Son Wasco Calif 1b 120w 154.57; 6m 60w 154.57 L
Narramore Welding & Constr Co Marysville Okla
10m 60w 49mc band L
Peter Salvacci Waltham Mass 1b 120w 30.62; 1m 60w 30.62 L
Delaware Drillers Phillips Talley Bldg
San Angelo Tex 1usq 72.5 T
Nr San Angelo Tex, 1b 20w 1b 400w 25.26 C; 2sr 75.42 T
Sill Properties Inc Bakersfield Calif
1b 60w 49.9; 10m 30w 49.9 M
Copano Cattle Co 408 Victoria Bank & Title Bldg
Victoria Tex
Rockport Tex 1b 120w 43.1 M
Cons Vultee Aircraft Corp San Diego Calif
1b 10w 154.47; 35m 15-10w 20-1w 154.47 M
Southwestern Formation Logging Corp
Midland Tex 1tb 70w 49.86; 10m 70w 49.86 G
Geolog Inc Continental Bldg Dallas Tex
10tb 70w 49.94; 15m 70w 49.94 G

Construction Aggregates Corp 1 E 42nd St, N Y
21m 8-30w 13-3w 43.18 M

LOW POWER INDUSTRIAL

New England Pr Serv Co 441 Stuart St Boston Mass
12m 3w 154.57 M
General Rwy Signal Co 881 West Av Rochester NY
17m 3w 154.57 G
General Motors Res Corp 3044 W Grand Blvd
Detroit Mich 5p .5w 154.57 M
C & G Supply Co 2502-6 Jefferson Av
Tacoma Wash 5p 1w 154.57 A
R B Rennaker 709 S Duxton Arlington Heights Ill
8m 3w 154.57 M
Baird Associates Inc 33 Univ Rd Cambridge Mass
6p 1w 154.57 M
Don Brickley 4101 Pittsburg Av Chicago 34 Ill
2m 3w 154.57; 4p 154.57 M
Lebanon Elec 66 E Sherman Lebanon Ore
5m 2w 42.98 M
Dept of Pub Wks Bureau of Sanitation
Sewer Maint Div Los Angeles Calif
Los Angeles area 10p 1w 154.57 M
Standard Oil Co of Calif 225 Bush St
San Francisco Calif 20m 250w 158.37 M
Maydwell & Hartzell Inc 518 11th St
San Francisco Calif 12m 2w 33.14 H
Maddor & Hopkins 8506 Dixon Av Silver Springs Md
6m 1w 154.67 M
Communications Engrg Co 1630 N Industrial Blvd
Dallas Tex 5m 2w 42.98 A
Owens-Illinois Glass Co N Laurel St
Bridgeton NJ 10m 3w 154.57 M

COASTAL & MARINE RELAY

Star & Crescent Boat Co San Diego Calif
1b 50w 2.738 X

ALASKAN CONTROL

Arctic Radio Tel Co 206A Glover Bldg Anchorage
Alaska 1p 50w 2.482, 2.986, 5.167, 5.207
5.622, 5.625 X

ALASKAN FIXED PUBLIC

Fred C Brechan 314 Bell St Seattle Wash
Spruce Creek Alaska 1b 30w BB
Harold Strandberg Box 2099 Anchorage Alaska
Folger Alaska 1b 40w 3.190, 5.167 Q

COASTAL & FIXED

Rudolph Carlson 314 Bell St Seattle Wash
Anchorage Bay Alaska 1b 60w 2.512, 2.382
2.430, 3.190, 2.632 BB

RAILROADS

Chesapeake & Ohio Rwy Co 823 E Main Richmond Va
Russell Ky 2b 25w 160.89, 161.37 W
Chicago Great Western RR Co 309 W Jackson Blvd
Chicago Ill 1b 60w 159.57, 160.17 S
So St Paul Minn 1b 60w 159.57, 160.17 S
Waterloo Ia 1b 60w 160.17, 159.57 X
Oelwein Ia 1b 60w 160.17, 159.57 X
S Freeport Ill 1b 60w 160.17, 159.57 X
Dyersville Ia 1b 60w 160.17, 159.57 X
St Louis-San Francisco RR Co Olive & Jefferson
Springfield Mo 10m 1w 160.71 N
Union Pacific RR Co 1416 Dodge Omaha Neb
Ogden Utah 1b — M

TAXICABS

Drake Cab Co Huntsville Ala
1b 15w 152.45; 20m 12w 157.71 K
Terminal Cab Co El Paso Tex
1b 60w 152.45; 20m 30w 157.71 M
Carter Cab Co Cape Girardeau Mo
1b 60w 152.39; 15m 10w 157.65 M
Yellow Cab Co Waterloo Ia
1b 60w 152.39; 20m 12w 157.65 M
Water Street Taxi Milford Mass
1b 30w 152.33; 2m 30w 157.59 M
Zero Cab Co Iron Mt Mich
1b 30w 152.27; 4m 10w 157.53 MR
Radio Cab Co Corsicana Tex
1b 10w 152.33; 15m 10w 157.59 G
Independence Taxi Operators Assn Boston Mass
1b 100w 452.05; 500m 15w 452.05 L
Redmond Cab Co Redmond Ore 1b 25w 152.45 T
Plains Taxi Milford Mass
1b 30w 152.27; 6m 30w 157.53 M
Town Taxi South Haven Mich
1b 50w 152.27; 8m 12w 157.53 G
210 Cab Co Harlingen Tex
1b 30w 152.45; 6m 30w 157.71 M
Farmington Taxi Farmington NM
1b 40w 152.27; 10w 40w 157.53 M
Maumee Valley Cabs Inc Perrysburg Ohio
1b 20w 152.39; 5m 20w 157.65 M
Oxford Cab Co Oxford Pa
1b 120w 152.39; 6m 24.8w 157.65 G
Adams Taxi Ironton Mo 1b 152.39; 10m 30w 157.65 M
Elmira Superior Taxi Inc Elmira NY
1b 60w 152.39; 12m 30w 157.65 M
Augusta Cab Co Inc Augusta Ga
1b 120w 152.27; 75m 25w 157.53 M
City Cab Cloquet Minn
1b 60w 152.45; 5m 30w 157.71 M
Joe's Cab De Soto Mo
1b 60w 152.33; 10m 30w 157.59 M
Red Top Cab Co Sylacauga Ala
1b 15w 152.45; 15m 15w 157.71 M

(Concluded on page 34)

NEW APPLICATIONS

(Continued from page 33)

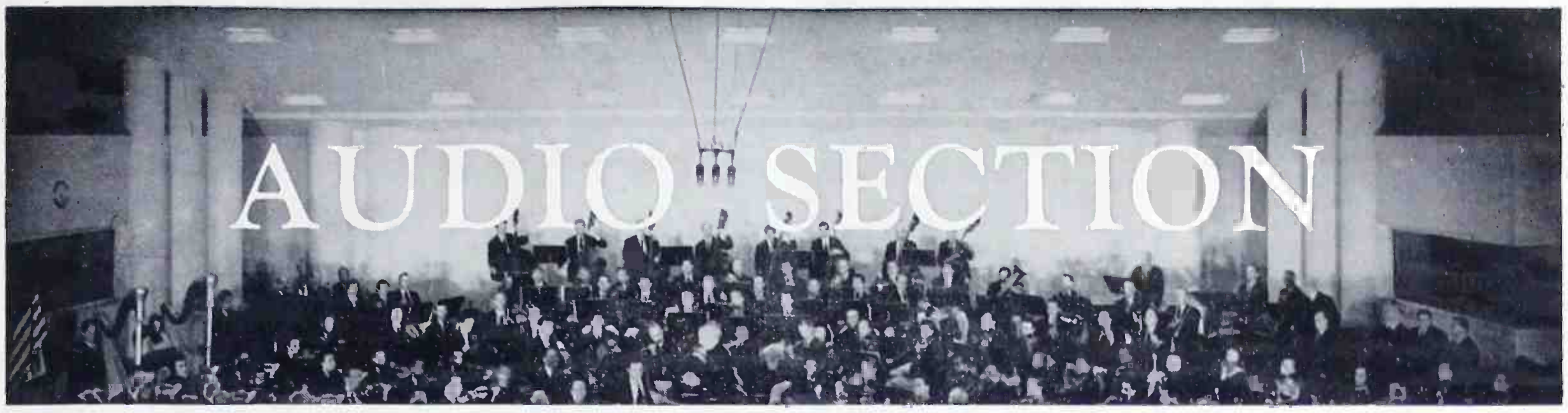
Chagrin Falls Cab Co Inc Bainbridge Ohio
1b 15w 152.45; 5m 15w 157.71 M
De Kalb Radio Cab De Kalb Ill
1b 50w 152.27; 10m 15w 157.53 M
Connelly's Cab Woodstock Ill
1b 60w 152.27; 4m 30w 157.53 M
Hodge Taxi Florala Ala
1b 12w 152.45; 10m 12w 157.71 M
United Cab Co Lake Charles La
1b 120w 152.27; 20m 30w 157.53 M
Arrow Cab Ithaca NY
1b 50w 152.45; 20m 10w 157.71 G
Waverly Cab Co Waverly Ia
1b 12w 152.45; 2m 12w 157.71 M
Yellow Cab Co of Calif Los Angeles Calif
1b 60w 152.27; 50m 15w 157.53 M
Mitchell Cab St Louis Mo
1b 120w 152.27; 50m 30w 157.53 M
Victory Cab Co Black Mtn NC
1b 50w 152.27; 10m 25w 157.53 B
Manhattan Yellow Cab Co Lima Ohio
1b 120w 152.39; 20m 20w 157.65 M
Camp Cab Co 119 N Morgan Morganfield Ky
Camp Breckenridge Ky 1b 152.33; 30m 157.65 R
Hopper's Taxi Oneida NY
1b 120w 152.39; 10m 30w 157.65 M
Bruce's Taxi Serv Stoneham Mass
1b 60w 152.33; 7m 30w 157.53 L
Hawkeye Cab Co Burlington Ia
1b 30w 152.45; 10m 10w 157.71 M
De Vose Taxi Co Macon Ga
1b 30w 152.27; 5m 30w 157.53 M
Shines Taxi Eldorado Ark
1b 30w 152.45; 20m 12w 157.71 M
Dauphins Taxi Serv Bath Me
1b 15w 152.33; 5m 15w 157.59 R
Kenton News Agency Kenton Ohio
1b 27.7w 152.33; 5m 24.8w 157.59 R
Service Taxi Cab Chester SC
1b 60w 152.39; —m 30w 157.65 M
Douglas R Ogilvie Hoosick Falls NY
1b 120w 152.39; 10m 30w 157.65 M
Gustafsons Taxi Serv Hudson Mass
1b 120w 152.45; 10m 30w 157.71 M
Richfield Suburban Cab 6425 Lyndale Minneapolis
Richfield Minn 1b 25w 152.39; 10m 25w 157.65 G
Hughes Taxi Inc Marlboro Mass
1b 120w 152.45; 10m 30w 157.71 M
Alden Terrace Taxi Inc Elmont NY
1b 40w 152.27; 2m 40w 5m 30w 157.30 RM
Red Top Taxi Braintree Mass
1b 30w 152.33; 6m 30w 157.59 M
Broadway Cab Co Santa Ana Calif
1b 30w 152.45; 10m 10w 157.71 M
City Cab Co Copperas Cove Tex
1b 80w 152.39; 15m 30w 157.65 M
Gables Taxi Inc Miami Fla
1b 120w 152.37; 30m 30w 157.65 X
1200 Cab Co Sumter SC
1b 120w 152.45; 10m 50w 157.71 B
Willits Cab Co Willits Calif
1b 10w 152.39; 10m 10w 157.65 G
Ferguson Cab Co Cincinnati Ohio
1b 120w 152.33; 30m 25w 157.59 M
Brewer Cab Co Lanett Ala
1b 60w 152.45; 20m 12w 157.71 M
City & Union Cab Co Springfield Mass
1b 60w 152.45; 15m 30w 157.71 M
Deluxe Cab Co Mansfield Ohio
1b 60w 152.45; 8m 30w 157.71 M
Blue Ribbon Taxi Club Columbia SC
1b 120w 152.39; 100m 50w 157.65 B
Joe Claude Burns Huntsville Tex
1b 20w 152.27; 10m 20w 157.53 M
Veterans Cab Co Platteville Wis
1b 30w 152.33; 3m 30w 157.59 R
Fairhope Taxi Co Fairhope Ala
1b 10w 152.39; 10m 10w 157.65 M
Green Top Cab Tooele Utah
1b 40w 152.39; 10m 30w 157.65 M
Yellow Cab Monahans Texas
1b 30w 152.27; 5m 12w 157.53 M

AUTO EMERGENCY

Bell & Meyer Auto Service Medway Mass
1b 60w 35.7; 6m 30w 35.7 L
Hall Wrecker Service Augusta Ga
1b 60w 35.7; 10m 12w 35.7 M
Johnston Wrecker Service Huntsville Tex
1b 120w 35.7; 2m 60w 35.7 G; 5m 60w 35.7 M

HIGHWAY TRUCKS

Fowler Butane Gas Co Pensacola Fla
1b 120w 35.9; 25m 60w 35.9 M
Propane Gas & Appliance Co New Brockton Ala
1b 60w 35.9; 10m 30w 35.9 M
Noble & Co St Augustine Tex
1b 85w 35.86; 10m 60w 35.86 K
Cox Trucks Midland Tex
1b 500w 35.9; 30m 95w 35.9 M
Endesburg Butane Co Gainesville Tex
1b 70w 35.9; 7m 70w 35.9 G
O T Byrne Clintondale NY
1b 60w 35.74; 5m 30w 35.74 M
Y G Gurley Tarrant Ala
1b 124w 35.78; 10m 124w 35.78 G
W H Bashnight & Co Inc Ahoskie NC
1b 95w 35.74; 25m 25w 35.74 M



REPORT ON HI-FI BUSINESS

WHAT THIS NEW, HUGE MARKET MEANS TO EQUIPMENT MANUFACTURERS AND DEALERS, AND HOW IT WILL AFFECT BROADCASTING — *By* MILTON SLEEPER

WHILE production figures on AM radio receivers show that sets are getting cheaper and cheaper, and that their audio performance is now hardly above minimum intelligibility,[1] more and more high-fidelity radio-phonograph-tape installations are being made in American homes, comprised of audio equipment in which the quality of reproduction is the controlling factor virtually without regard to price.

Well-informed guesstimates put the sales of hi-fi equipment and classical LP records at about $1½ billion for 1952. Where is this business coming from? How did it get under way? Who is making the sales? Where is it going from here?

Because public interest in high-fidelity is beginning to have an effect on all segments of the industry, it is worth while to back up on these questions, to examine the answers and to see just what they mean to manufacturers, dealers, and also to the audio broadcasters. Hence these notes which may seem unrelated at first thought, although they tie together to make a picture of important changes already under way.

Interest in Music:

It isn't exactly clear why the American public is becoming conscious of and interested in good music. Increasing attendance at recitals and concerts all over the Country indicate the fact, without explaining it. The comment has been made that this is only a passing fad, but those who study people and their interests are definite in their opinions that the love of music is a heritage of the human race, limited in expression only by the opportunity to enjoy it. And it is generally held that, in this respect, we are only now catching up with European countries, where the appreciation of music is so highly developed as to be an established, long-ingrained characteristic of the people.

In years past, musicians came from the Continent to make brief tours here because it was profitable, but otherwise unrewarding to artistic temperaments. During the last decade, however, many of the most renowned Europeans have found in the United States such a favorable climate for the expression of their talents that they have come to make their homes here on a permanent basis.

In short, all significant factors offer reliable assurance that the demand for finer music in public performances, and for more realistic reproduction in our homes are not a passing fad, but a new phase in the cultural progress of the American people.

Appreciation of High-Fidelity:

The demand for fine music from FM, records, and tape has far outgrown the original group of hi-fi enthusiasts who initiated the improvement of audio equipment and records, and the development of tape recorders. Those men were chiefly engineers, interested principally in the art of faithful reproduction. They were not so much concerned with listening to musical compositions as in playing spectacular passages which could not be reproduced by conventional equipment.

But today, the rapidly increasing hi-fi sales are being made to people who are discovering that, through the medium of fine audio equipment, FM radio, LP records, and 15-in. tape, they can have musical entertainment in the home that is virtually equivalent to the original performance.

We can expect the market for high-fidelity equipment to be permanent, and to continue to grow because the quality of performance is approaching the ultimate in perfection. The mechanical phonograph flourished because it had great appeal as a novelty, but it faded out because it had no permanent status as a means of realistic reproduction.

AM radio rose to popularity as a scientific marvel of universal appeal, but it settled down to the status of an essential home appliance, important mostly because it furnishes listen-while-you-work soap operas, makes it possible to hear crime stories instead of reading them, and provides communication in the form of news and weather reports.

Then, in succession, came FM radio, LP records, and magnetic tape. Each is capable of development as a source of musical entertainment that provides the illusion of bringing the artists and musicians into our homes.

Of these media, LP records are the most popular, although they are by no means uniform as to audio quality. FM broadcasting varies even more widely, ranging from poor transmission of inferior records to live-talent programs that are perfect as to tonal fidelity and dynamic range. It is possible to make tape recordings of completely realistic quality, but such tapes are not yet available commercially.

Meanwhile, an increasing number of people are installing high-fidelity equipment capable of getting the best possible reproduction from one or more of these sources of music. As the number continues to grow, the demand will increase for FM programs using live talent or 15,000-cycle tape, for LP records of uniformly higher fidelity, and for pre-recorded tape of 15,000-cycle quality.

What Kind of Music?

For some unexplained reason, the term *high-fidelity* has become associated specifically with formal music. Thus, broadcast stations specializing in concert

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[1] Of the home-type AM sets manufactured in February of this year, 25% were clock models!

NOTES ON AUDIO EQUIPMENT

DESCRIPTIONS OF A NEW 18-IN. WOOFER — H. H. SCOTT LABORATORY POWER AMPLIFIER — THE FAIRCHILD 200 SERIES PLAYBACK ARM AND CARTRIDGES

THE new 18-in. woofer shown in Fig. 1 is said to have a cone resonance between 27 and 31 cycles. Made to sell in the low-price range, it has, nevertheless, a 2½-pound Alnico V magnet and a heavy cast-aluminum frame. Voice coil is 2 ins. in diameter, has an impedance of 12 ohms. Overall dimensions are 18¼ by 8 ins. More detailed information can be obtained from *C. S. Manufacturing Company, 4089 Lincoln Boulevard, Venice, California.*

Fairchild's model 200 transcription arm and mount are shown in Figs. 2 and 3. This extraordinary arm is finding wide acceptance among audio enthusiasts as well as in professional applications.

The Pickup Arm:

Although the arm itself is rigid and heavy, with considerable inertia, it is counterbalanced precisely. A ball-type pivot is employed, shown in Fig. 2. The arm is actually supported on the rounded point of the shaft extending vertically upward from the center of the cup. A thin layer of viscous fluid between the ball and the cup provides optimum tracking, and prevents damage to the record or stylus should the arm be dropped.

A turret-type cartridge receptacle is employed, as Fig. 3 shows in detail, which holds 3 cartridges. Any cartridge can be turned into position quickly by the lever projecting through the end of the head. The cartridge in use at any time is indicated by the number appearing at the top of this lever.

As the cartridges are changed, the stylus force is changed automatically to the proper value. This is accomplished by an extension lever, attached to the turret through the contact switch. The extended section of the cartridge-change lever can be seen between the 2 large closely-spaced screws at the right in Fig. 3. A fiber square is held outward against the end of the lever by spring tension. Thus, the position of the lever

FIG. 1. THIS WOOFER HAS 30-CYCLE RESONANCE

determines the vertical position of the fiber section. Another lever within the rectangular part of the arm is attached to the fiber piece, and this lever adjusts the position of the roller wheel which can be seen at the left of the ball in Fig. 2. In the microgroove position of the turret, this roller is lowered so that it rides the rim of the cup, thereby decreasing the stylus force.

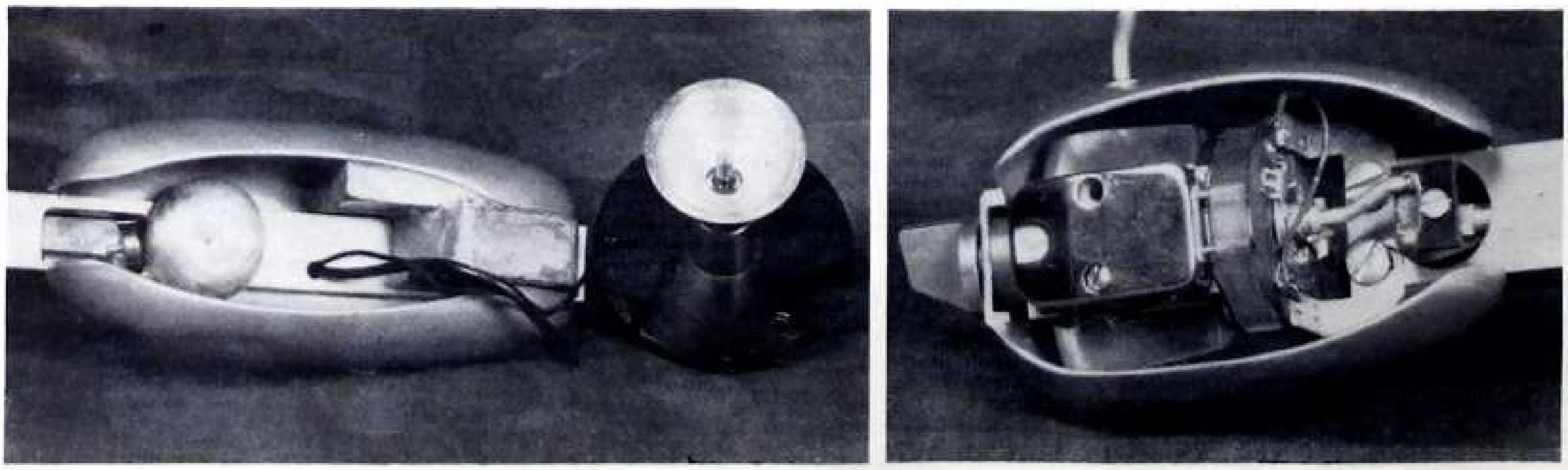
For standard 78 lateral and vertical cartridges, the force is 15 grams; for microgroove cartridges, 6 grams. These forces are variable, but not individually. The difference of 9 grams is fixed. Weights equivalent to those of the cartridges are installed in all 3 turret positions, so that the correct stylus forces are maintained even if only one or two cartridges are used with the arm.

Pickup Cartridges:

Four types of cartridges are available, all with diamond styli. They are:

1. No. 210 — 1.0-mil stylus for microgroove recordings.
2. No. 211 — 2.2-mil stylus for lateral transcriptions and some European 78's.
3. No. 212 — 2.8-mil stylus for standard 78's.
4. No. 213 — 2.0-mil stylus for vertical transcriptions. These can be installed in any combination of 3 or less in the turret head.

Cartridges are of the dynamic moving-coil type. Only the diamond stylus is vertical, being attached to one end of a thin metallic strip which is parallel to the record. The coil is wound on the end of this strip, and is positioned between the magnet poles by two thin pads of damping material. A thin plastic vane attached to the coil is anchored to a small post farther toward the rear of the cartridge, and this holds the stylus and coil in position with respect to the direction of the record groove. Because the vane is flexible in one direction, however, it provides the lateral compliance required. A small pad of damping ma-



FIGS. 2 AND 3. DETAILS OF BALL-JOINT PIVOT AND THE CARTRIDGE ASSEMBLY. STYLUS FORCE CHANGES AUTOMATICALLY FOR MICROGROOVE RECORDS

FIG. 4. LABORATORY POWER AMPLIFIER, USEFUL ALSO FOR HIGH-FIDELITY HOME MUSIC SYSTEMS. A SWITCHED AC POWER OUTLET AND A POWER PLUG FOR EXTERIOR PREAMPLIFIER ARE PROVIDED

terial directly above the stylus is used to obtain vertical compliance for groove pinch.

Inductance of the cartridge is so low that it has virtually no reactance within the audio range. Thus, it can be treated as pure resistance. The cartridge can be connected through a passive equalizer to a low-impedance channel at microphone level. Alternatively, it can be connected directly to the grid of a preamplifier-equalizer at 2.5 millivolts, or through a step-up transformer to a grid at a level of 35 millivolts. This compares to an average output of 25 millivolts from other magnetic cartridges.

Frequency response is guaranteed to be flat within ± 2 db from 20 to 12,000 cycles. Hum and noise are said to be at least 15 db below other professional cartridges. The extremely small moving-coil construction provides exceptional freedom from non-linearity. At maximum recording levels, the total harmonic distortion produced by a cutting amplifier, cutter-head, record, pickup, and pickup preamplifier can be made less than 3%. *Fairchild Recording Equipment Corp., 154th Street and 7th Avenue, Whitestone, New York.*

Fig. 4 shows a laboratory power amplifier, designated type 220-A by the manufacturer. Although relatively inexpensive, it should be an extremely versatile instrument, useful both in the laboratory and for high-fidelity reproduction.

Rated power output is 20 watts. At this level, harmonic distortion is said to be less than .5%, and first-order intermodulation less than .1%. Frequency response is claimed flat from 12 to 55,000 cycles. At the high-level input, 1.5 volts is required for full output; at the low-level input, .5 volts will produce full output. High-level impedance is 1.5 megohms; low-level impedance, .5 megohm. Both inputs are controllable by an input-level adjustment. Hum output is 90 db below 20 watts.

A bulletin is available on request to *Herman Hosmer Scott, Inc., 385 Putname Avenue, Cambridge 39, Mass.*

"MICROPHONES"

A new book, written originally as a textbook for use in training BBC engineers, and now made available to the public. Covers in detail sound theory relating to microphones, and the design and characteristics of ribbon, moving-coil, crystal, condenser microphones. Available in the USA only through RADIOCOM, INC., Great Barrington, Mass. Price $3.25.

DESIGN DATA for AF AMPLIFIERS — No. 18 Positive Feedback

PART 2 — HOW POSITIVE CURRENT FEEDBACK CAN BE TAKEN FROM A VOICE-COIL CIRCUIT TO PROVIDE GREATLY-IMPROVED LOUDSPEAKER DAMPING

POSITIVE feedback for application in voltage-amplifier circuits was discussed in Part 1 of this series. By increasing the gain of an early stage in the amplifier, it was shown to be possible to employ more negative feedback over the complete amplifier, thus decreasing overall distortion.

Positive feedback can be employed in another way, to obtain better speaker damping than is possible with negative voltage feedback alone. This is so because the effective output impedance of an amplifier can only be made to approach zero by means of negative feedback. Even if it were possible to reach zero output impedance, the speaker would not be infinitely damped because the resistive component of the voice-coil impedance would remain effectively in series with the coil, and would prevent perfect swamping of spurious cone movements. As proof of this, a speaker cone will ring when tapped, even with a direct short across the voice-coil terminals.

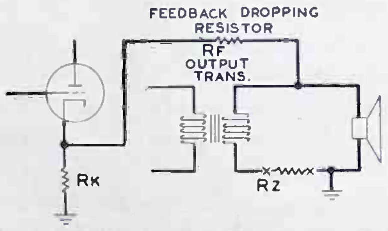


FIG. 1. BASIC CIRCUIT FOR COMBINING VOLTAGE AND CURRENT FEEDBACK FROM LOUDSPEAKER

Evidently, then, the amplifier must be made to exhibit negative output impedance in order to cancel the resistive component of voice-coil impedance. This can be accomplished by means of positive current feedback used in conjunction with negative voltage feedback. Voice-coil resistance cannot, in practice, be cancelled completely, but it is possible to cancel enough of it so that a significant and noticeable improvement in performance is obtained. Also, this change is simple enough so that it can be made on most existing amplifiers.

The basic circuit for this modification is given in Fig. 1. Here, negative feedback is taken as usual from one side of the output transformer and applied through a dropping resistor to the cathode of an early stage in the amplifier. The other side of the transformer is grounded, normally. Thus, feedback is proportional to the voltage applied to the speaker voice coil, but may not be strictly proportional to the current in the circuit. Now, consider the effect of adding the resistor Rz. A voltage directly proportional to the current through the voice coil is developed across Rz, and is applied through Rf to the cathode resistor Rk. This voltage is in phase opposition to the negative feedback voltage, and is ordinarily of smaller magnitude. Thus, it subtracts from and reduces the effective negative feedback.

On slowly-changing applied waveforms, the speaker cone follows the voltage across the voice coil closely. Therefore, under such conditions, current and voltage in the circuit are similar, and the ratio of positive to negative feedback voltage is constant. Rz has little effect. However, most music and speech program material is primarily transient in nature, and the speaker cone may not follow the applied voltage exactly. If the cone lags the applied voltage, the current in the circuit increases, causing a greater voltage drop across Rz. More voltage is subtracted from the negative feedback voltage, and the output of the amplifier is increased, thereby exerting greater force on the cone in the desired direction. If the cone should overshoot, an additional voltage is developed across Rz of the same polarity as the negative feedback voltage, and the output of the amplifier is decreased. Rz can be thought of as an addition to the voice-coil resistance, from which it is possible to take a feedback voltage.

Fig. 2 is a more practical circuit for the experimenter and home constructor. Rz is made variable so that the optimum value can be more easily obtained. Its total resistance should be about 1/8 the voice-coil impedance, in order to provide a reasonable range of adjustment. It should be a wire-wound potentiometer, capable of handling about 1/4 the average output power of the amplifier. Because Rz does consume appreciable power, it is advisable to utilize the full voltage developed across it as feedback. This prevents the use of a feedback dropping resistor. Accordingly, the negative feedback taken from the voice coil must be reduced and Rn is provided for this purpose. So that Rk will not be shunted unduly at either extreme of adjustment for Rn, two resistors of 20,000 ohms are inserted in series.

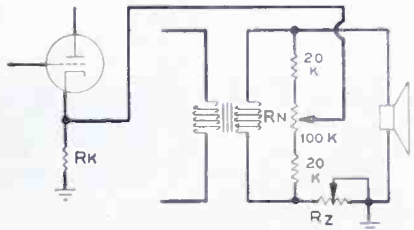


FIG. 2. A PRACTICAL CIRCUIT WHICH PERMITS PRECISE ADJUSTMENT OF FEEDBACK AMPLITUDES

The optimum adjustment for Rz is the maximum position for which Rn can subsequently be set to provide approximately the same overall gain, with a 6db safety factor, as was obtained without Rz.

HI-FI-BUSINESS

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music have become known as "high-fidelity stations." That is very much of a misnomer. It would be much more descriptive to say that they are "concert-record stations." To a considerable extent they use records of inferior audio quality, many of which seem badly worn. Even WQXR-FM, which ranks among the best concert-record stations, sometimes uses discs that have as high a level of needle-scratch as the background noise on AM reception. Obviously, the standing or style of a composer bears no relation to the degree of fidelity with which his music is recorded or broadcast.

The fact is that full-range reproduction adds as much entertainment value to a hill-billy band as to a philharmonic orchestra. Of course, people supply what might be called mental compensation for background noise, needle-scratch, distortion, and limited audio range, at least to a considerable extent. So they accept inferior reproduction of music with which they are familiar, according to their tastes.

But those who abhor barber-shop quartets discover that the presence-effect resulting from full audio range and dynamic range gives a totally new and very engaging quality. Truly, something has been added! Similarly, people who find orchestral compositions tiresome and confusing find new and interesting qualities in such music when they hear it without background noise and distortion, and with full bass and treble response.

Tape Duplicating:

Some of the finest tape recording is done in the broadcast studios. The reason for taping shows is that they can be put on during the daytime, and the tapes aired subsequently, according to the network schedule. What listeners hear, unfortunately, bears only a similarity to what is available from the tape. Even a hundred miles of telephone line is enough to cut the audio range and to introduce intermodulation distortion. One of these days, when duplicating equipment is available, tapes will be sent to broadcast stations. Then FM listeners will hear programs that will sound very much like local, live-talent shows.

The one thing holding back tape now is the lack of suitable duplicating equipment. Record companies now make their original recordings on tape, and use them to cut master records and transcriptions. If tape copies could be made cheaply and easily, they could furnish 15,000-cycle tapes to the broadcast stations. Since they can be run over and

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over without deterioration, that would eliminate the objectionable scratch now heard from records and transcriptions.

In fact, when duplication becomes a commercial reality, the record companies will be able to supply 15,000-cycle copies of their own original tapes. They will probably cost more than LP's but, to those who can afford them, the difference will be worth while.

Several companies are now studying the possibilities of pre-recorded tape, and a little progress has been made in that direction. At present, the prevailing opinion is that 15 ips. runs the cost up too high, and that the consideration of competitive price indicates the use of 7½ ips. tape, even at some sacrifice of audio quality.

That could be. On the other hand, unless tape provides definitely superior performance, there is little to recommend it over discs. Thus it seems that people will only buy pre-recorded tape of the top audio quality, and people who want that quality will certainly pay for it.

Audio Equipment Dealers:

In step with the growing volume of hi-fi equipment sales, the number of dealers specializing in this field is gradually increasing. So far, most of them are in the parts-jobber category. Many have been doing a substantial retail business in tuners, amplifiers, and speakers. Now they are installing audio demonstration rooms in increasing numbers.

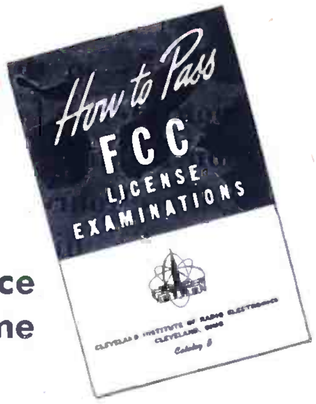
Retail radio stores, handling factory-built audio and television sets, along with electrical appliances, do not have sufficient understanding of hi-fi customers or equipment to get into that business. Or they can't afford to, because an adequate inventory runs into an extremely heavy investment.

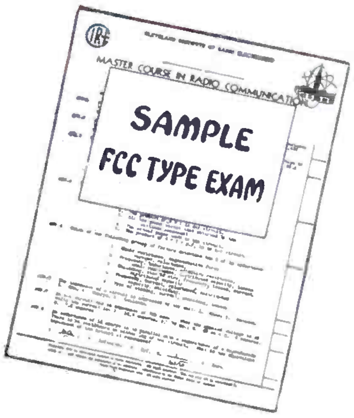
However, public interest is already at such a level that any city of 100,000 population can support a store specializing in hi-fi equipment sales and installation work. Because practically all the present hi-fi dealers started as parts jobbers, they have shied away from handling records. Very few salesmen who know the equipment have any knowledge of music. Yet equipment and records can and should be sold together. Once a customer has bought the components for a home installation, there is nothing to keep him coming back at frequent intervals. But if he can get records at the same store, he will return regularly. Thus, he will see new items of equipment, and thereby expose himself to the opportunity and temptation to improve his initial installation.

NEED A LICENSED RADIO OPERATOR YOU CAN COUNT ON?

HERE'S WHAT TO DO . . .

1. Send for this FREE Material





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

TELLS HOW . . .

TO GO ABOUT SELECTING A MAN

- NOW WITH YOU
- WHO WILL STAY WITH YOU
- WHO WANTS TO GET AHEAD

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

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

Send for Information on These Plans

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

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

Cost is Minor Compared to the Security

WE GUARANTEE

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

HIS FCC LICENSE

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

Cleveland Institute of Radio Electronics
Special Attention: Desk 20
4900 Euclid Avenue
Cleveland 3, Ohio

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

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

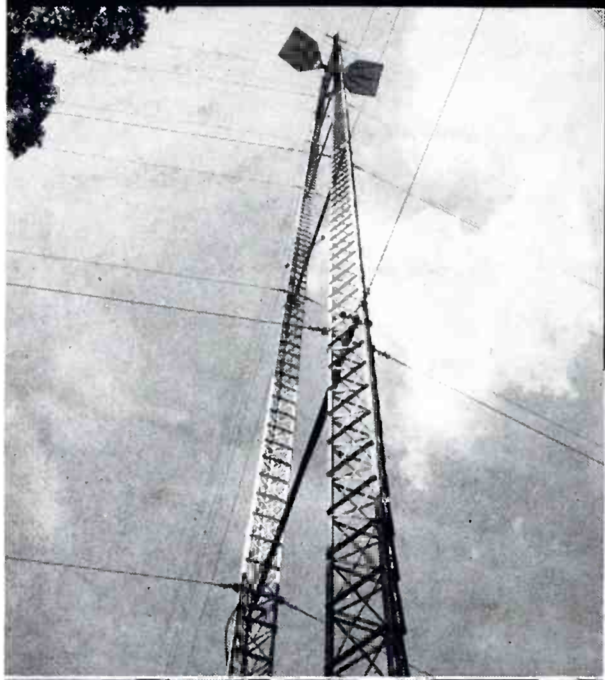
NAME ....

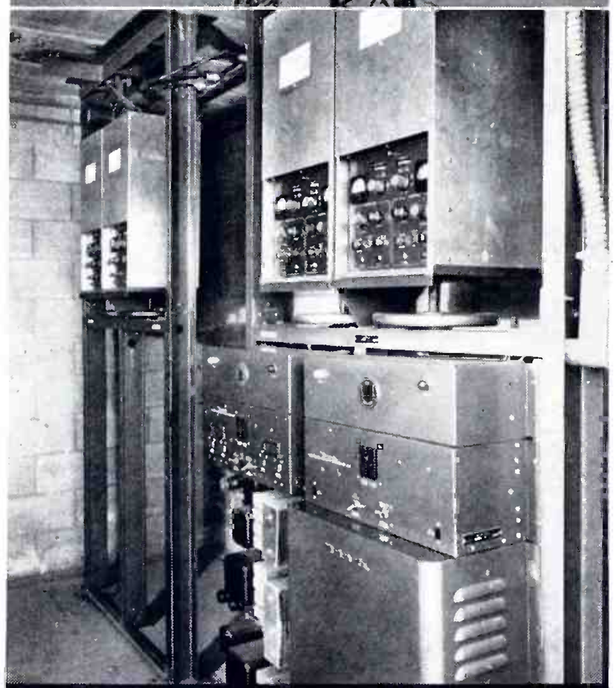
ADDRESS ....

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

Paste on 2-cent postcard or send air mail.

21—Motorola microwave systems are <u>in</u> and working!





Partial List of Microwave Systems

- Aeronautical Radio Incorporated
- State of California
- Pan American Pipeline Co.
- Shell Pipeline
- Panhandle Eastern Pipeline Co.
- Texas Illinois Natural Gas Pipeline Co.
- Mid-Valley Pipeline Co.
- Brazos River Electric Transmission Cooperative
- City of Dayton, Ohio
- Michigan State Police

Including the world's first 1000-mile private operating system

Here is Experience that you can rely on!

Facing a healthy new demand for more serviceable and flexible communication facilities, responsible management turns to Microwave for the extension of communication facilities.

Use the Motorola Microwave circuit for telephone, teletype, telemetering, remote switching and general supervisory control applications.

Motorola is experienced in shaping the systems-design to meet the customers day-in-day-out operational problems.

More than 20,000 installations in the past ten years have proved the reliability of Motorola 2-way radio—and now more than 25,000 miles of Motorola Microwave operating circuits have proved the unquestioned reliability of Motorola Microwave Communications.

Make your new plant truly *new* all the way with Motorola Microwave.

Write for free booklet "The Motorola Microwave Story" and incidentally a Motorola engineer is ready to assist you with generous and thoroughly competent information.

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4545 Augusta Blvd., Chicago 51, Illinois

The Specialists in industrial radio communication systems

22 Years of Leadership in Mobile Radio
World's leading producers (twice as many as all others *combined)* of 2-way mobile radio. Microwave, carrier and control systems and general radio communication equipments.

Remember! *Experience Counts*
Especially in Microwave