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Dec. '51

FM-TV RADIO COMMUNICATION

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CHAIRMAN, FEDERAL COMMUNICATIONS COMMISSION

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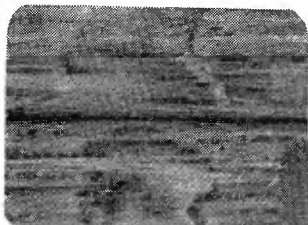
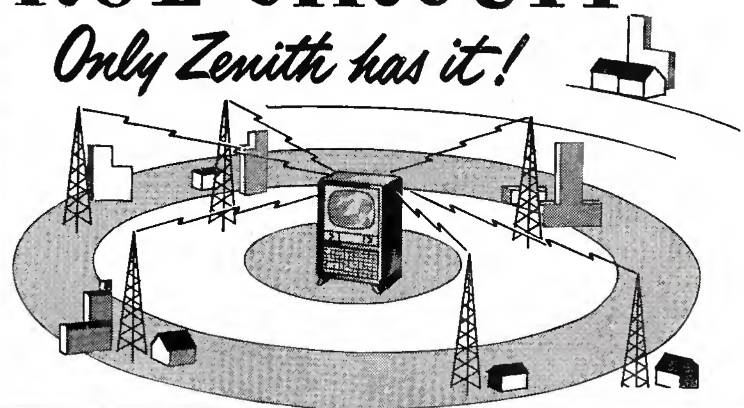
Clifton, New Jersey
Dept. FV

New ZENITH "FRINGE-LOCK" CONTROL CIRCUIT



Only Zenith has it!



New Zenith Invention Brings World's Finest Fringe Area Picture

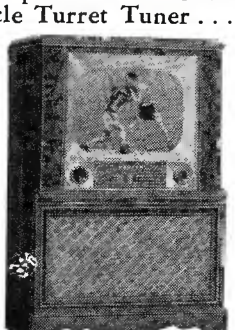
See the picture at left above? That's fringe area reception on ordinary TV. Vertical "wobble" and horizontal "roll" are caused by ordinary fringe area interference. New Zenith "Fringe Lock" Control Circuit blocks out interference, concentrates on picture signal alone, gives you far better picture shown at right.

Sells television's toughest customers *on sight!* Means faster, easier sales, more profits for *You!*

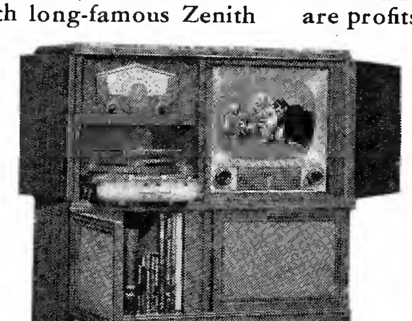
They're television's toughest customers . . . the folks who live in remote "fringe areas." But show them Zenith's remarkable new Distance-Reception, and, brother, you've made yourself a whole stack of sales!

It's Zenith's new "Fringe Lock" Control Circuit in action . . . bringing the finest fringe area picture in television! What's more, this sensational Zenith invention teams up with Zenith's "Electronex" Tube, Custom-Tuned Miracle Turret Tuner . . . and with long-famous Zenith built-in quality . . . to sell *all* your prospects quickly and *keep* them sold! You get *more* sales, *more* satisfied customers, *less* dissipation of your profits through costly customer complaints and "call back" servicing.

Check your Zenith Distributor now about these three new 1952 models. See them. Demonstrate them. They'll prove to you beyond a doubt that—in fringe area and TV center alike—Zenith sales are easier sales. Zenith profits are profits you can keep!



1952 Zenith "Golsworthy" Console. 18th Century motif in Mahogany veneers and hardwoods. 17-inch Electronex Tube for world's finest "full-focus" picture. New Dust-Proof Picture Screen. Model J2042R



1952 Zenith "Kipling" TV-Radio-Phonograph—17-in. "Electronex" Tube. Cobra-Matic Record Player, Super-Sensitive FM and Long Distance AM. Mahogany solids and veneers. Model J2868R

1952 Zenith "Fielding" Table Model. A sales sensation! Mahogany Pyroxylin. 17-inch "Electronex" Tube. Also in Blonde Model J2030R

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

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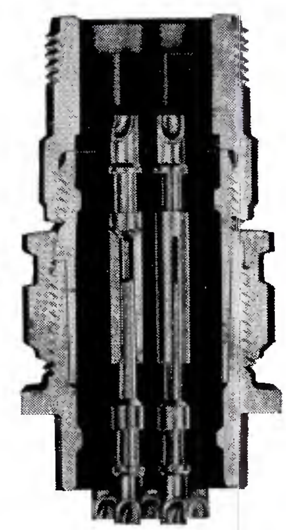

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High dielectric strength . . . High insulation resistance.

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FM-TV RADIO COMMUNICATION

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

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TELEVISION

COMPONENT DESIGN

FM BROADCASTING

COMMUNICATION

AUDIO SECTION

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CPA AUDIT

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

SET production in each category during October was substantially below the 10-month average for this year. The TV figure went up slightly over September, but all the others were down.

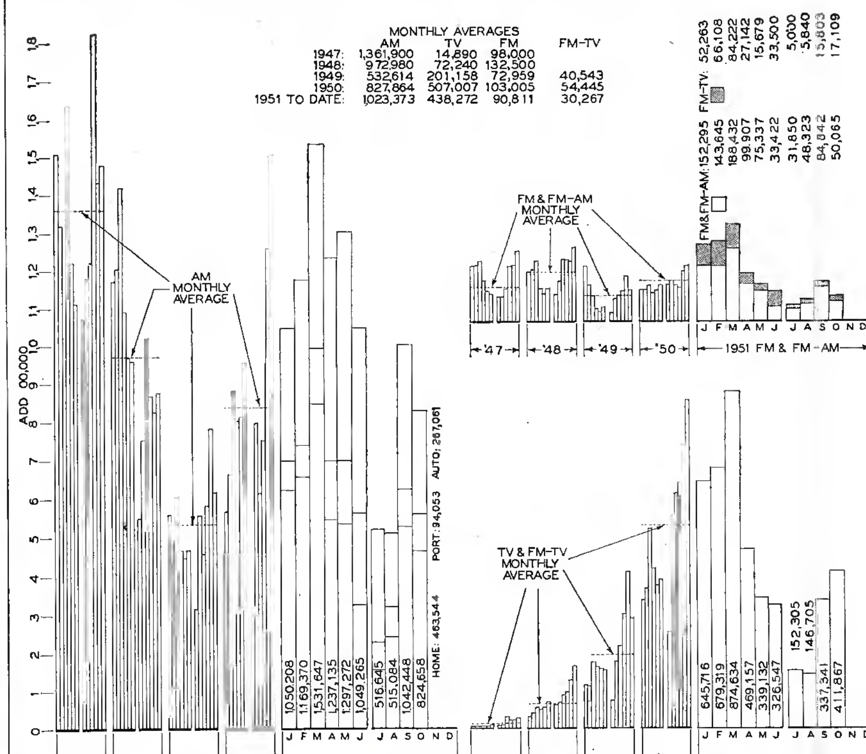
However, audio receivers are up to an average production level substantially above 1950, and nearly double that of '49, while TV sets are running considerably under 1950. About the only conclusion that can be drawn from the Barometer record is that television has not killed public interest in audio programs. At the same time, any comparisons must take into account the relation between nation-wide and regional markets.

A matter of confusion in the records of RTMA's statistics has been brought to our attention. The Association's report on October production states that "838,300 TV sets and 1,229,900 radios" were manufactured in October, 1950. Yet the figures recorded in our Barometer from the RTMA report issued at that time show only 641,927 TV sets and 750,325 radios. These differences of nearly 200,000 and ½ million are probably due to the fact that, last year, RTMA was reporting only the production of member companies. The higher figure used now is probably for all manufacturers. That is regular RTMA practice now. Presumably, the total figures are checked with licensee reports made to RCA.

There is a growing need for statistical data on radio tuner chassis and amplifiers intended for custom installations. RTMA might well undertake to gather this information, because it is of great significance to the radio industry. The only hitch is that some of the most active concerns are not members of the Association. Still, it is a job that should be done, for the annual volume of sales is far up in the millions of dollars. New companies have come into this group in 1951, and such reports as are available indicate a very large increase in sales over last year.

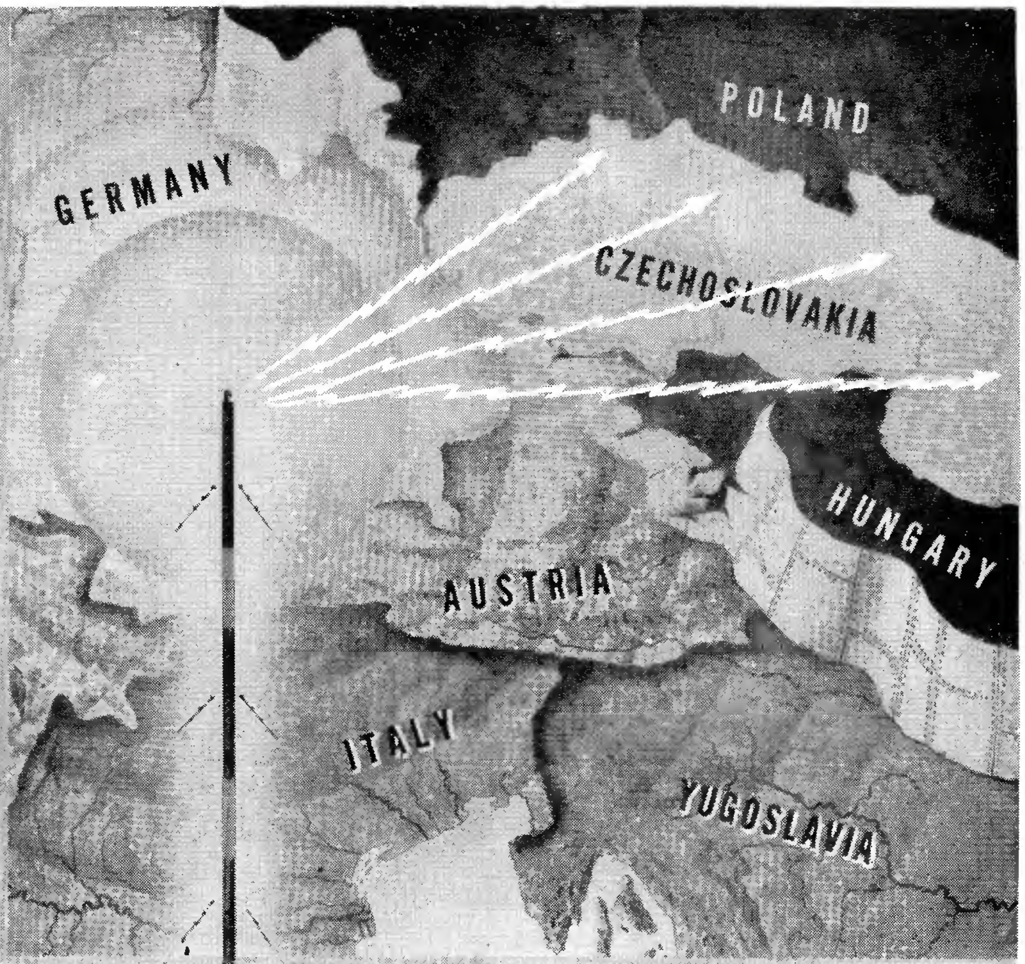
September tube sales reached a new high of 37,031,373, making the 9-month total 264,804,746. Of these, 30,092,789 were for new sets, 5,828,446 for replacements, 941,688 for export, and 168,450 for Government agencies.

Picture-tube sales to manufacturers were up in September, amounting to 294,951 units valued at $6,138,571. Of these, 97% were rectangular, and 16 ins. or larger in size. Year's total reached 3,146,173, valued at $78,852,954.



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

It's the TRUTH *that* HURTS!



Your **CRUSADE FOR FREEDOM** is telling the truth . . . the truth that undermines the communist lie. Via Radio Free Europe, you, and all the freedom loving world, are bringing to the people of Czechoslovakia the truth that gives them hope of eventual liberation . . . the hope that respect for human dignity will triumph over a godless tyranny. Radio Free Europe is helping the people of Czechoslovakia by telling them where missing friends now are. Identifies by name the quislings and informers. And RFE sends messages from escapees to their families and friends voiced in their own language by their own countrymen.

Your Crusade for Freedom hurts the Communist dictators because RFE tells the truth behind the Iron Curtain where truth is an alien freedom. Freedom is indivisible. Where some men have lost freedom, the freedom of men everywhere is in danger. The Crusade for our freedoms may be beginning in Munich today. You and 25,000,000 freedom loving Americans—with your dollars and cents are setting up more transmitters beamed to more communist dominated countries in Europe and Asia. The Crusade for Freedom is a continuing agency for piercing the Iron Curtains. Its address is: Crusade for Freedom, 308 Empire State Building, New York 1, New York.

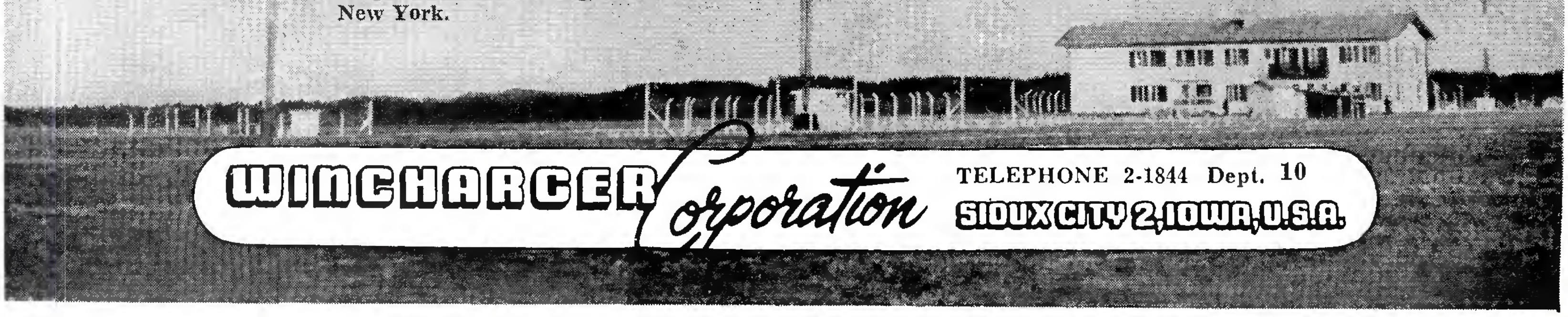
WINCHARGER Broadcasting Towers were selected for RFE Munich to permit it to beam the truth that hurts the communist line in Czechoslovakia.

It is these four Wincharger Towers and their scientifically engineered arrangement that keeps RFE Munich on the air in the homes of freedom-loving Czechs.

Each of these towers, type 300, rises 350 feet from ground level. At these heights, Wincharger Towers will withstand winds of 100 M.P.H. velocity. Each side of these triangular cross section towers is only 28½ inches wide. Heavy hot-dipped galvanized high carbon steel is used throughout all Wincharger Towers. Three insulated guys at 50 foot intervals add to the strength of the type 300 tower.

Strength plus accurate, easy to tune, easy to hold, sinusoidal current distribution keeps the powerful 135,000 Watt Radio Free Europe installation tuned to Czechoslovakia.

The Wincharger Corporation engineering skill can help every station, commercial, police—or freedom, with their antenna problems. Let us help you keep your station on the beam.



WINCHARGER *Corporation*

TELEPHONE 2-1844 Dept. 10

SIOUX CITY 2, IOWA, U.S.A.

THIS MONTH'S COVER

During Wayne Coy's administration, the FCC has been called upon to resolve a heavy load of inherited problems, complicated by the passage of time and the progress of science. Moreover, the expansion of common carrier, safety, and special services has increased the Commission's work load enormously. Fortunately, Mr. Coy has met this challenge. Under his leadership, the Commission has maintained a cooperative attitude, yet it has been unresponsive to pressures that might have created new legal or technical confusion. Constructive changes have been made in the FCC organization. Procedures have been brought up to date. The Four Horsemen ride no more. All this is highly reassuring, in view of the industry problems coming up in 1952.

SPOT NEWS NOTES

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

Taxi Radio Interference:

Two very bad spots in the US, where the taxi channels are loaded far beyond their effective capacity, are new Orleans and Washington, D. C.

FM Broadcast Tuner:

We haven't seen one yet, but we have heard some very enthusiastic reports about a new FM tuner brought out recently by Sargent-Rayment Company, 212 9th Street, Oakland 7, Calif.

New FCC Applications:

At a recent FCC conference with Edward F. Giovannetti, plans were discussed for our publishing the monthly list of new applications for radio communication systems. We expect that this will start in the January issue. It is a highly useful feature which we want to add as a part of our plans for further expansion of our services in this field. It is proposed that each listing will show the name and address of each applicant, operating frequencies, type of service, facilities for which the application is made, and the make of equipment to be used.

Set Ownership:

A national survey made for CBS and NBC shows that homes where there are TV sets have the largest number of audio broadcast receivers. Here is the breakdown by families:

	RADIO ONLY	RADIO & TV
2 or more radio sets	68%	77%
3 or more radio sets	35	46
4 or more radio sets	14	22
5 or more radio sets	5	10

In every 100 homes with TV sets there are 253 radio receivers in working order, while every 100 homes with radio only have but 219 sets.

Pennsylvania Turnpike:

Combination automatic microwave relays and mobile communication provided for this highway have been described by FCC Commissioner Webster as an outstanding example of system engineering. Publication of a detailed account of this system in Radio Communication has been authorized by the Turnpike Commission.

Larry LeKashman:

Former advertising and sales promotion manager of RCA's tube department has joined Electro-Voice, Inc., Buchanan, Mich., as vice president. Prior to going with RCA, he was vice president and general manager of Radio Magazines.

Antenna Service:

All California business of Andrew Corporation is now being handled by the Andrew California Corporation at Simi. 35 miles northwest of Los Angeles. Telephone number is Simi 225J.

Trade Name:

Our attention has been called to the fact that the name "Handie-Talkie" has been registered as a trade-mark by Motorola, Inc. Registration No. 524,561 was issued by the US Patent Office on May 22, 1951.

Air-Coupler Installation:

The description of the original Air-Coupler stressed the importance of fastening it firmly to the floor, or weighting it down in cases where the Coupler is not actually built into the floor. We under-

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SPOT NEWS NOTES

(Continued from page 6)

stand that there has been considerable discussion of the fact that the Triplex Air-Coupler demonstrated at the Audio Fair was merely set in a corner, without fastening or weights. Actually, wedges were used under the bottom front edge to force the cabinet firmly against the wall. That was adequate, because the total weight of the Triplex Air-Coupler is nearly 200 lbs.

Shawnee, Oklahoma:

Sylvania's new plant of 35,000 square feet is now in operation. This factory is devoted to the manufacture of miniature tubes.

FM vs. AM Pulling Power:

Zenith Radio has set up their broadcast campaign on hearing aids in such a way as to compare the pulling power of FM and AM. That is, separate transcriptions are used on FM and AM, with different post office boxes in the commercials. Some stations declined to go along with this plan. However, a sufficient number agreed to use the separate transcriptions that Zenith will be able to make an accurate check on relative FM and AM pulling power, and to give the stations useful data for establishing their rate structures.

Dr. Irving Wolff:

Named director of research of the RCA laboratories division, the headquarters of which are at the David Sarnoff Research Center, Princeton, N. J. Dr. Wolff is a specialist in UHF, and has been the director of tube research at the RCA laboratories.

Data on Tape:

A pocket-size reference book entitled "Fundamentals of Magnetic Recording" by C. J. LeBel has been published by Audio Devices, Inc., 444 Madison Avenue, New York 22. Well-illustrated sections of this book are devoted to recording methods, tape characteristics, bias, erasure, response, noise, distortion, and recording equipment. Copies are available without charge.

TV for Cuba:

Two complete DuMont iconoscope film chains have been shipped to Circuito CMQ, S.A., Havana. This equipment is for a chain of stations to extend across the island. Two 500-watt DuMont Acorn transmitters are already in use.

Listening and Reading:

A study made by the American Research Bureau for NBC and CBS revealed that

(Continued on page 8)

SPOT NEWS NOTES

(Continued from page 7)

the average individual in the US spends 109 minutes each day listening to radio broadcast programs, and devotes 35 and 19 minutes reading newspapers and magazines, respectively.

Underwater Television:

Work on the use of underwater TV cameras by the US Navy has been going on for the last three years under the direction of J. R. R. Harter, Bureau of Ships electronic division, and M. L. Lasky, David Taylor Model Basin. Purpose is to supplement diving operations, and to save time in underwater exploration. At depths of more than 200 ft., the time required to lower and raise a diver is more than the time he can spend on the bottom. TV cameras can be dropped and raised quickly, operated for any length of time, and do not raise clouds of silt. Also, images can be photographed for records and study.

JAN Components:

A cross-reference guide showing JAN components and their commercial equivalents, as well as commercial-to-commercial equivalents, has been prepared by Hudson Radio Corporation, 48 W. 48th Street, New York 19. The initial guide, listing several thousand items, will be kept up to date by supplementary charts. Copies are available on request.

J. Raymond Peterson:

Named deputy director of the NPA communication division, Washington, D. C. Mr. Peterson, a telephone man for the past 30 years, was assistant vice president for plant, commercial, and traffic operations of Southwestern Bell Telephone. He succeeds Warren H. Chase, who has returned to Ohio Bell Telephone.

FM Audience Data:

Interesting figures are disclosed by a survey of three western counties of Massachusetts, financed by Springfield stations WBZA-FM (NBC), WMAS-FM (CBS), WSPR-FM (ABC), WJKO-FM (independent), and Holyoke station WHYN-FM (Yankee-MBS). Percentage of FM ownership in Hampden, Hampshire and Franklin counties has increased as follows:

1947 7% 1949 20% 1951 36%
1948 12% 1950 29%

Contention that FM listening is greater at increased distances from AM transmitters is confirmed by the fact that Franklin, most remote from Springfield of the counties surveyed, has 41% ownership, which is 5% more than the 3-county average. Conclusion is that FM adds

(Concluded on page 9)

SPOT NEWS NOTES

(Continued from page 8)

about 50% to the AM audiences of the Springfield-Holyoke stations.

George I. Long:

Elected vice president and general manager of Ampex Electric Company, Redwood City, Calif. Previously, Mr. Long was assistant vice president of Wells Fargo Bank and Union Trust Company, San Francisco, and chairman of the trust investment committee of the California Bankers' Association.

Broadcast Station Operation:

The second edition of "Broadcast Operator's Handbook" by Harold Ennes has been released by John F. Rider, Publisher, Inc., 480 Canal Street, New York 13.

This book is recommended highly for its complete and practical treatment of FM and AM station operating practice. It covers the use, maintenance, and repair of equipment; transcriptions and tape recording; placement and use of microphones; and such special subjects as measurements, antennas, monitoring, and FCC Rules and Regulations.

Lloyd A. Hammarlund:

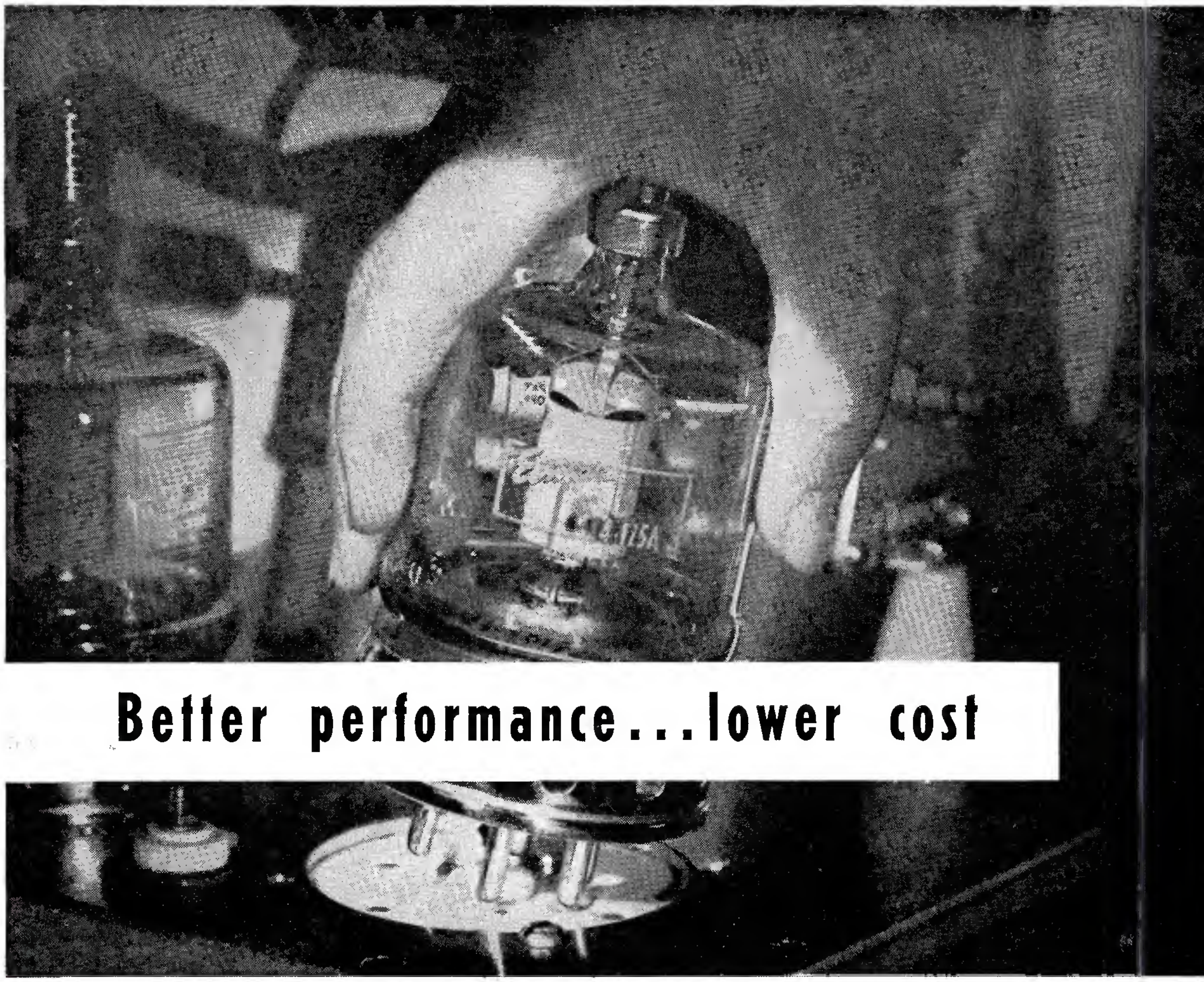
Has completed 35 years at Hammarlund Manufacturing Company, of which he has been president for the past 10 years. This company was started by his late father, Oscar Hammarlund, in 1910, as a small machine shop on Fulton Street, New York City. Precision variable condensers are still important items at this plant, but the major activity is the quantity production of receivers for military use, equipment for remote controls and telemetering, and special signaling devices operated over multiplex radio circuits.

More Power for WBZ-TV:

Westinghouse station in Boston has moved its present 3-bay antenna to a 210-ft. tower for emergency use, so that a 6-bay antenna can be mounted on the old 570-ft. TV tower. In the spring, an output stage of higher power will be added to the transmitter. Subsequently, it is expected that the FCC will authorize an increase of effective radiation to 100 kw.

Narrow Escape:

When one of the public utilities was refused authorization to erect a transmitter at a site chosen for that purpose, the installation was made, nevertheless, at that location. Later, this was brought to the attention of the FCC, and the company officials responsible very nearly went to jail.



Better performance...lower cost

Transmitter performance goes up — costs go down . . . the inevitable result of specifying Eimac tetrodes to fill key sockets. Costs will stay down because the service life of these time-proved tubes is long, replacement costs are low, and the circuit simplicity they allow keeps power bills down.

Eimac tetrodes are made for a wide range of power from 65 watts plate dissipation to 20,000 watts dissipation. They are unexcelled for amplifier, oscillator, and modulator service. All are backed by the experience and know-how of America's foremost transmitting tube manufacturer.

Take the advice of countless users and equipment manufacturers who consistently not only recommend but rely on . . . Eimac tetrodes for unvarying performance, exceptional service life, and compatibility to modern circuit techniques.

Write For The Free Eimac Quick Reference Tube Catalog

302

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

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

NTSC COLOR TV STANDARDS

COMPLETE DESCRIPTION OF THE COLOR TELEVISION SYSTEM PROPOSED BY NTSC, AND TECHNICAL SPECIFICATIONS OF EQUIPMENT FOR FIELD TESTS

THE NTSC color television standards are designed to meet two basic requirements: 1) to provide the best color television service possible within the standard 6-mc. television channel, and 2) to provide a color signal that will produce a high-quality monochrome image on existing black-and-white receivers, without requiring any change whatever in such receivers.

This performance is achieved by transmitting 2 signals, one identical in all essential respects to the black-and-white television signal, the other (the *chromatic signal*) carrying two types of color information which represent jointly the chromatic values of the scene. By the use of multiplex techniques, these signals are sent simultaneouly over a 6-mc. channel.

When a conventional black-and-white receiver is tuned to transmissions conforming to the NTSC color standards, the receiver responds fully to the first signal (the *brightness signal*) and recreates from it an image in black-and-white having a quality equal or superior to that provided by present black-and-white standards. Because of the nature of the chromatic signal, no normally-perceptible effect is produced by it in the black-and-white image on such a receiver.

The color receiver, however, responds to both signals, and the chromatic signal is then used specifically to recreate in the image the color values lacking in the brightness signal. Moreover, when the chromatic signal is absent, as when the color receiver is tuned to a black-and-white transmission, the receiver produces without any change or adjustment an image in black-and-white.

In this manner, compatibility is achieved between color broadcasts and black-and-white broadcasts. The black-and-white receiver produces black-and-white images from either type of broadcast, and the color receiver produces images according to the type of broadcast, in color or in black-and-white.

Basis of NTSC Standards:

The technical basis of NTSC color standards lies in the science of color measurement, or colorimetry. Those concerned with the matching of colors, for example those engaged in color printing and color photography, have, for many years, recognized that the color of an object can be identified by three quantities representative of its brightness, its hue and its saturation. *Brightness* is a measure of the lightness or darkness of a color; *hue* specifies whether the color is red or blue or yellow, for example; and *saturation* is a measure of the mixture of this hue with white light. The hue and the saturation values together represent the chromatic values of the color.

When a scene is photographed on black-and-white film, the film responds only to brightnesses in the scene, while the chromatic values of the colors are lost. When the same scene is photographed on color film, three individual images are recorded, one in each of the three primary colors. By keeping the brightness of the three primary colors in proper proportion, the chromatic values of the colors are preserved and can be reproduced in the color print or transparency. Photographic technicians have, in fact, produced experimental photographs which are somewhat analogous to the two signals of the NTSC color standards, one photograph (in black-and-white) showing only the brightness values on the scene, and another (in color but having equal brightness at every point) indicating only the chromatic values present. The NTSC color standards define an electrical process for achieving the same result. The essential elements of the system are outlined in the following paragraphs.

Terminal Equipment:

The apparatus suitable for the NTSC standards is divided conveniently into two more or less independent groups, the *terminal equipment*, including the camera at the transmitter and the picture tube at the receiver, and the *transmission equipment* that carries the television signal from one terminal to the other terminal.

A color camera suitable for the NTSC color standards incorporates three image-orthicon camera tubes, similar to the camera tubes used in black-and-white broadcasting. Each tube is fitted with a color filter, of transparent colored glass, in such a way that one camera tube receives an image in red light, the second an image in green light, and the third an image in blue light. In this manner, the color values of the scene are resolved into three primary colors. The three camera tubes are so mounted that they view the scene from the same vantage point. Therefore, the three primary color images have the same geometric form, but differ in the color of the light. In the camera tubes, each image is converted into a corresponding electrical signal.

The color camera thus produces three signals, each representing the same scene, but differing according to the colors present in the scene. For example, in representing the white and gray parts of the scene, all three signals are active, since white or gray light is produced by a combination of all three primary colors. In red parts of the scene, the red primary signal is predominant; in yellow parts, both red and green signals are strong, since yellow light is produced by a combination of red and green lights.

The opposite terminal of the color television system is the picture reproducer. To it are fed three signals similar to those generated by the camera, producing corresponding images in red, green and blue light. A typical picture reproducer suitable for the NTSC color standards is the tricolor picture tube. In one form of tricolor tube, the viewing screen consists of several hundred thousand individual phosphor dots of three different types. One set of dots produces red light; a second set, green light; and the third, blue light. The dots are uniformly interspersed on the viewing screen, so that dots of different colors are adjacent, but do not overlap. This arrangement of colored dots is similar to that used in color printing.

To excite the phosphor dots, three electron beams are formed at the end of the tube. The internal structure of the picture tube is so arranged that one electron beam is constrained to fall only on the red dots, the second beam only on the green dots, and the third only on the blue dots. In order to recreate the image in colors, the three electron beams are produced simultaneously, forming three primary-color images that consist of dots so interspersed that the images occupy the same space on the viewing screen. The dot structure is so fine that it is not perceptible as such at normal viewing distances. Consequently, the three images appear to be superimposed, and the primary colors combine to reproduce the image in full color.

The three electron beams scan the viewing screen in the same manner as the corresponding electron beams in the three tubes of the color camera described previously. Thus, if the camera tube viewing the scene through the red filter is caused to control the beam in the tricolor tube which excites the red dots, the red colors in the resultant image correspond to the red colors in the scene. A similar connection is provided between the blue camera tube and the blue dots, and between the green camera tube and green dots.

In brief, the three camera tubes generate three signals which, transmitted to the picture tube, recreate three corresponding primary-color images, superimposed on the viewing screen, to provide a single full-color image.

Signal Transformation:

From the foregoing discussion, it would appear that the transmission system connecting the camera and the picture-tube should carry three signals, representing the red, green, and blue primary-color values in the scene to be reproduced. But this simple one-to-one correspondence between images and signal has two important disadvantages, as follows:

First, no one of these three signals is suited ideally to the operation of black-and-white receivers; a preferable signal arrangement involves a brightness signal intended particularly to operate black-and-white receivers.

Second, and more important, the transmission of these three signals in this way does not make the most efficient use of a television channel. The characteristics of human vision are such that in order to use the channel most efficiently, the three signals should be transmitted in a preferential way. One signal, representing brightness, is accorded the major part of the channel, while the other signals, which together represent chromatic values, are given less channel width.

The transformation from the primary-color signals produced by the color camera to the preferentially-treated brightness and chromatic signals is performed readily by simple electronic circuits. If the primary-color signals are fed to such a circuit, a signal representative of brightness and a pair of signals representing the chromatic values are produced. At the color receiver, a similar circuit transforms the brightness and chromatic signals into the primary-color signals suitable for controlling the three electron beams in the tricolor picture tube.

Simultaneous Transmission:

The remaining problem is the simultaneous transmission of the brightness and chromatic signals in the same band without mutual interference. This technique can be explained briefly by reference to the method of transmitting a television image by means of radio. All radio transmissions involve a high-frequency carrier wave which is modulated in accordance with the program or other information to be transmitted. In AM, the power of the carrier wave is varied; in FM, the frequency of the wave changes. In addition to these methods, phase modulation (PM) can be used. Phase and frequency modulation are intimately related. One can be derived readily from the other.

In NTSC color standards, the chromatic signal modulates a so-called *color carrier.* The pair of signals described previously as representing jointly the chromatic values are applied together as modulation to the color carrier. The two signals are so applied to the color carrier that it is modulated in two ways, in amplitude and in phase. By modulating this carrier in two ways simultaneously, two signals representing the chromatic values can be carried without loss of identity, provided that proper timing is maintained between the modulation process at the transmitter and the inverse demodulation process at the receiver. This latter requirement is met by sending to the receiver, along with the television synchronizing pulses, a timing signal known as the color-phase signal, which causes the receiver chromatic circuits to operate in synchronism with those at the transmitter.

The brightness signal is transmitted in a manner exactly like that used in transmitting an image over a black-and-white transmitter. Consequently, the quality associated with the brightness values in the received color image is at least equal to that of the black-and-white system and, for the same reason, reception of the color signal on black-and-white receivers is of high quality.

It then remains to arrange the chromatic signal and the brightness signal so that they utilize the channel assigned to the transmitter without undue interference. This problem is simplified by the fact that, as a result of the scanning process used in dissecting and reassembling the image, the brightness signal components are concentrated in uniformly spaced intervals across the channel. The chromatic signal is concentrated in a similar fashion, since it arises from the same scanning process.

It is feasible to shift the concentrations in the spectrum of the chromatic signal so that they fall between those of the brightness signal spectrum. This is accomplished by choosing the frequency of the color carrier as an odd multiple of one-half the line freqency. In this manner, the whole of the spectrum assigned to the picture transmission is more completely occupied, and the two sets of signals are transmitted simultaneously without one interfering unduly with the other. This is due to the fact that, with the particular choice of carrier frequency, the unwanted signal received with a certain phase in one field will be received with the opposite phase in a succeeding field, 1/30 of a second later. Thus, because of the persistence of vision, the eye cannot follow the interference which averages zero amplitude.[1]

Another factor which eliminates interference is inherent in the transmission of the brightness and chromatic signals as separate entities. Whenever a substantial portion of the televised scene appears in shades of gray or white, as previously noted, all three primary colors are active in the camera and picture tube. But in transforming the primary-color signals to brightness and chromatic signals, only one signal, the brightness signal, appears from such gray and white portions of the scene. Since the chromatic signal is then absent, there is no opportunity for interference to exist in such portions of the scene.

The overall result is that the NTSC color television standards are capable of providing a high-quality color picture, with definition equal to that of present black-and-white pictures, and of producing a higher-quality monochrome image on existing black-and-white receivers, without requiring any change whatever in such receivers.

FIELD TEST EQUIPMENT SPECS

DETAILED technical specifications of the signal to be used in field tests of compatible color television were released on November 26, 1951. These tests will be conducted by NTSC over television stations in New York, Philadelphia, Chicago, Syracuse, and Washington during forthcoming months.

In releasing the information, Dr. W. R. G. Baker, NTSC Chairman, stated that the specifications were adopted unanimously by the Committee. They will serve as the basis of tests to investigate field performance of compatible color television.

All segments of the industry, including manufacturers, consulting engineers, broadcasters, servicemen, amateurs, and experimenters, are urged to participate in the tests. Reports of such participation are solicited, and should be sent to Dr. Baker, care of the General Electric Company, Electronics Park, Syracuse, N. Y.

The test specifications are divided into two groups, the first comprising the FCC

(Continued on page 35)

[1]For a more detailed discussion of this phenomenon, see "Frequency-Interlace Color TV," by R. B. Dome, RADIO COMMUNICATION for October, 1950.

NEW TRANSISTOR APPLICATIONS

THE NEW *n-p-n* TRANSISTOR, DEVELOPED AT BELL LABORATORIES, PROMISES TO EXTEND APPRECIABLY THE RANGE OF TRANSISTOR APPLICATIONS*

ALMOST two years ago, W. Shockley [1,2] first published the theory of a transistor made from a single piece of germanium in which the conductivity varies in such a way as to produce two rectifying junctions. Since that time, M. Sparks, G. K. Teal, and others at the Bell Telephone Laboratories [3,4] have contributed notably to the physical development of this device.

Recently, Sparks produced a number of *n-p-n* transistors and found their behavior to be closely in accord with Shockley's theory.[4] Preliminary circuit studies on these devices have shown that, in several respects, their performance is remarkable. In view of this, the transistor development group has undertaken to produce small quantities of *n-p-n* transistors in a form suitable for incorporation in working circuits.

This discussion will deal principally with the circuit aspects of the *n-p-n* transistor, presenting and analyzing performance data on a small number of experimental units. For information as to the solid state physics of its design and operation, the reader is referred to the previously-mentioned works of Shockley, Sparks, and Teal.

Appearance and Construction:

Fig. 1 shows schematically the configuration of an *n-p-n* transistor. The small bar of single-crystal germanium contains a thin layer of *p*-type interposed between regions of *n*-type. Mechanically strong ohmic connections are made to the three regions, as indicated, and are brought out through a hard plastic bead. A finished transistor is shown in Fig. 2. It should be pointed out that Fig. 1 is not drawn to scale, and that the *p*-layer may be less than .001 inch thick.

Static Characteristics:

A great deal of information about the low-frequency performance of a transistor can be obtained from a set of static characteristics, such as those shown in Fig. 4. Curves of this sort are obtained simply by connecting suitable current

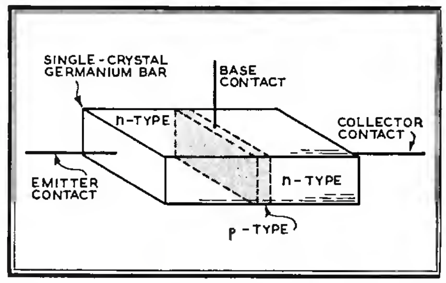


FIG. 1. CONSTRUCTION OF THE N-P-N TRANSISTOR, SHOWING THE TWO RECTIFYING JUNCTIONS

sources to the emitter and collector circuits of the transistor and measuring the resulting voltages. The currents are called positive when they flow into the emitter and collector as shown, and the voltages are called positive when they have the signs shown in Fig. 3.

Let us first examine these curves with an eye to finding out what kind of voltage and current supplies are needed to bias the transistor into the range in which it can amplify. To facilitate this study, that part of the characteristics which lies within the normal operating range has been shown as solid lines, and that part of the characteristics corresponding to cutoff has been shown as dotted lines.

Note from the upper set of curves that Vc is positive in the operating range. This indicates that the collector must be biased positive with respect to the base. For this particular transistor, a bias voltage anywhere between 0.1 volt and 35 volts is suitable. Note also that all the curves on this plot correspond to negative emitter currents. Thus, the emitter must be biased in such a way that current flows out of the emitter into a suitable current supply. Furthermore, the collector current corresponding to any given emitter current can be seen to be almost equal in magnitude to the emitter current. Since these two currents are opposite in sign, this means that most of the current which flows into the collector leaves by way of the emitter, with the result that the current in the base circuit is very small.

Suppose that the collector is held at a constant positive voltage as, for example, by connecting a battery between collector and base with, perhaps, a transformer winding in series. If a negative current is forced into the emitter by a battery, with a resistance connected in series between emitter and base, the collector current can be controlled by varying the emitter current, and is always approximately equal in magnitude to the emitter current. Suitable collector currents for this particular transistor range from

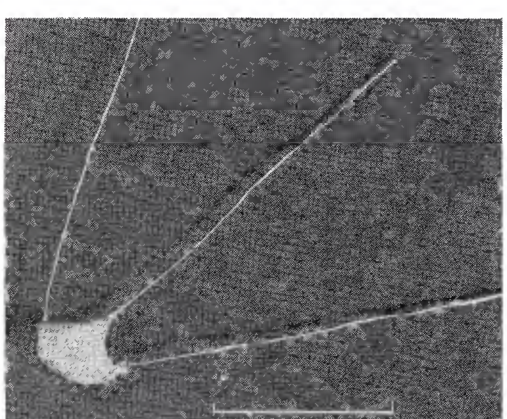
*Extracted from "Some Circuit Properties and Applications of *n-p-n* Transistors," by R. L. Wallace, Jr., and W. J. Pietenpol, *Bell System Technical Journal*, volume XXX, 1951. Interested readers should consult the original article, which gives complete circuit design analyses and recommendations.

[1] "The Theory of *p-n* Junctions in Semiconductors and *p-n* Junction Transistors," by W. Shockley, *Bell System Technical Journal*, volume XXVIII, 1949.

[2] "*Electrons and Holes in Semiconductors*," by W. Shockley, Van Nostrand, 1950.

[3] "Theory and Experiment for a Germanium *p-n* Junction," by F. S. Goucher, G. L. Pearson, M. Sparks, G. K. Teal, and W. Shockley, *Physical Review*, *81*, 1951.

[4] "*p-n* Transistors," by W. Shockley, M. Sparks, and G. K. Teal, *Physical Review*, *83*, 1951.



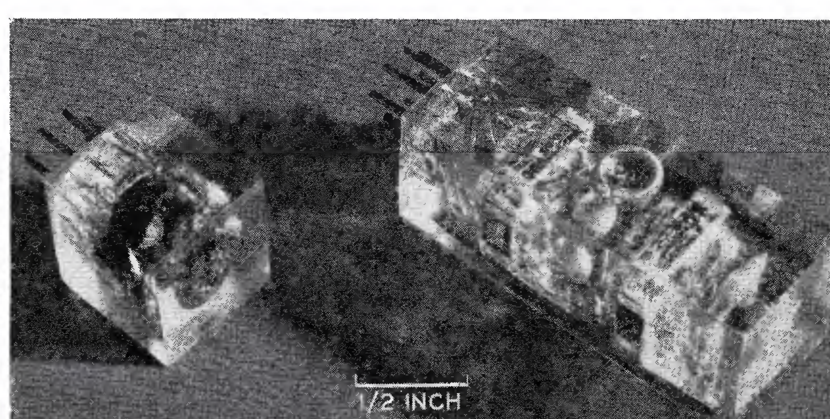


FIG. 2. AN N-P-N TRANSISTOR, SHOWN APPROXIMATELY TWICE ACTUAL SIZE. FIG. 6. TWO CIRCUIT ASSEMBLIES UTILIZING N-P-N TRANSISTORS

about 20 microamperes to about 5 milliamperes.

The exact choice of collector current and voltage within the ranges mentioned above is dictated largely by the amount of power output required. As power output requirements increase, more current and voltage are needed from the power supply. Since the collector circuit efficiency cannot exceed the theoretical limit of 50% in Class A operation, the signal power output cannot exceed half the power supplied by the battery. This means, for example, that if the collector is worked at 20 volts and 2 milliamperes, the Class A power output cannot exceed 20 milliwatts.

From the lower plot of Fig. 4 it is possible to obtain information about the bias voltage required for the emitter. Note, first, that the entire emitter voltage plot corresponds to a very small range of emitter voltages near zero and, furthermore, that the part of the characteristics corresponding to the operating range covers only a few thousandths of a volt. This means that if the collector *voltage* is held constant, very small changes in emitter voltage produce fairly large changes in collector current. If the collector *current* is held constant, very small changes in emitter voltage produce relatively enormous changes in collector voltage. This suggests at once the use of this transistor as a DC amplifier between a low-impedance source and a high-impedance load. In this application, voltage stepup in the order of 10,000 times is possible.

The very great sensitivity of the collector circuit to emitter voltage suggests, however, that for AC amplifiers a current source should be used as an emitter bias supply. This can be obtained from a battery with a large resistance in series. Furthermore, since the emitter voltage is always nearly zero, the emitter current can be calculated in advance by dividing the battery voltage by the value of the series resistance — provided, of course, that the supply voltage is large compared to the few hundredths of a volt drop across the emitter circuit.

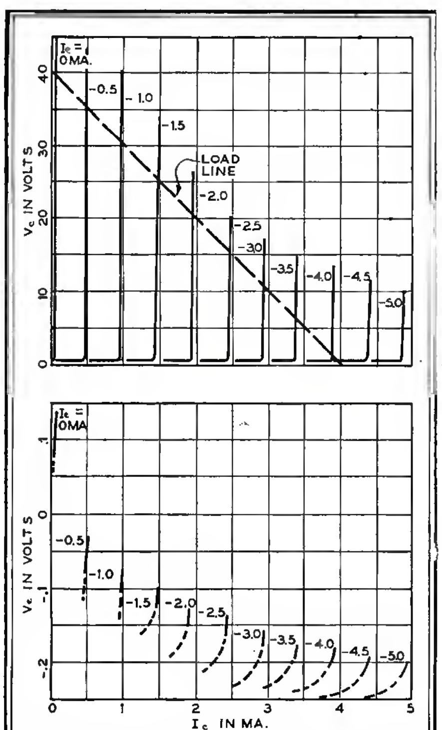


FIG. 4. CHARACTERISTICS FOR LARGE SIGNALS

Some interesting conclusions about the large-signal operation of the transistor can be drawn from the static characteristics also. If the load is resistive, the instantaneous operating point swings up and down along a straight line, such as the load line shown in the upper plot of Fig. 4. This particular load line corresponds to an AC load resistance of 10,000 ohms. Suppose that the steady collector bias is 20 volts at 2 milliamperes, so that the drain from the power supply is 40 milliwatts. Now consider the permissible swings of collector voltage and current.

Since the collector characteristics are quite straight and evenly spaced over a wide range of current and voltage values, the output signal can swing down nearly to zero collector voltage, and nearly up

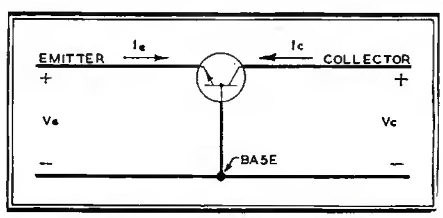


FIG. 3. SIGNS OF VOLTAGE AND CURRENT FLOW

to zero collector current, without introducing distortion. The limit on the lower end is imposed by the fact that the collector characteristics begin to curve when Vc is less than about 0.1 volt; the limit on the upper end is imposed by the fact that the collector current does not drop completely to zero when Ie drops to zero. The lower limit of collector current is, in this case, about 50 microamperes and, since that amount of current in 10,000 ohms corresponds to 0.5 volt, this means that the instantaneous collector voltage is limited to the range between 39.5 volts and 0.1 volt.

Starting from a quiescent value of 20 volts, the permissible positive swing is then 19.5 volts, and the permissible negative swing is 19.9 volts. Reducing the quiescent voltage to 19.8 volts with the same load line makes it possible to obtain a peak swing of 19.7 volts, which corresponds to 19.45 milliwatts signal delivered to the load. Therefore, a collector circuit efficiency of 48.5%, with a maximum of 50% possible, has been obtained. Some transistors take even less collector

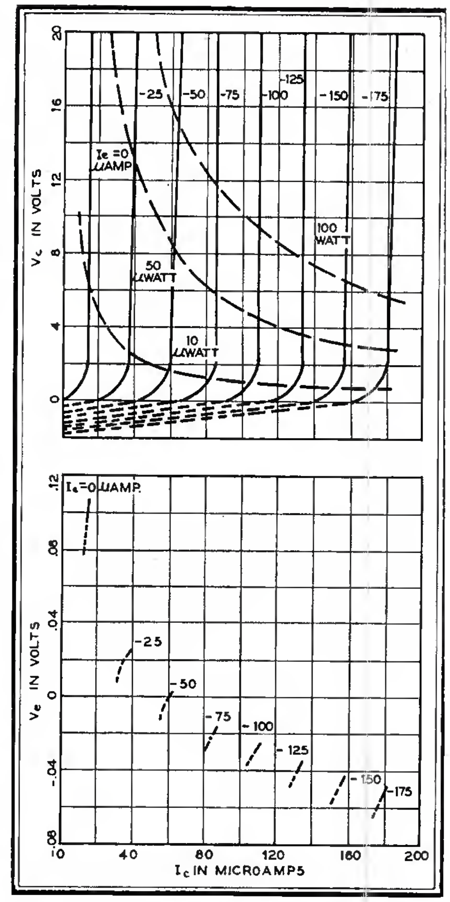


FIG. 5. MICROPOWER OPERATING CURVES. VALUES GIVEN FOR Vc SHOULD BE DIVIDED BY 10. "100 WATT" CURVE IS FOR 100 MICROWATTS

current when the emitter current is zero, thus providing even higher efficiencies.

These computations of efficiency have all been based on the assumption of sinusoidal current applied to the emitter. Actually, emitter resistance varies with emitter current, and to realize high efficiency with low distortion it is necessary to drive the emitter from a high-impedance source.

Low-Power Operation:

For small-signal applications, the transistor represented by the characteristics of Fig. 4 can deliver useful gain at very much lower voltages and currents than those used in the example above. In order to show this, the characteristics of Fig. 5 have been plotted for a range of collector voltages extending up to only 2 volts, and for a range of collector currents extending up to only 200 microamperes. It can be seen from the upper plot that the collector circuit characteristics are still quite usefully straight and evenly-spaced in this micro-power range. In fact, for small-signal operation, it is sufficient to use a collector voltage only a little in excess of 0.1 volt, and a collector current a little in excess of 20 microamperes. This means that the power required to bias the collector into the operating range amounts to only a few

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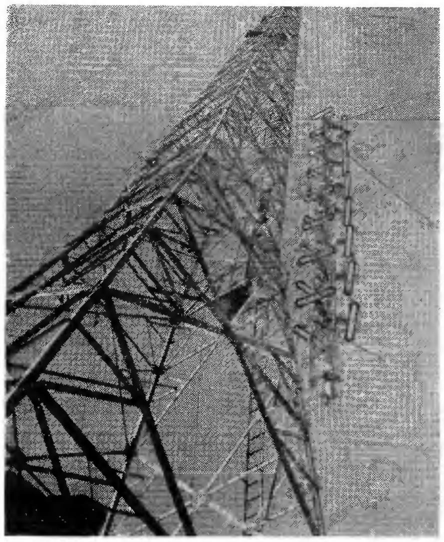
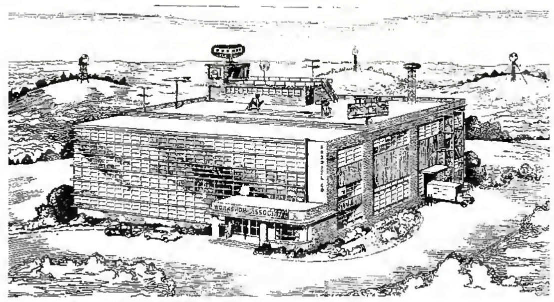


NEWS PICTURES

ABOVE, the 8-bay TV antenna for Radio Belgrano at Buenos Aires. Isolation rings were removed during construction. Equipment for this station was supplied by Federal Telecommunication Laboratories.

RIGHT ABOVE, antenna laboratory under construction for Workshop Associates on a 46-acre tract at Natick, Mass. Arrangement of the roof will accommodate antennas under test. Pattern ranges will be set up in the adjacent area. The new laboratory represents an investment of $400,000.

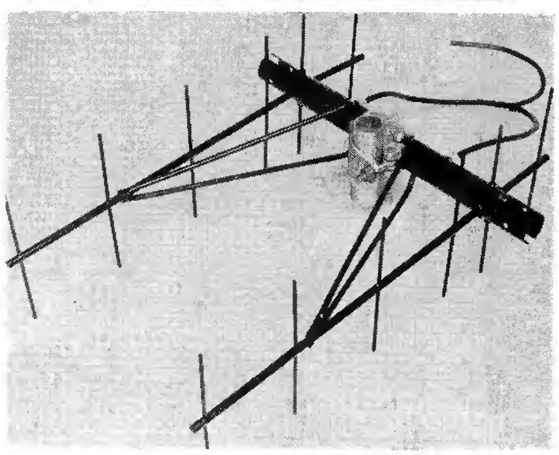


BELOW, an RCA microwave TV link mounted at the base of the new tower on the Empire State Building, facing northeast.

ABOVE, the balloon-like construction at the left is an Arctic Bubble, designed to protect a radar antenna of the type shown at the right from damage by the elements. The bubble, supported by internal air pressure, was photographed at the Bendix radar test site, near Baltimore, Md. This type of protection was developed particularly for service under subzero conditions where radar stations are operated by the U.S. Air Force and the Navy.

ABOVE, FM station WPJB, operated by the **Providence Journal,** has been building its audience by a consistent series of personal appearance programs. Here is "Miss America" with a service guard arriving to do a disc jockey show for the Red Feather campaign.

BELOW, about 80 people will be employed by GE at an advanced electronic research center on Cornell University property at Ithaca. Signing the agreement for establishing this project are, seated left to right, Dr. W. R. G. Baker of GE; Dr. T. P. Wright, Cornell v.-p. for research; standing, Brig. Gen. T. C. Rives, manager of the new center, and Dr. S. C. Hollister, dean of the Cornell College of Engineering.

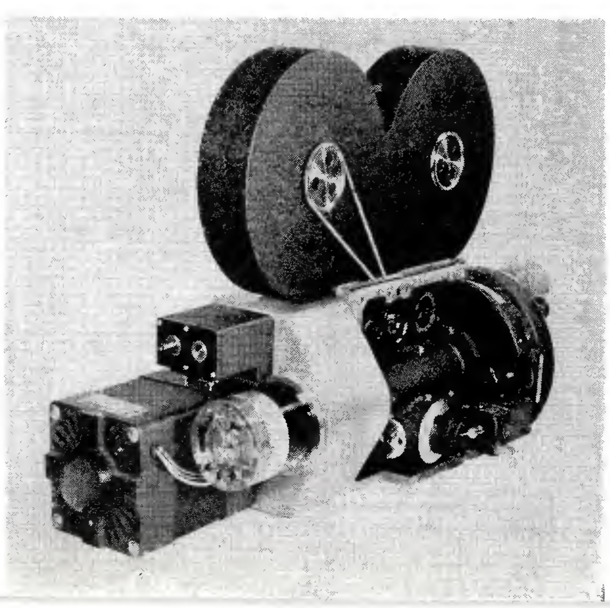


ABOVE, Yagi antennas for 450 to 470 mc. are now in production at Ward Products Corp., Cleveland. The 12-element type illustrated has a gain of 11 db, handles up to 250 watts.

LEFT BELOW, high-precision synchronized camera system, manufactured by **J. A. Maurer, Inc.,** is designed for 3-dimension studies and simultaneous precision recording of separate actions.

ABOVE, New Jersey super-highway has an RCA relay system on 960 mc. running for 118 miles to communicate with patrol cars.

BELOW, Consolidated Vultee estimates that $30,000 a year will be saved by installing 2-way Motorola radio units on lift trucks and other vehicles at their Fort Worth plant, where B36D bombers are built.



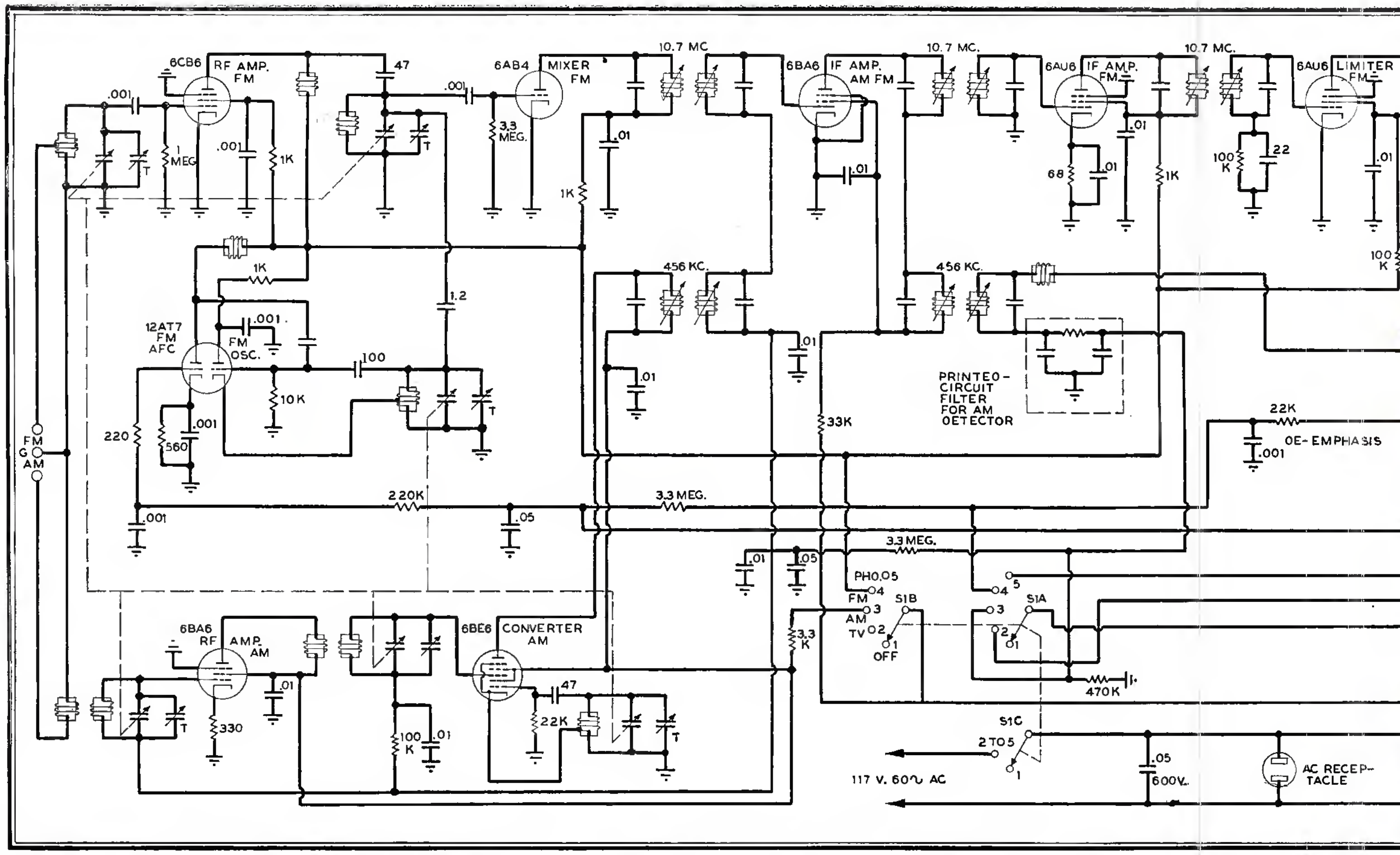


FIG. 1. SCHEMATIC OF THE BOGEN R604 FM-AM TUNER. NOTE LOW-NOISE FM RF INPUT CIRCUIT, EMPLOYING GROUNDED-CATHODE 6CB6 PENTODE

A NEW FM-AM TUNER CHASSIS

DESCRIBING AN FM-AM TUNER THAT IS DESIGNED SPECIFICALLY TO GIVE EXCELLENT PERFORMANCE WITHOUT EXPENSIVE EXTRAS—*By* ROBERT FURST*

RECEIVERS and tuners which can deliver performance that does justice to the capabilities of FM are not easy to design. However, because of the growing demand for sensitive and quiet FM receivers, particularly from the thousands of new high-fidelity enthusiasts who want fine performance from moderately-priced tuners, the time and expense involved in designing, producing, and promoting such receivers and tuners can be recovered quickly. Also, we have learned through observation that inferior designs are more expensive to the manufacturer in the long run, for they cause difficult relations with dealers and, because the public simply will not buy them, they must be discontinued in a short time. It was clear to us, therefore, that we had to exert every effort to produce a tuner which would deliver truly fine FM performance, in order to meet the demands of a market that is large today and is growing at an accelerated pace. We are confident that we have such a tuner in the Bogen model R604, which is described below.

General Considerations:

In preliminary plans, we set up the following criteria as essential features of a successful tuner design:

1. High sensitivity, coupled with a low input-circuit noise figure. One characteristic without the other makes the tuner useless for long-distance reception.
2. Freedom from drift, even without the corrective action of AFC.
3. A reliable AFC circuit, to facilitate tuning for those not accustomed to FM, with a provision for disabling the AFC if it is not desired.
4. Conservative operation of all components, to minimize service requirements.
5. Wide-band acceptance with good rejection of unwanted signals.
6. Output adequate to drive any standard amplifier.
7. FM audio response flat from 30 to 15,000 cycles.
8. Facilities for AM reception also, with as good fidelity as is consistent with adequate interference suppression.
9. No unnecessary circuits or controls.
10. Limiter-discriminator detector circuit.
11. As low a price as is possible without sacrifice of any essential features.

The circuit of Fig. 1, with the lay-out shown in Fig. 2, was evolved to meet all these design objectives.

Circuit Description:

One of the most outstanding features of the R604 is its low input-circuit noise figure, achieved by the RF and mixer section design. A 6CB6 sharp-cutoff pentode is employed as an FM RF stage, with a low admittance and equivalent noise resistance in the grid circuit and with a grounded cathode. Half of a 12AT7 is utilized as a triode oscillator. The RF and oscillator signals are applied to the grid of a 6AB4 triode mixer, and the difference frequency of 10.7 mc. is coupled to the first IF stage.

On AM, a 6BA6 RF amplifier stage feeds a 6BE6 converter. The converter

*Project Engineer, David Bogen Company, Inc., 663 Broadway, New York 12, N. Y.

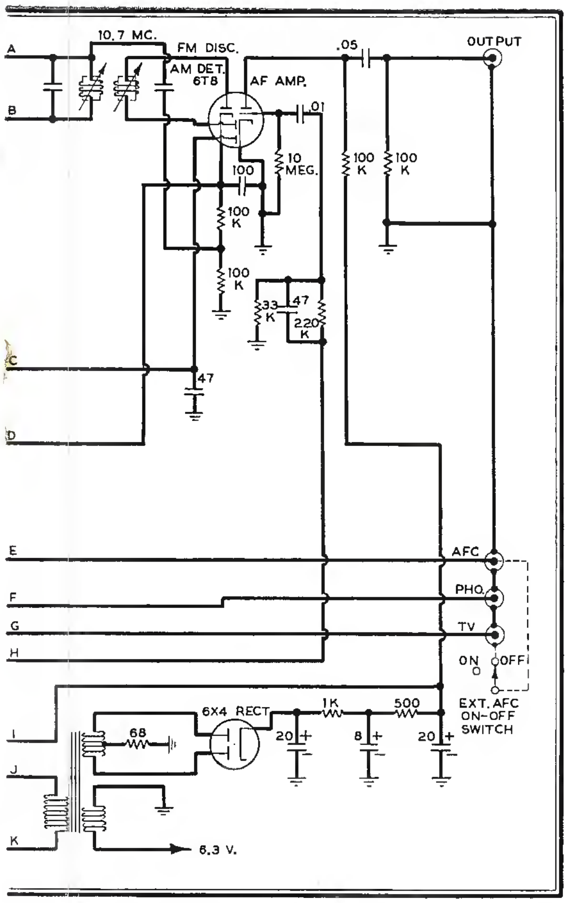


plate load is a 455-kc. IF input transformer whose secondary is in series with the secondary of the 10.7-mc. IF input transformer. Thus, although the same IF amplifier tube is used for both AM and FM, the transformers are completely separate.

At the output of the 6BA6 IF stage, the second FM and the output AM IF transformer primary windings are in series. Because of the great difference in the IF frequencies, and the fact that only one signal can be present at a time, there is no deterioration of performance from employing such an arrangement. At 10.7 mc., the 455-kc. transformer has a very low impedance, and the same is true of the FM transformer at 455 kc.

The second FM IF amplifier stage employs a 6AU6 pentode. Another 6AU6 follows as a double-tuned limiter, which drives the 6T8 Foster-Seeley discriminator circuit. It will be noted in Fig. 1 that the time-constant of the de-emphasis network is, seemingly, only 22 microseconds. Actually, wiring capacity increases this to the correct 75-microsecond figure.

The AC component of the discriminator output is fed to the selector switch, S1A. The DC component, however, is filtered further and applied to the grid of the AFC reactance tube. This is the remaining half of the 12AT7, which is employed also as the FM local oscillator. The AFC line is brought out to an RMA jack, so that an external AFC ON-OFF switch can be employed or, if it is so desired, the AFC can be grounded permanently. Even with the AFC disabled, drift is not more than ± 20 kc. after the set has been turned on for 45 seconds.

One diode section of the 6T8 is employed as an AM second-detector. A printed-circuit filter network is used, in addition to another filter section composed of an RF choke and a 47-mmf. capacitor. In this way, a low-distortion AM detector is obtained without the expense of an additional tube envelope. AVC voltage is fed to the AM RF and converter stages, in addition to the 6AB6 IF amplifier stage.

Sensitivity on AM is 10 microvolts for full output. On FM, an input of 10 microvolts provides 20 db quieting.

The Power Supply:

Since miniature tubes are employed throughout the tuner, the power requirements are not high. This makes practical the use of an RC filter, with the elimination of a power supply choke and its attendant expense and hum problems. The double-pi RC filter employed is so effective that the hum level is 60 db below the output signal.

The AC power switch is controlled by a third section of the selector switch. Also, a switched power receptacle is provided on the tuner chassis for operation of an amplifier.

B+ is supplied to the 6T8 and the 6BA6 IF amplifier at all times, since these stages are employed in both AM and FM sections. In the FM position of selector switch S1, plate voltage is applied by S1B to the 6CB6 RF amplifier, the FM oscillator, mixer, and AFC reactance tubes, and the 6AU6 IF and limiter stages. In the AM position, S1B switches the plate voltage to the AM RF amplifier and converter tubes. Thus, it is impossible to have both AM and FM signals at the grid of the 6BA6 amplifier, or to have either when neither is desired. Filament power is supplied to all tubes whenever S1 is not in the OFF position, however, so that both FM and AM circuits are ready for instant operation without frequency drift.

Total power consumption is rated at 50 watts.

Audio Circuits:

It can be seen in Fig. 1 that switching is provided for phonograph and TV inputs by S1A, in addition to its FM-AM switching function. The audio signal selected is fed through an RC network to the triode grid of the 6T8, where it is amplified and brought to the high-impedance output jack. Nominal output is 1 volt.

The RC network in the audio line serves three purposes, as follows:

1. It reduces the maximum-signal amplitude, so that the 6T8 is not overdriven.

2. It can be seen that the amplifier is biased by grid-leak current. The network reduces distortion caused by signal clipping to a negligible value.

3. The capacitor in the network compensates for high-frequency attenuation caused by the capacity of wiring to the 6T8 grid through the switch. As a result of this compensation, the overall frequency response is flat within ± 1 db from 30 to 15,000 cycles.

A volume control was not provided, for the tuner was intended for use with a preamplifier and a power amplifier, or with an amplifier incorporating volume and auxiliary controls. It is obvious that a volume control on the tuner would

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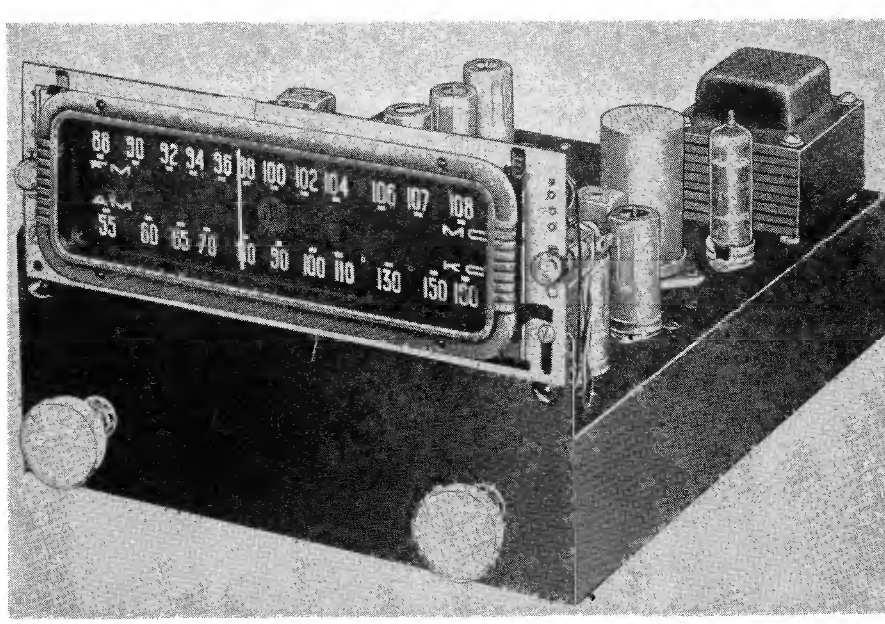


FIG. 2. MODEL R604 FM-AM TUNER HAS ONLY SELECTOR SWITCH AND TUNING CONTROL KNOBS

MOBILE RADIO

NEWS AND FORECASTS

IT was 50 years ago, on December 12, 1901 to be exact, that Guglielmo Marconi picked up the first transatlantic wireless signals at St. John's, Newfoundland, sent out by a station that he had erected at Pohdhu, England.

Since then, wireless telegraph communication service has been extended to practically every civilized part of the world. US companies now serve 82 foreign countries. In addition, there are radio telephone links between the US and 88 foreign countries, providing direct connections from their 25 million telephones to our 43 million.

FCC records disclose some of the highlights of the radio progress in the past 50 years that many of the younger engineers may not know about, and that the older ones may have forgotten.

1901: Radio telegraph service inaugurated to connect five Hawaiian Islands.

1903: Marconi station at Wellfleet, Mass., exchanged greetings between President Theodore Roosevelt and King Edward VII.

1905: First distress call from an American vessel was transmitted.

1906: Reginald Fessenden transmitted speech and music from Brant Rock, Mass., and reception by ships at sea was reported at distances of several hundred miles.

1909: Jack Binns summoned aid for the S. S. Republic by radio.

1910: Marconi inaugurated American-European wireless telegraph service.

1912: Transpacific wireless telegraph service was established, linking San Francisco and Hawaii.

1915: Transcontinental radio telephone transmission, from New York City to San Francisco, and transatlantic radio telephone transmission, from the Navy's station NAA at Arlington, Va., to the Eiffel Tower station in Paris.

1922: First 2-way ship-to-shore telephone conversation occurred between Deal Beach, N. J., and the S. S. America, 400 miles at sea.

1927: Commercial radio telephone service opened between US and Europe.

1930: Radio telephone transmission on microwaves across the English Channel.

1932: Two-way AM mobile radio communication demonstrated by REL for the Boston police department.

1933: Two-way AM for communication from locomotive to caboose demonstrated by REL for the Lehigh Valley Railroad on the run from Newark to Buffalo.

1933: Two-way AM communication from tugboat to dispatching office demonstrated in New York Harbor for the Dalzell Towing Company, with equipment by REL.

1940: First 2-way FM mobile radio system installed in Connecticut under the direction of State Police Commissioner Edward J. Hickey and chief engineer Sidney E. Warner. Prof. Daniel E. Noble was the engineering consultant to the State. Equipment was built by Fred M. Link.

1945: Microwave telegraph relay opened between New York and Philadelphia.

1947: AT & T multiplex FM microwave relay service opened between New York City and Boston.

1951: AT & T multiplex FM microwave relay service opened between New York and San Francisco.

FCC figures just released show that there are now more than 300,000 mobile radio units in use, operated in conjunction with 10,000 transmitters in the public safety group, 3,200 in land transportation, 11,000 in the industrial group, and part of the 800 common carrier stations.

Add to these 33,000 marine, 32,000 aeronautical, 4,700 broadcast, 450 experimental, and 100,000 amateur stations, and you have a bird's-eye picture of what has happened in radio communication here in the United States during the past 50 years.

Television Interference:

Probably the TV broadcast stations should have been included in the preceding list but, among communication engineers, the less said about television the better. A few people owning poorly-designed TV sets can make a howl that starts with the local board of selectmen or city council and extends all the way to the FCC offices in Washington. And it's a very painful sound to the chief of police, the taxi operator, or the electric light company complained against. Even when the Radio Inspector gives the transmitter a clean bill of health, people still blame the station rather than the manufacturers of TV sets that lack adequate interference rejection.

More Microwave Systems:

Now that point-to-point and relay systems on microwave frequencies have demonstrated their ability to provide performance equal to the best quality of wire circuits, their use is increasing rapidly. And to their dependable performance the advantages of multiplexing have been added. Thus, in 1952, the largest new investment in radio communication equipment will be for multiplex microwave systems. Another factor in the substitution of radio for wire circuits in certain instances is that radio communication is less vulnerable to air attack. A hit at any point in a wire-line circuit can interrupt service, but a relay station must be hit directly.

Packaged Installations:

Although the sale of equipment for communication systems has shifted, for the most part, to a relatively few large companies, the change has by no means eliminated the small concerns. On the contrary, many have enjoyed a substantial increase in volume.

Here's what has happened: The trend in the purchase of equipment has been toward packaged installations. Thus, instead of purchasing individual items from their respective manufacturers, a single order is placed with one company which, in addition to furnishing equipment of its own manufacture, provides the antenna, tower, fittings, test instruments, and whatever associated facilities are required. This simplifies the details of procurement, and centralizes the responsibility for system performance in one company.

Sometimes original bids specify the exact items from other manufacturers that will be supplied. The tendency now, however, is to employ consultants to plan new systems, and to prepare specifications as to make and type of the equipment and the system performance for submission to bidders. This avoids complications arising from the old technique of "confusing the issue" so frequently employed by unsuccessful bidders in dealing with municipal, state, or company officials who, lacking technical knowledge, were reluctant to make decisions on their own responsibility.

Another practice currently gaining favor in situations which involve unusual system engineering problems is to place the contract for the equipment and its installation with an independent engineering firm. The advantage is that such a contractor is then free to select equipment from the various manufacturers as is considered best suited to the system requirements.

Technical failures and legal complications resulting from efforts to cut corners have emphasized the economy of competent engineering counsel, either by employing a full-time communication engineer, or retaining a firm of consultants.

A public utility official responsible for a radio system now extending over several states put it this way: "It took so much time and cost so much money to correct some of our early mistakes. We found out the hard way that it's cheaper to pay the price of being right the first time."

Low-Power Portables:

Hand-carried transmitter-receiver units are coming into wide use for a great variety of applications. Here are some excerpts from a report on the use of the Doolittle Littlephone, by C. F. Hebard of the Cushing Electronic Laboratories, Cushing, Oklahoma:

"For operation in the State Police planes, the unit is used with a headset and hand mike. When the pilot leaves the plane, he plugs in the telephone handset and takes the radio with him. In this way, they have the use of the radio in police work that does not involve the use of the plane.

"When the unit is used in the plane, the regular antenna is taken off and the permanent antenna on the ship is plugged in. On their Beechcraft, this is a quarter-wave whip mounted vertically in the center of the fusilage, just back of the rear seat. On the Stinson, the quarter-wave whip is mounted on the pants of the right landing gear, in line with the axle of the wheel. When the landing gear is folded up, the antenna points straight down, and when the gear is down for landing, the antenna is horizontal and out of the way.

"Since the unit is used as many hours out of the plane as in it, it is desirable to obtain maximum range with the regular antenna. We tune it with the regular antenna plugged in. No retuning is required for use in either plane.

"We can contact any of the 8 base stations in the State from 2,000 ft. over the central part of the State, and have no trouble getting 2-way contact with any patrol car within a radius of 100 miles from that altitude. We can work 2-way with patrol cars up to 25 miles while air-patroling at about 500 ft., which is the way they fly traffic patrol.

"Cushing is 29 miles from the district base station at Pawnee. On routine checks here at Cushing, standing in the highway with the unit in my hand, I have on two different days contacted KKC881 at Pawnee on the first call using the State Police frequency of 44.7 mc. Flying with the City Police, we have continuous 2-way contact on 156 mc. within a radius of 100 miles at an altitude of 1,000 ft."

The service provided by low-power, hand-carried equipment is truly remarkable. However, it should be noted that the range on the ground may be reduced greatly by conditions of use. For example, many of these units are being used by plant-protection guards. Inside or adjacent to steel structures, the range may be very limited. It is important, therefore, that any plan of use for these units be worked out on the basis of preliminary tests, rather than assuming that operation under one set of conditions can be duplicated at another location.

450 to 460 Megacycles:

There seems to be a lack of understanding as to what services can use the channels in what is generally referred to as the 450 to 460-mc. band. Actually, the Commission made very broad provisions for communication systems in its allocation table of July 1, 1949, as indicated by the following list of channels:

TAXICABS	
452.05 mc.	452.55 mc.
452.15	452.65
452.25	452.75
452.35	452.85
452.45	452.95
URBAN TRANSIT	
453.05 mc.	453.45 mc.
453.15	453.55
453.25	453.65
453.35	453.75
AUTO EMERGENCY	
453.85 mc.	453.95 mc.
POLICE, FIRE, FORESTRY, HIGHWAY MAINTENANCE, SPECIAL EMERGENCY	
454.05 mc.	455.05 mc.
454.15	455.15
454.25	455.25
454.35	455.35
454.45	455.45
454.55	455.55
454.65	455.65
454.75	455.75
454.85	455.85
454.95	455.95
POWER UTILITIES, PIPELINES, FOREST PRODUCTS, MOTION PICTURES, RELAY PRESS, SPECIAL INDUSTRIAL SERVICES	
456.05 mc.	457.05 mc.
456.15	457.15
456.25	457.25
456.35	457.35
456.45	457.45
456.55	457.55
456.65	457.65
456.75	457.75
456.85	457.85
456.95	457.95

In addition, twenty 100-kc. channels from 458.05 to 459.95 mc. are provided for common carrier service. Above that is the Citizens Radio band from 460 to 470 mc. Since this use has not been developed, it is hoped that at least a part of it may be made available for urban trucking, and delivery and maintenance service companies which are not now permitted to operate their own communication systems.

Radio Paging:

Neither Dick Tracy's wrist-watch nor the cheap sets envisioned for use on the Citizens Radio band have emerged in commercial form. However, it does appear that a practical vest-pocket receiver can be made and used in conjunction with limited common carrier stations for calling subscribers. Enough sensitivity can be built into a set comparable to standard hearing aids so that subscribers can receive messages over a considerable radius.

In such service it would only be necessary for the main station to give the name of the person wanted. He, in turn, would call the station from the nearest telephone. The FCC looks upon this type of frequency use with favor, particularly because time on the air is reduced to the very minimum.

Monkey Wrench:

In the course of a recent hearing at the FCC, we learned first hand just how a well-meaning lawyer without experience in radio matters can perform a serious disservice for his client. It is perfectly natural for an applicant or a licensee to consult with his local attorney when he has an FCC problem, just as he would if he should be threatened with a suit for damages or breach of contract. And lawyers as a group are not distinguished by their modesty in admitting that there are legal matters outside their experience or beyond their ability to handle them.

We watched the faces of the Commissioners on this occasion, and listened to the lawyer's elaborate and largely irrelevant presentation of his client's case. It was plain the situation which called for the hearing was becoming rapidly more involved because the lawyer was so completely uninformed as to FCC practice and procedure. This appeared to be a simple case, on which a decision could have been reached promptly. We never did learn the outcome, but when we left the hearing room, it appeared that the case was so thoroughly bogged down as to indicate an indefinite delay before the Commission could take any final action.

As pointed out previously in these pages, a similar fate generally befalls applications for new facilities or modifications if they are not made out correctly. FCC procedures provide a straight, fast route for applications which present the required information correctly, but those that do not are shunted onto bypaths where they may languish indefinitely.

(Continued on page 29)

COVERAGE OF STATION ANTENNAS

HOW THE INTENSITY OF SIGNALS RECEIVED BY MOBILE UNITS IS AFFECTED BY HEIGHT AND GAIN OF FIXED-STATION ANTENNAS—*By* GEORGE C. TERRILL*

THE various factors affecting radio wave propagation, as they pertain to the vertically-polarized beacon type of antenna most commonly used in mobile communication systems, will be the subject of this paper. Also, the effect of antenna characteristics and installation on the useful range of the transmitting station will be discussed.

In general, only the ground wave need be considered at distances involved with mobile communication systems. The ground wave can be assumed to be made up of two components, a direct wave and a ground-reflected wave, whenever the transmission distance is small enough so that earth curvature can be neglected. The assumption of a plane earth is permissible up to distances of about $\frac{50}{\sqrt[3]{f(mc.)}}$ miles. For the three bands used, namely 30 mc., 150 mc., and 450 mc., these limiting distances are 16.1 miles, 9.4 miles, and 7.45 miles respectively.

Plane Conductivity:

When a plane wave is guided by a perfectly-conducting plane, it will be found to propagate parallel to the conductor with the velocity of light. The wave has an electric field component normal to the plane which is n_1 times the magnetic field component parallel to the plane. These field components produce charges on the conductor and current flow in the direction of propagation. If the plane is imperfectly conducting, conditions will be disturbed to some extent. This case can be solved exactly to determine the effect of the imperfect conductivity.

If the conducting plane which is to guide the wave has a finite conductivity, it must require some component of electric field in the direction of propagation to produce the current flow. This can be found from the impedance of a plane conductor of infinite depth:

$$Ez = Zs\,Jz = Rs\,Jz\,(1+j) \quad (1)$$

$$Jz = Hy \quad (2)$$

where Ez=component of electric field in direction of propagation.

Zs=surface impedance.

Jz=component of current in direction of propagation (both conduction and displacement current).

Hy=tangential component of the magnetic field.

Rs=skin effect surface resistivity.

With the value of Jz found in *(1)*,

$$Ez = (1+j)\,Rs\,Hy \quad (3)$$

The current flow in the plane of finite conductivity also produces a finite power loss, which is determinable from the resistance component of the conductor impedance and the current flow in the plane:

$$\text{Loss} = \frac{Jz^2 Rs}{2} = \frac{Hy^2 Rs}{2}\ \text{watts/meter}^2 \quad (4)$$

Since a small component of Ez is given by *(3)*, and since a component of energy flow into the plane accounts for ohmic losses, the wave can be considered to be plane itself, with its wave front tipped slightly so that it is incident at a small but finite angle measured from the plane. The tangent of this angle is given approximately by the ratio of Ez to Ex. From *(3)* and

$Ex = n_1 Hye^{(jwt-K_1z)}$, this ratio is

$$\frac{Ez}{Ex} = \frac{(1+j)Rs}{n_1},$$

where Ex = component of electric field normal to direction of propagation.

A specific analysis of the effect of earth conductivity on the useful range of a transmitter is extremely involved, and beyond the scope of this paper. Generally, so far as a qualitative analysis is concerned, it can be said that the attenuation of a signal due to ground losses increases with frequency, so that signals at 150 mc. are attenuated more than those at 30 mc., and those at 450 mc. are attenuated more than those at 150 mc. The maximum possible ratio of the normal electric field to the tangential electric field corresponds to a tilt angle of about 22°. This means that the traveling wave loses its energy approximately at the rate described by the function $P_x = P_o e^{-\frac{x}{5}}$, where P_x is the value of the Poynting vector at a point described by its distance x from the point where the value is P_o.

A more interesting aspect of earth conductivity is its effect on the reflected portion of the ground wave. In considering reflection by a discontinuity, there are two extremes involved. The discontinuous surface may have zero conductivity (a perfect dielectric), or it may have infinite conductivity (a perfect conductor). For vertically polarized waves, which are waves polarized normal to the plane of incidence, the nature of the reflection is opposite for the two cases at grazing angles of incidence. For a perfect conductor, the reflection takes place with zero phase change. For the perfect dielectric, on the other hand, the reflection occurs with 180° phase change. For actual ground, which is neither a perfect conductor nor a perfect dielectric, but is more a dielectric than a conductor, the phase change is very nearly 180° at grazing angles of incidence.

The important conclusion to be drawn is that in regions where the assumption of a plane earth is valid, the signal strength along the ground is very low because of the destructive interference between the direct and ground-reflected waves. This is an important consideration for mobile communications work because, in most cases, the receiving antenna height is less than 10 feet, and the distance usually greater than one mile, so that the angle subtended by the receiving antenna at the transmitter is about $\arctan\frac{10}{5{,}280}$, or about 5 minutes. Thus, for all practical purposes, the receiving antenna is on the ground, and the task of the transmitting antenna is to lay the maximum possible signal on the ground.

Antenna Characteristics:

Calculations can be simplified considerably, yet still yield the desired information, if absolute values involving the use of actual ground constants and distances which vary from case to case are not used, but calculations are made on a relative basis only.

First, assume the transmitting antenna to be on the ground. It has been shown already that, for mobile communications, the receiving antenna can be considered to be on the ground also. Assume, too, that the field at the receiving antenna can be represented by a unit vector. If a perfect-dielectric ground is considered, and the method of images is employed, the two sources would be coincident and 180° out of phase, yielding zero field at the receiving point. However, this is not the case if some representative values for the reflection coefficient and phase factor of the actual ground are taken.

Assuming zero incidence, or grazing angle, the reflection coefficient is 1. This means that the source and image are of equal amplitude. However, the actual phase change will be about 170°, instead of 180° as for a perfect dielectric. The resulting signal amplitude will then be

$$A = \sqrt{1^2+1^2-2(1)(1)\cos(180^\circ-170^\circ)}$$

$$A = .184$$

(Continued on page 30)

*Workshop Associates Division of the Gabriel Company, Newton Highlands, Mass.

SELECTING VEHICULAR ANTENNAS

MECHANICAL AND ELECTRICAL FACTORS TO BE CONSIDERED WHEN CHOOSING MOBILE RADIO ANTENNAS — *By* M. R. FREIDBERG AND J. F. LOWENSTEIN*

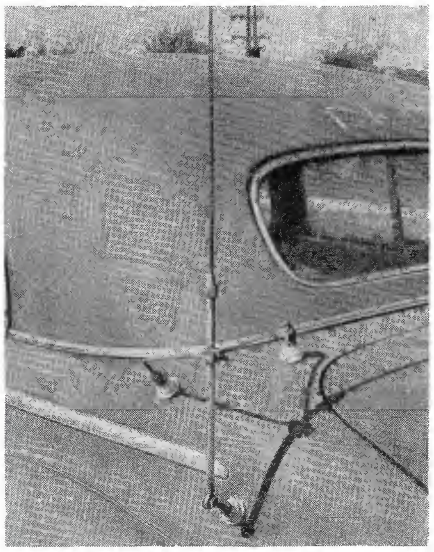


FIG. 1. TRIPOD-MOUNTED WHIP INSTALLATION

TOO often, the importance of proper antenna installation is not appreciated fully when mobile radio equipment is being planned. Unless the most suitable antenna is chosen for a particular installation, and is mounted correctly on the mobile unit, it cannot be expected to operate at its highest potential efficiency or to stand up under the physical abuse encountered in practical service. This paper discusses the selection of the proper antenna for a given installation, the electrical characteristics for various mounting positions, and the means to achieve good electrical performance from antennas of rugged construction.

Mechanical Considerations:

One of the first widely-utilized types of mobile antennas was the tripod-mounted whip, Fig. 1. Support at three points, as shown, minimized the danger of bending the body or fender of the vehicle, and provided an extremely sturdy mount for the antenna. Because it did not permit adequate rod flexure, however, this method of mounting resulted in frequent antenna breakage. In addition, the tripod arms caught debris and reduced the antenna efficiency by adding a secondary conduction path to ground.

The disadvantages of the tripod mount were overcome with the introduction of the swivel mount, Fig. 2. which consists of a split ball on a flat insulating plate. An outstanding feature of this type of mount is that the antenna can be made to stand vertical regardless of the angle of the surface upon which it is mounted.

A low-inertia rod, with a maximum stress taper, is used customarily with the swivel mount. If greater shock protection is required, a spring can be added between the swivel and the whip. The bending constant of the spring should then be low enough so that an appreciable part of the bending moment is bypassed from the antenna rod itself.

Experiments to determine the actual utility of base springs used with whip antennas were conducted recently, as follows: A two-by-four plank, Fig. 3, was braced to a tree so that it overhung the test road at a height such that the test antenna, when mounted on a vehicle, would strike it at right angles 24 ins. below the antenna tip. Various types of springs with different constants were tested. Even with the best spring, the antenna tip broke off before the last of four runs at 40 mph. After each run, the tip was straightened which, undoubtedly, weakened the metal and hastened its breakage. Next, a similar test was made without a spring. The tip broke, of course, but the antenna took a permanent set at the base also. Thus, the spring preserved the lower part of the antenna, and assisted to some extent in shielding the tip against shock.

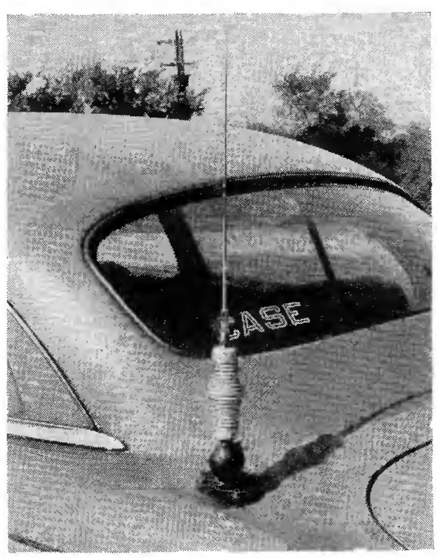


FIG. 2. THE SPRING-AND-SWIVEL BASE MOUNT

In order to determine whether still lighter springs would reduce the distortion at the tip of the antenna, the setup of Fig. 4 was employed. The antenna was suspended by two cords attached to the base. It was held nearly vertical by means of a thread attached at a point higher up on the rod. With this mounting, the tip impact distortion would be at a minimum, for the slightest sudden force would break the thread and allow the antenna to fall. Any distortion under these conditions would be caused only by the momentum of the floating antenna, and could not be reduced by any spring, even the weakest. This test showed just as much tip distortion as the previous ones on spring-mounted antennas, thereby proving the high effectiveness of present springs.

Disguising the Antenna:

When the antenna is less than 4½ ft. long, a quarter-wavelength at 50 mc., it can be mounted conveniently on the fender or cowl as is done with a standard broadcast antenna. Fig. 5 shows how it can be constructed to resemble a broadcast antenna, thereby concealing the fact that the vehicle is equipped with 2-way radio equipment.

However, the collapsible broadcast receiving antenna is unsuitable for actual 2-way radio use for the following reasons: First, the contacts between sections are unsatisfactory. Transmitting currents passing through the phosphor-bronze spring fingers tend to arc at points of imperfect contact. Further, the heat generated anneals the fingers, eventually destroying all contact and permitting the sections to collapse. The resulting changes in length, both physical and electrical, cause loading difficulties and failure of components. Thus, a non-adjustable antenna which appears to be adjustable is the logical solution to the

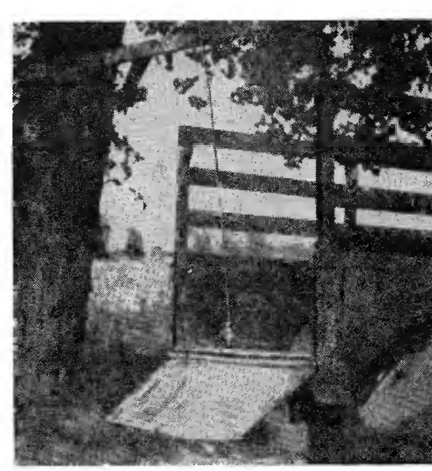


FIG. 3. TESTING UTILITY OF BASE SPRINGS

*Director and Project Engineer, respectively, Communications Department, Ward Products Corporation, division of the Gabriel Company, 1523 East 45th Street, Cleveland 3, Ohio

problem of deception. Such an antenna is now available commercially. An incidental advantage of this type is that the antenna can be replaced directly by a standard broadcast whip when the vehicle is sold.

Frequency Limitations:

At higher frequencies, the roof is the ideal location for the antenna, even though a flat roof does not provide optimum mechanical support. For frequencies above 100 mc., however, the ultimate in efficiency can be obtained only with a roof-mounted antenna, Fig. 6. At the lower end of this frequency range provision must be made to reduce the height of the antenna in some way, so that it will not be damaged in areas of restricted overhead clearance.

Thus, the mounting location is determined to a great extent by the frequency employed. Physical limitations restrict the maximum length of a mobile antenna to 10 ft., or to 6 ft. when roof-mounted.

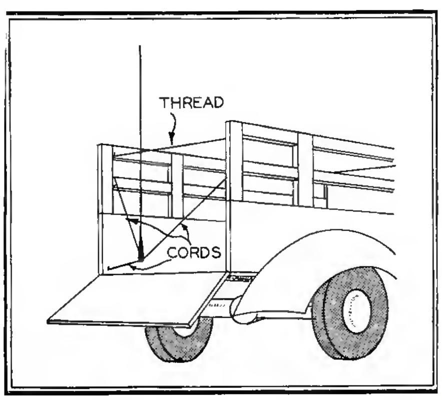


FIG. 4. DETERMINING MINIMUM USEFUL SPRING

It is desirable, when possible, to utilize the metal body as a ground plane, for ground-plane antennas are more efficient and physically smaller as well.

The quarter-wave antenna operated against the car body is very useful in some mobile applications. A good impedance match to standard coaxial cables is obtained without complicated matching devices. The horizontal radiation pattern is fairly non-directional, and the vertical pattern shows a small radiation angle. This simple type is useful down to 25 mc., for it is extremely rugged. It is used almost universally, with a swivel base, in the 30 to 50 mc. band. Below 25 mc., however, its physical length becomes excessive, and a loaded antenna or some other type must be employed.

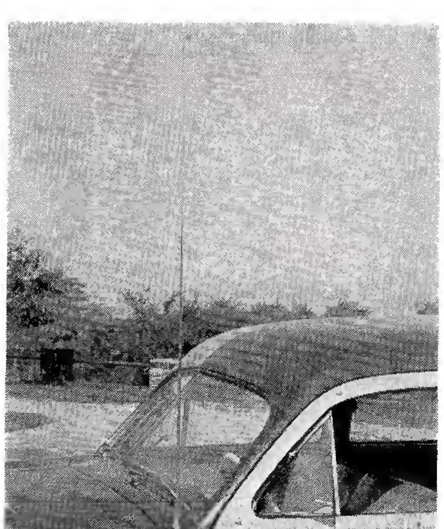


FIG. 5. ANTENNA IS ACTUALLY A 2-WAY WHIP

Loading Devices:

Fig. 7 shows the variation in impedance at the base of a whip antenna for various antenna lengths. The impedance is a pure resistance at a quarter-wavelength, with a value of about 35 ohms. When the antenna is short physically at the operating frequency, a capacitive component is added to the impedance. This reactance must be cancelled at the antenna base or at a point on the feed line close to the antenna, so that a proper impedance match with the transmitter can be obtained.

A popular method of cancelling capacitive reactance is shown in Fig. 8, where a loading coil is inserted in series with the antenna at its base. If the resistance of the antenna is then too low to provide an efficient match to the coaxial line, a simple quarter-wave impedance transformer can be used.

The loading coil need not be located at the base. It can be inserted at any point in the antenna, but it must be taken into account that the physical inertia of the rod is affected by the weight of the coil. Insertion at a higher point is advantageous in that the current-carrying requirement of the coil is reduced, and the radiating base of the antenna is not impeded, but the mechanical ruggedness of the assembly is reduced.

A transmission line stub, either shorted or open, is utilized in another method of feeding a short antenna. Inductive reactance is provided by a shorted line-stub less than a quarter-wavelength long, while an open stub of the same length presents capacitive reactance at its terminals. When an electrically short quarter-wave antenna is connected to a 52-ohm transmission line, the values of R and X as seen looking toward the antenna vary as indicated in Fig. 9. At some point on the line, the resistive component is equal to the characteristic impedance of the line. A stub is connected at this point to cancel the reactance seen by the line. All that remains is a pure resistance equal to the nominal line impedance. Thus, the short antenna is coupled efficiently to the cable. The useful frequency range of loaded antennas for mobile use extends to 1.5 mc., although efficiency is quite low in that region.

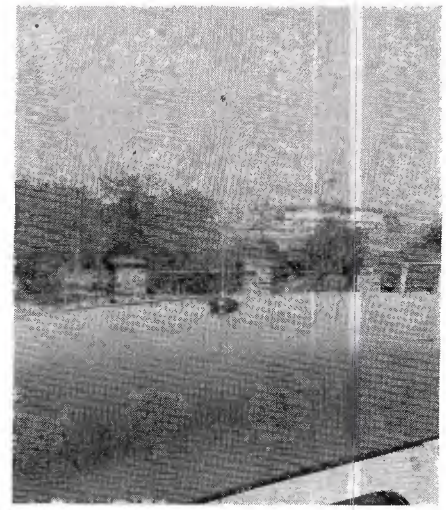


FIG. 6. A GROUND-PLANE ANTENNA FOR 150 MC.

Colinear Antennas:

Antennas longer than a quarter-wavelength are practical at frequencies above 120 mc. The simple ¾-wave antenna has excellent impedance characteristics, similar to those of the quarter-wave whip. However, the vertical angle of maximum radiation is higher, which reduces its effectiveness along the horizon.

The J-match antenna consists of a quarter-wave stub surmounted by a half-wave antenna. The stub elevates the main radiating part of the antenna, and serves to match it to the line. Unfortunately, the stub radiates to some extent, thus decreasing the effectiveness of the asembly.

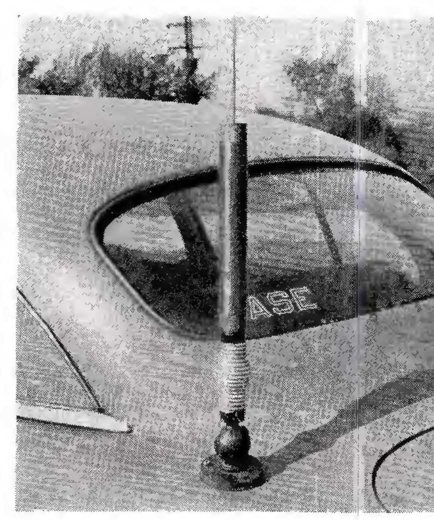


FIG. 8. BASE-LOADED QUARTER-WAVE ANTENNA

On an open vehicle, or where a roof-top installation is impractical, the coaxial antenna can be used. It is composed of a quarter-wave rod and a tube or skirt of the same length. The rod forms the upper half of the antenna, and the skirt the lower half. Both sections radiate. The two sections are insulated from each other at the center, and are fed at that point by a coaxial cable which passes through the lower section. This antenna is sensitive to ground proximity, and is affected by adjacent vehicular traffic.

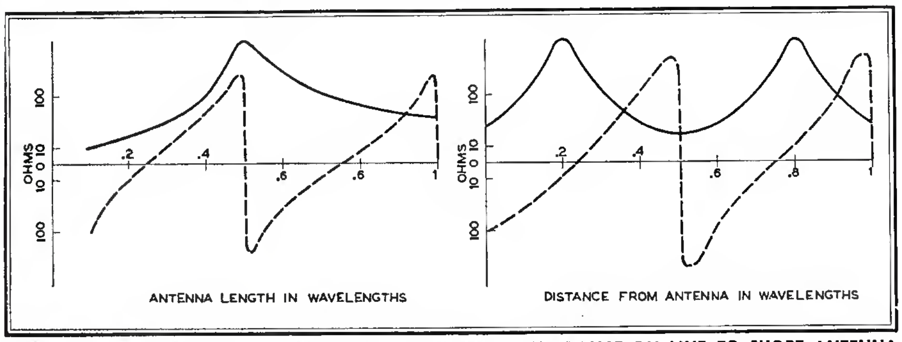
Some increase in gain is possible above 250 mc., where a quarter-wave-length is in the order of 1 ft., by employing a more elaborate colinear array. For instance, a useful increase in signal strength is obtained with a quarter-wave section surmounted by a phased half-wave antenna. The slot antenna, a relatively recent development, appears to have practical applications at the higher mobile frequencies. Experiments are now being conducted with it.

Horizontal Directivity:

Generally, mobile units must communicate with fixed stations at nearly ground level, and skip transmission is not desired. As much power as possible, therefore, should be radiated along the horizon or at very small angles above it. Also, a circular horizontal radiation is ideal, so that the direction of the vehicle's motion will not affect communication.

At frequencies above 100 mc., the most desirable horizontal pattern is obtained with a roof-mounted whip. The roof of the vehicle, being relatively large compared to a wavelength, acts as an excellent smooth-ground system. Fig. 10 shows a scale-model horizontal field pattern for a quarter-wave whip mounted on the roof of a vehicle. Operating frequency in this case is 160 mc. As the frequency decreases, the ground plane becomes smaller electrically, and the horizontal pattern becomes increasingly irregular. In general, maximum-signal lobes appear in the direction of the longest ground path.

When the antenna is mounted on the fender, this effect is more pronounced, as can be seen in Fig. 11. Maximum signal strength occurs in a direction diagonally opposite the antenna through the center of the vehicle. Fig. 12 shows how this tendency is exaggerated as the antenna is mounted nearer the edge of the vehicle. Here, the solid curve is for a conventional mount at the upper left corner of the trunk door. The dashed curve is for a mounting at the side of the left rear fender, one foot from the end.



FIGS. 7 AND 9. IMPEDANCE OF ANTENNA SEEN AT BASE, IMPEDANCE ON LINE TO SHORT ANTENNA

However, when a half-wave type such as a coaxial antenna is employed, the direction of maximum radiation is exactly reversed. This is explained by the fact that the vehicle no longer acts as a ground plane but as a reflector.

In cases where horizontal directivity is desired, two general methods for obtaining it are convenient and effective. First, two or more whips can be fed with signals of the proper amplitude and phase. Second, half a vertical Yagi antenna can be employed, with reflector and director elements grounded and the quarter-wave radiator driven in the usual manner. A gain of 6 db, or a power gain of 4, is obtainable easily with the latter arrangement.

The Yagi antenna described is being used by the Cleveland Police Department on an emergency mobile unit, equipped with a 60-watt transmitter, which is intended for use in case of damage to the base station. When the unit is situated on a high location overlooking the City, system-wide communication is maintained with dependability approaching that of the 250-watt base-station transmitter.

NBS MODEL ANTENNA RANGE

THE National Bureau of Standards has recently completed a model antenna range to facilitate the measurement of antenna radiation patterns in the vertical plane. The new range, believed to be the largest ever designed for this purpose, is composed of an inverted V-type structure which supports a target transmitter more than 50 ft. above a ground plane, in the center of which is placed the model antenna to be tested.

The NBS investigations are concentrated on the band from 3 to 30 mc., which is employed primarily for long-distance communication. At these frequencies, the wavelengths vary between 300 and 30 ft.; consequently, measurements on full-sized antennas would require a site several thousand feet long. This presents a problem even when only

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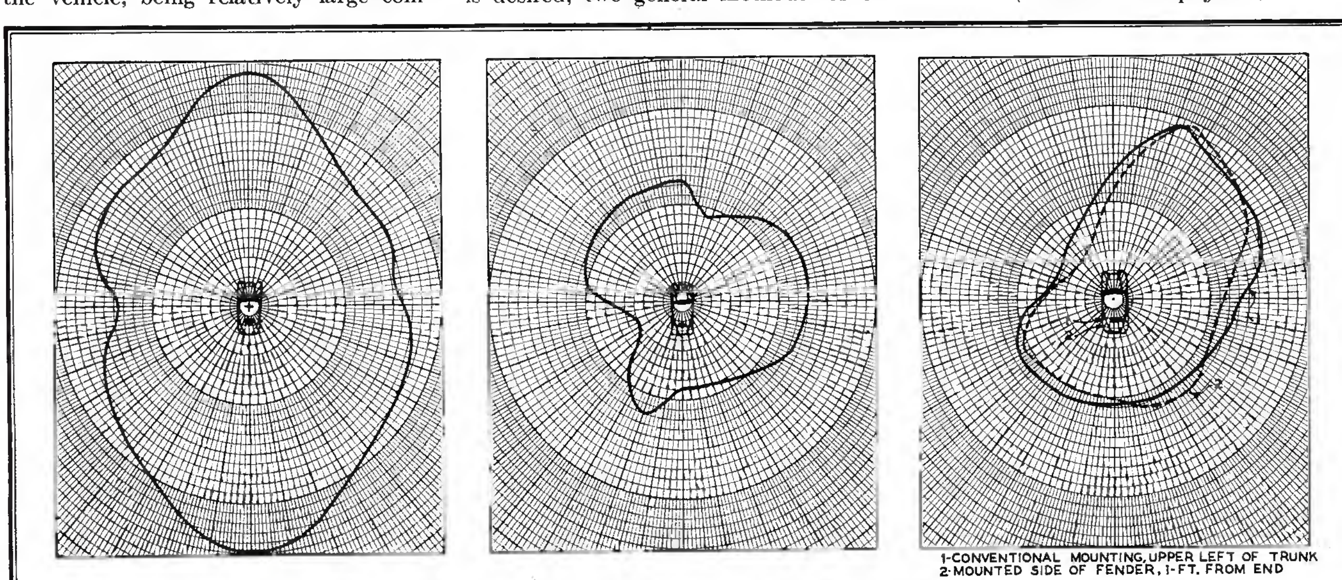

FIGS. 10, 11, AND 12. HORIZONTAL DIRECTIVITY PATTERNS FOR QUARTER-WAVE ANTENNAS MOUNTED ON ROOF, LEFT COWL, AND LEFT REAR FENDER

A NEW SYNCHROSCOPE DESIGN

INCREASED VERSATILITY AND SIMPLICITY OF OPERATION ARE FEATURES OF IMPROVED SYNCHROSCOPE FOR PULSE EXAMINATIONS — *By* F. A. SPINDELL*

THE precise analysis of short-duration pulses has become increasingly important during the past few years, with refinements in equipment for radar, telemetering, and other pulse-modulation applications dependent to a large extent on the control of pulse shape. Basic versions of the synchroscope, an instrument of the oscilloscope type, were developed some time ago to simplify the examination and measurements of pulses. Designs differ primarily in the sweep and sync circuits of the synchroscope, which permit expansion of short-duration waveforms and provide sweep deflection only during the actual times of the pulses. In order to meet the new, more rigorous requirements the Browning P4-EX synchroscope, shown in Fig. 1, has been developed recently. A block diagram of the new instrument is given in Fig. 2.

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Circuit Description:

It will be noted that a trigger generator is an integral part of the instrument. The trigger repetition rate is adjustable by means of a calibrated panel control from 50 to 5,000 pulses per second, and can be used to trigger the external equipment under observation as well as the sweep generator. Also, this generator can be synchronized to an external source if it is so desired.

The output of the trigger generator is fed to two delay circuits simultaneously. One has a fixed delay of 10 microseconds, for reasons which will be apparent later, while the other is of the phantastron delay type which can be adjusted continuously from less than 10 to approximately 500 microseconds. The switch following these delay circuits is so arranged that the output of either circuit can be applied to the output trigger-forming circuit and brought out for external application, while the other drives the sweep generator. This arrangement makes it possible to phase the trigger output with respect to the sweep, so that it can be delayed from zero to 500 microseconds after the start of the sweep, or the sweep can be delayed by the same amount after the trigger output. A diagram of the time relations for maximum delays is given in Fig. 3.

The pulse selected to instigate the sweep is applied to a gate generator, which drives the sweep generator as well as providing the brightening pulse for the CRT grid. A feedback circuit controls the duration of the gate to produce automatic blanking of all but the useful forward motion of the CRT sweep trace. The actual sweep generator is of the bootstrap variety, providing sweep rates continuously variable from 1 to 25,000 microseconds per inch with excellent linearity. Panel controls are calibrated directly and are reliable within ± 10%. The sweep voltage is applied through a cathode follower to one horizontal deflection plate, and through a unity-gain inverter to the other horizontal plate, thus giving the advantages of push-pull deflection.

It will be noted from the block diagram that pulses from an external source, of either positive or negative polarity, can be used to trigger the sweep circuit directly. No delay is possible with an external trigger source, so that the sweep begins less than 0.1 microsecond after the triggering impulse.

Vertical deflection voltage can be applied directly to one deflection plate, provided the amplitude is sufficient to produce usable deflection. Voltages too small to be applied directly can be fed through the video amplifier, which has sufficient gain for a 1-in. deflection with an input of 1 volt peak-to-peak. Bandwidth of the amplifier is 5 mc. A compensated video attenuator preceding the amplifier makes it possible to use signals too small in amplitude for direct observation, but large enough to saturate the amplifier if applied to the first grid directly.

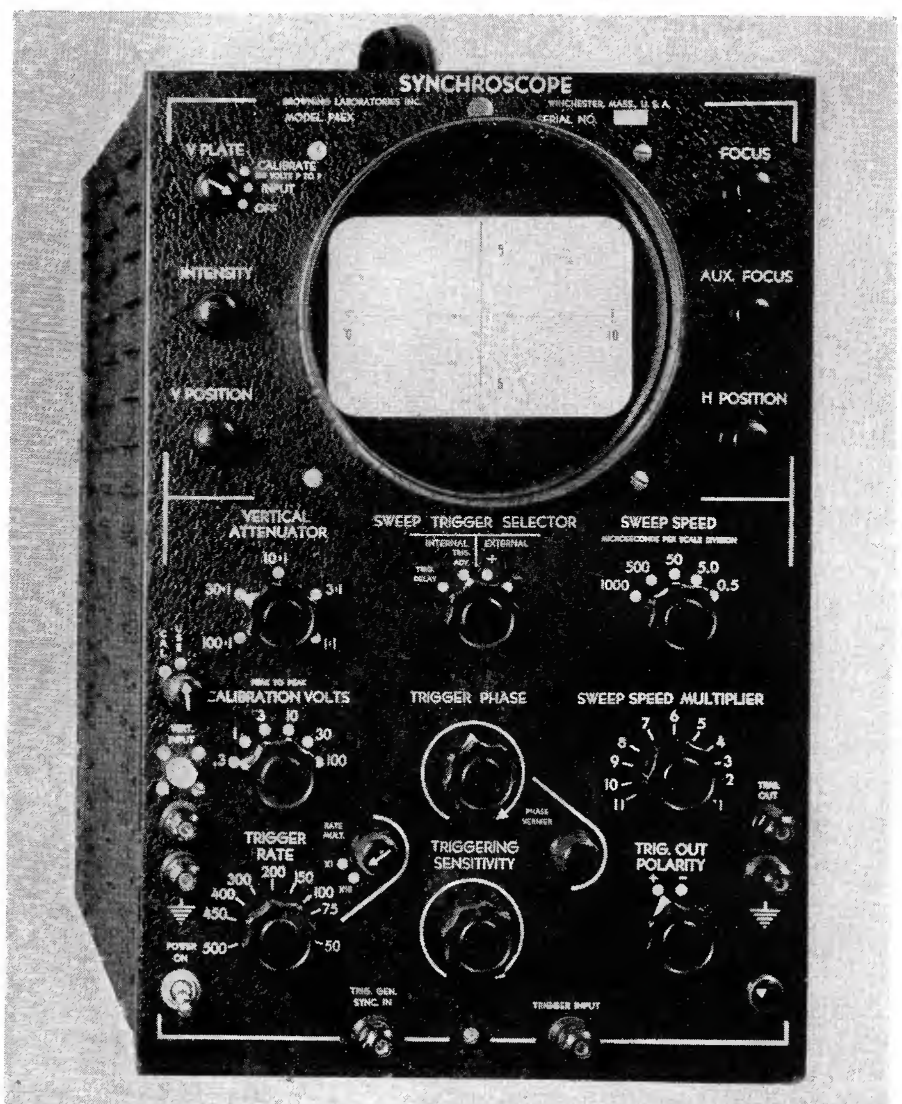

FIG. 1. THE BROWNING P4-EX SYNCHROSCOPE, FOR MAKING PRECISE WAVEFORM OBSERVATIONS

(*Continued on page 26*)

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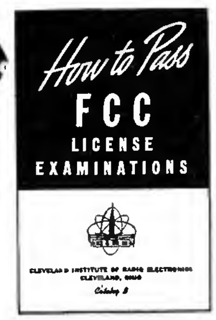

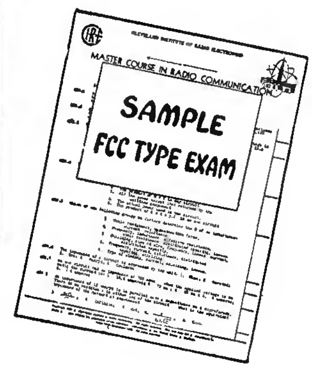

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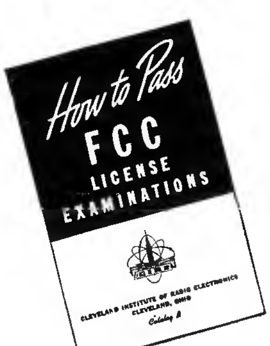

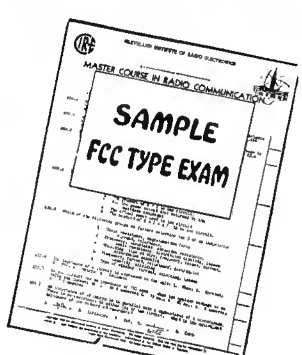

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SYNCHROSECOPE

(Continued from page 24)

Internal calibration voltages are provided so that the amplitude of a vertical deflection signal can be determined accurately. For cases when a signal can be applied directly to the vertical plate, a 100-volt peak-to-peak signal is available for calibration of the direct deflection sensitivity. When the video amplifier is used, several standard peak-to-peak voltages can be selected by means of a panel switch for calibration of the deflection sensitivity at any vertical attenuator setting.

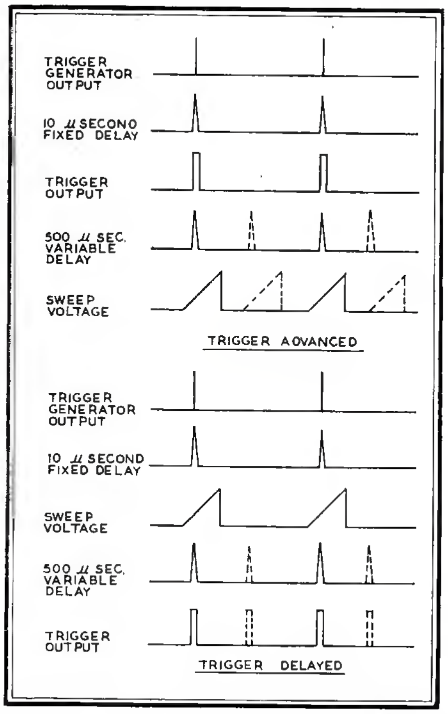

FIG. 3. SWEEP AND TRIGGER TIME RELATIONS

The 5UP cathode-ray tube produces an extremely small, well-defined spot with 2,600 volts applied to the anode. Two focus controls are furnished on the panel to permit rapid adjustment of focus with minimum astigmatism under any operating conditions. The usual intensity and beam-positioning controls are also provided.

Using the Synchroscope:

Using the equipment setup shown in Fig. 4, the waveforms of Fig. 5 were obtained in order to illustrate the application of the new synchroscope. Positive trigger pulses, with a repetition rate of approximately 1,000 pps, were taken from the synchroscope trigger generator and applied to a sweep calibrator to drive it in synchronism. One of the outputs of the sweep calibrator is a rectangular pulse of variable amplitude and duration. This pulse was adjusted to 2 volts peak-to-peak amplitude and 50 microseconds duration, and was applied to the input of the synchroscope video amplifier. The variable delay was set to zero.

Then the photograph of Fig. 5A was made with a sweep speed of approximately 100 microseconds per inch. At this sweep speed, very little detail of the rise and fall of the pulse could be seen, although the characteristic shape is clearly evident in the illustration. The sweep speed was then increased to approximately 20 microseconds per inch for the photograph in Fig. 5B. Somewhat more detail is apparent here. Still, the rise and fall are too rapid for quantitative analysis. Raising the sweep speed to approximately 2 microseconds per inch, the photograph of Fig. 5C was made. This displays very clearly the way in which the pulse rises. By using the sweep control calibration, it was possible to determine that 1.4 microseconds elapsed during the rise of the pulse from 10% to 90% of its peak value. Then, without altering the sweep speed, it was possible to examine and photograph the trailing edge of the pulse as shown in Fig. 5D. This was accomplished by introducing a delay of 50 microseconds between the output trigger and the start of the sweep by means of the variable delay controls. Again, the use of the calibrated sweep permitted the direct determination that 3.7 microseconds were required for the pulse to fall from 90% to 10% of its peak amplitude.

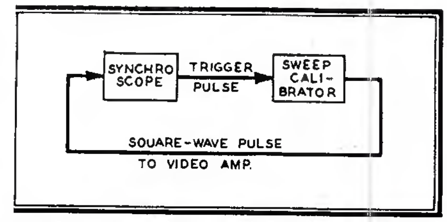

FIG. 4. HOW FIG. 5 WAVEFORMS WERE OBTAINED

While the rectangular pulse is one of the simpler types, it is illustrative of the value of the variable delay in observing the minute details of any desired portion of a complex pulse or transient. A major advantage, also, is the continuously variable, calibrated sweep speed control, which facilitates time measurements by permitting expansion of the time base to the rate at which the display is most convenient to work with and measure.

Flexibility is increased over the older Browning synchroscopes by the elimination of a detector at the video amplifier input. The high-impedance input of the

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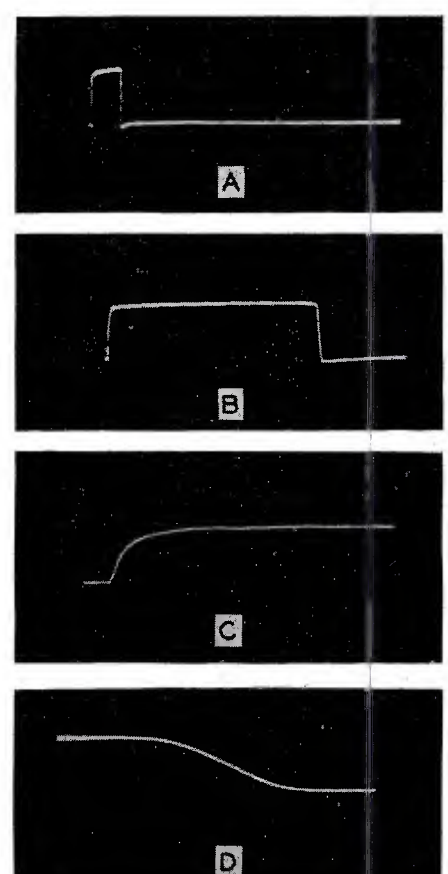

FIG. 5. DETERMINING RISE AND DECAY TIMES

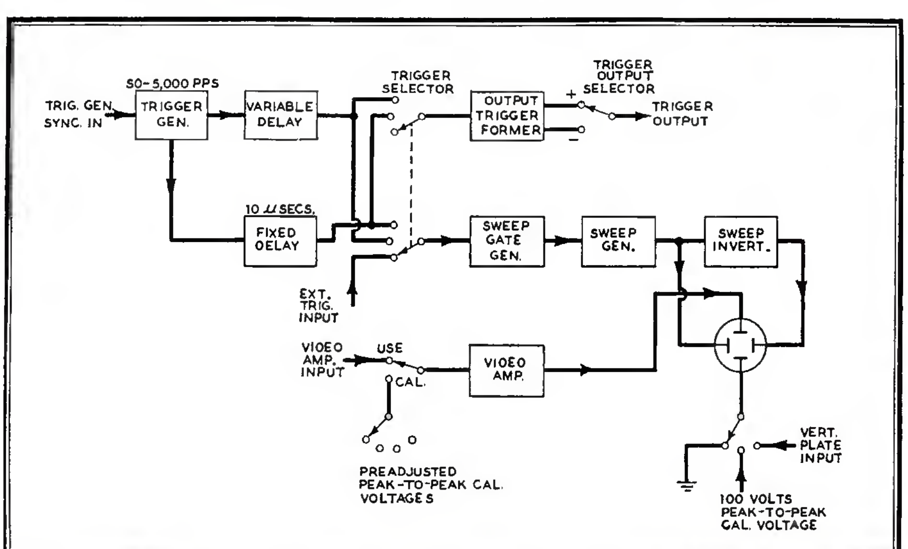

FIG. 2. SYNCHROSCOPE CIRCUITS PROVIDE VARIABLE DELAY FOR SWEEP OR TRIGGER OUTPUT

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SYNCHROSCOPE

(Continued from page 26)

new model can be fed directly from the output of a crystal or other detector. Thus, envelopes as well as the ordinary waveshapes encountered in pulse circuitry can be examined.

Specifications:

Measurements made on the P4-EX synchroscope show that the response of the video amplifier is down 3 db at 5 cycles and 5 mc., with a maximum rise time of .08 microseconds. Maximum vertical sensitivity is 1 volt peak-to-peak per inch with input impedance of 2 megohms and 40 mmfd.

Sweep speeds range from 1 to 25,000 microseconds per inch, are continuously variable, and can be triggered from a pulse at ratios up to 50:1.

Positive or negative output triggers are supplied from 50 to 5,000 pps. These triggers are .5 microsecond wide, have a rise time of .15 microsecond, and can be phased from 500 microseconds before the start of the sweep to 500 microseconds after the start of the sweep. Sweeps can be triggered from an external source if such operation is desirable. Direct connection can be made to a vertical deflection plate if large signals are to be observed.

The instrument is housed in a steel case measuring 14½ by 10 by 16¾ ins., and weighs 50 pounds.

TRANSISTORS

(Continued from page 14)

microwatts. Contours are shown for 10, 50, and 100 microwatts of power-supply load.

This ability of the transistor to work with extremely small power consumption is one of its most striking and, perhaps, most important features. When it is considered that the total power consumption of a single transistor stage can be smaller by many thousands of times than the power required to heat the cathode in a vacuum tube, it is obvious that the advent of this device will increase tremendously the range of transistor applications. Fig. 6 shows only two examples of these startling possibilities. At the left is a complete audio oscillator assembly which draws less than a microwatt from a battery power supply and at the right is a 2-stage audio amplifier with a gain of 90 db.

Conclusion:

In review, the salient features of this new transistor are:

1. *Relatively low noise figure.* Most of the units measured so far have a noise

(Concluded on page 29)

TRANSISTORS

(Continued from page 28)

figure between 10 and 20 db at 1,000 cycles.

2. *Complete freedom from short-circuit instability.* The input and output impedances are always positive, whether the transistor is connected with the emitter, base, or collector grounded. This permits a great deal of freedom in circuit design and makes it possible, by choosing the appropriate connection, to obtain a considerable variety of input and output impedances.

3. *High gain.* Power gains of the order of 40 to 50 db per stage have been obtained.

4. *High power-handling capacity and efficiency.* The design can be varied readily to permit the required amount of power dissipation, up to at least 2 watts. Furthermore, the static characteristics are so nearly ideal that Class A efficiencies of 48 or 49%, with a maximum possible efficiency of 50%, can be realized. The efficiencies for Class B and Class C operation are correspondingly high.

5. *Ruggedness and small size.* The germanium part of the transistor is enclosed in a hard plastic bead about 3/16 inch in diameter. Inside the bead, three connections are mechanically as well as electrically fastened to the germanium, and are brought out as pigtails through the bead. This makes for a very sturdy unit.

6. *Freedom from microphonics.* Vibration tests in the AF range indicate that these devices are relatively free from microphonic noise.

7. *Limited frequency response.* Collector capacitance limits the frequency response at full gain to a few kilocycles. By using a suitable impedance mismatch, it is possible to maintain the frequency response flat to at least 1 mc., while still obtaining a useful amount of gain.

8. *Operation with small power consumption.* The best example of this feature, to date, is the audio oscillator mentioned previously, which requires from a power supply only 6 microamperes at 0.1 volt. This represents 0.6 microwatts of power, which contrasts sharply with the million or more microwatts required to heat the cathode of an ordinary receiving-type vacuum tube.

MOBILE RADIO NEWS

(Continued from page 19)

What is the best way to speed the processing of FCC matters? We inquired about this in various quarters, so as to present the most useful advice here. The answers boiled down to this: Keep local lawyers, particularly corporation lawyers, out of FCC matters. Secure the services

MOBILE RADIO NEWS

(Continued from page 29)

of an attorney who is a member of the FCC Bar Association.

Export Business:

An increasing amount of communication equipment is being shipped to foreign countries. South America is a particularly active market. Much of it is going into multiplex telephone installations, for use over mountainous terrain or jungle country where telephone lines cannot be installed, or maintained in bad weather.

Another factor favoring the use of radio circuits is the lack of materials, particularly copper. In some areas, sabotage by guerillas is an important consideration. It is much easier to protect a series of stations than continuous wire lines.

A serious handicap to the extension of radio communications in many countries, however, is the shortage of engineers capable of maintaining the equipment. That applies particularly to multiplex relay systems. While it is true that they are automatic in operation, it is also true that the installations require regular and expert maintenance.

ANTENNA RANGE

(Continued from page 23)

horizontal-plane radiation patterns are desired, but when the pattern in a vertical plane is required, the problem is even more complex.

It has been found that model techniques are useful for the analysis of antenna problems. A scaling factor of 60 is employed for the new NBS range at Sterling, Va.

STATION ANTENNAS

(Continued from page 20)

If the gain of the transmitting antenna is increased, so that it has a value of 2, we find that

$$A = \sqrt{2^2+2^2-2(2)(2)\cos(180°-170°)}$$
$$A = .360$$

If the gain is increased to 4,

$$A = \sqrt{4^2+4^2-2(4)(4)\cos(180°-170°)}$$
$$A = .707$$

Thus, it appears that the increase in signal at the receiving point is less than the increase in the source gain by a small amount. However, the increase in signal is roughly proportional to the increase in gain of the transmitting antenna.

Raising the transmitting antenna to a height of 100 ft. affects the signal at the receiving point in the following way:

Assume that the distance between the two antennas is one mile. The angle subtended by the transmitting antenna at

(Concluded on page 31)

STATION ANTENNAS

(Continued from page 30)

the receiving point is then $arctan \frac{100}{5,280}$, or about 1°. This may not at first seem to be very significant. However, an important characteristic of vertical polarization is the rapid change of reflection coefficient in this angular range. For an angle of 1°, the reflection coefficient can drop from 1 to .9. The phase angle, however, changes only slightly in this region. Select a phase angle figure of about 168°. For a source having a value of 1, the resultant would be

$$A = \sqrt{1^2 + .9^2 - 2(1)(.9)\cos(180^\circ - 168^\circ)}$$
$$A = .223$$

This represents a gain over the first case of

$$\frac{.223}{.184}, \text{ or } 1.64 \text{ db.}$$

For a source having a directivity of 4,

$$A = \sqrt{4^2 + 3.6^2 - 2(4)(3.6)\cos(180^\circ - 168^\circ)}$$
$$A = .905$$

Comparing this with the corresponding case on the ground, the improvement is

$$\frac{.905}{.707}, \text{ or } 2.15 \text{ db.}$$

Another series of calculations for a different antenna height is necessary before drawing any general conclusions. Raising the antenna to 200 ft. should provide the required information. The new subtended angle is about 2° 10′. The reflection coefficient is about .7, and the phase angle about 165°. Thus, for the source with a gain of unity,

$$A = \sqrt{1^2 + .7^2 - 2(1)(.7)\cos(180^\circ - 165^\circ)}$$
$$A = .374$$

This is a gain over the first case of 6.21 db, and over the second case of 4.52 db.

For a source with a gain of 4,

$$A = \sqrt{4^2 + 2.8^2 - 2(4)(2.8)\cos(180^\circ - 165^\circ)}$$
$$A = 1.5$$

This is a gain over the first case of 6.55 db, and over the second case of 4.4 db.

It would appear, therefore, that the signal received at a ground point due to an antenna of directivity D and height h is nearly directly proportional to the directivity, and varies with height according to

$$E = (1.7)^{\frac{h}{2}} E_o,$$

where E_o is the field strength at the receiving point when the transmitter is on the ground, and h is the height of the transmitter in hundreds of feet. However, it must be remembered that this is an empirical relationship, derived from assumed values, and does not represent a universal case. The values of reflection coefficient and phase angle were taken from the "Radio Engineers' Handbook," page 698, by F. E. Terman.

IMPROVING THE AIR-COUPLER

PART 2 — CONSTRUCTION AND PERFORMANCE OF THE TRIPLEX AIR-COUPLER, WHICH CAN BE OF A PORTABLE OR BUILT-IN DESIGN — *By* ROY F. ALLISON

IN Part 1 of this series,[1] the development of the Dual Air-Coupler[2] was described in detail. This new, improved Air-Coupler was the result of an attempt by the Fowler-Allison-Sleeper group to smooth out the measured response curve of the original model, and to increase the relative sound output below 40 cycles.

The improvement was accomplished without altering the outside dimensions. As shown in Fig. 8, the only change was internal. This consisted of the addition of partitions to provide two air-columns, of different lengths, in the space formerly used as a single 6-ft. column. A 12-in. speaker was employed as before, so that those who have built Air-Couplers of the original design can make the changes required for conversion quite simply. Response of the Dual Air-Coupler is shown by the curve in Fig. 9, which appears on page 34 of this issue.

[1]Radio Communication for October, 1951.

[2]In the first article of this series, the new Air-Coupler was identified as the "Duplex" type. However, to avoid any confusion with the well-known Altec Lansing Duplex loudspeaker model 604B, the name "Dual Air Coupler" is used in this text.

Baffling Back Radiation:

However, our measurements indicated that some cancellation occurs when the Air-Coupler is employed without a baffle for the back radiation of the speaker. This was shown by Fig. 7 in Part 1, which is a curve of the free-field response of the Dual Air-Coupler placed in front of a right-angle reflector to simulate a room-corner mounting. Thus, it was recommended that the Dual Air-Coupler be mounted under the floor, in a closet, or in some other manner whereby an infinite baffle would be provided for the back radiation.

It was recognized that it is not practical, in every installation, to cut a port-hole in a floor or a closet for the Dual Air-Coupler. In some cases, too, it might not be desirable to install an Air-Coupler in such a manner—even though it does provide complete concealment of the enclosure. Therefore, a corner reflex design,

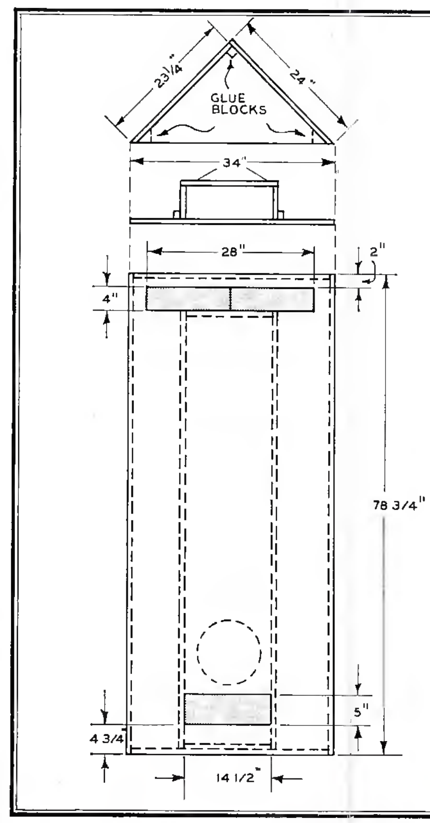


FIG. 11. ASSEMBLY OF TRIPLEX AIR-COUPLER

which converts the back radiation to useful energy, was developed also. This reflex design is completely self-contained, and does not have to be fastened down because of its greater weight. It can be placed in an inconspicuous corner of a room, just as any other corner cabinet.

Building the Triplex Coupler:

Since a total of 3 air-columns is employed in this version, it has been called the Triplex Air-Coupler. Constructional details are given in Figs. 10 and 11.

Fig. 12 shows a photograph of a developmental model. The design illustrated in the drawings is identical to this, except for slight modifications in con-

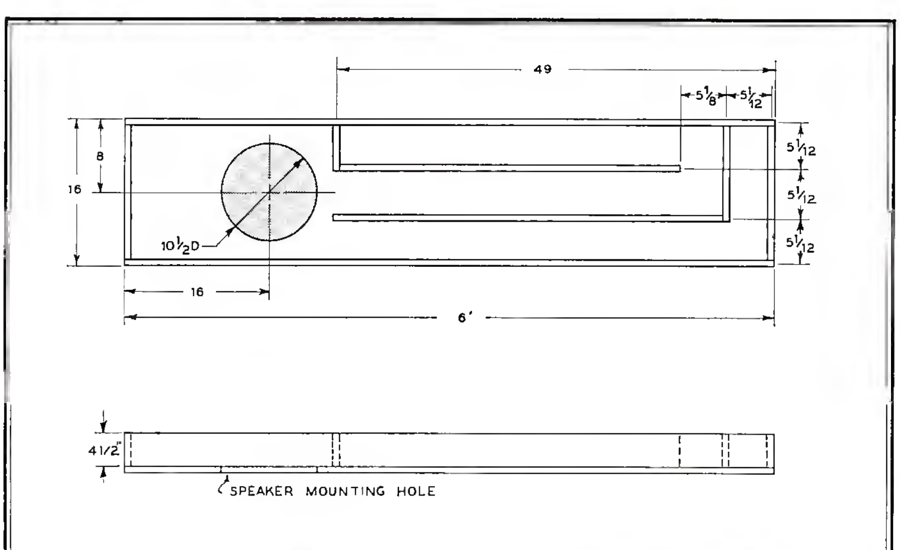


FIG. B. THIS IS BASIC DUAL UNIT, WHICH IS INCORPORATED IN THE TRIPLEX AIR-COUPLER

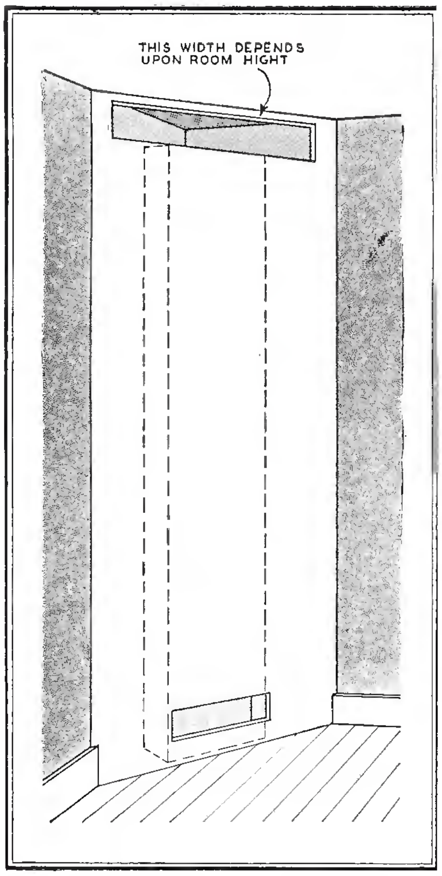


FIG. 13. BUILDING IN THE TRIPLEX COUPLER

struction to provide a more rigid and better-looking assembly.

First, the Dual Coupler is assembled completely, following the dimensions of Fig. 8, except for the front panel sections above and below the port. This assembly consists of the back panel, the side and end pieces, and the internal partitions. Then the front panel, cut to the dimensions given in Figs. 10 and 11, is attached.

Care should be taken that air-tight seals are obtained when the front and back panels are secured. This can be accomplished by drilling the screw-holes through both panels at once, as explained in Part 1, and mounting the side, end, and partition pieces of the Coupler on center-lines drawn on the panels through the screw-holes. Alternatively, if it is not desired to put in screws from the front, the Coupler can be glued to the panel and further secured by 1-in. square strips screwed to the sides of the Coupler and to the back of the front panel. This is shown clearly in Fig. 11. It is especially important that the partition boards be perfectly square and exactly of the same width as the side and end pieces, if the latter mounting method is employed, for the partition boards will then be sealed to the front panels only by the glue bond.

The assembly is then ready to mount in the corner enclosure. Construction of this unit is quite simple, and should be perceived readily from the drawings, Figs. 10 and 11. A note of caution: the speaker should be mounted on the back panel of the Coupler, and the speaker lead attached and brought out through one of the corner-enclosure sides before the front panel and Coupler are secured to the corner enclosure! Glue-blocks along the edges of the joints at the top and sides will be of help in obtaining an air-tight seal around the edges of the front panel.

Where permanent corner mounting is desired, the corner enclosure can be eliminated. The front panel can be cut to reach the ceiling, as shown in Fig. 13, and to fit snugly around the baseboard. Suitable methods for securing the assembly in place will depend on room construc-

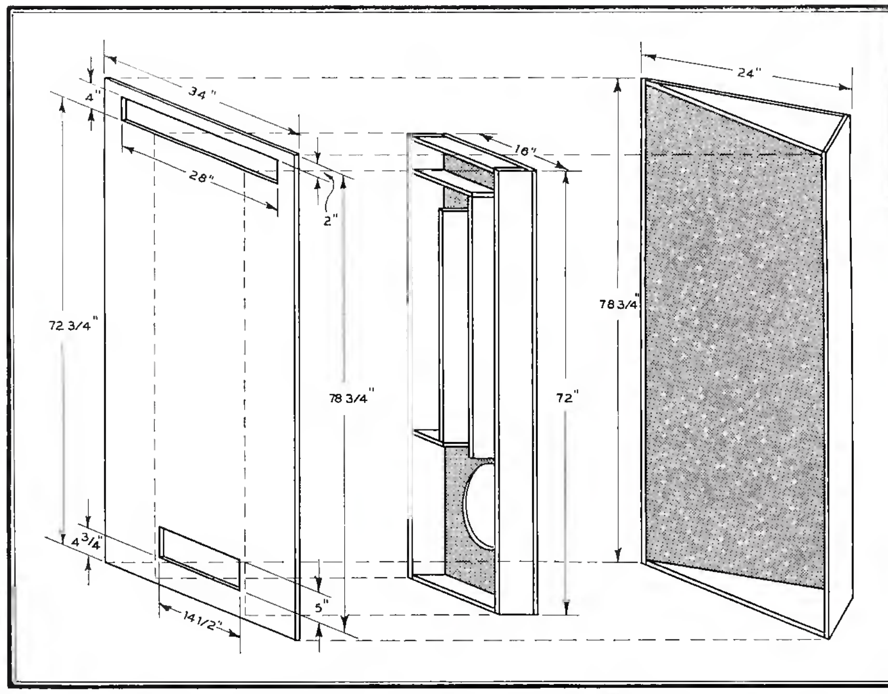


FIG. 10. DIMENSIONS OF FRONT PANEL AND CORNER ENCLOSURE ASSEMBLY FOR ¾-INCH PLYWOOD

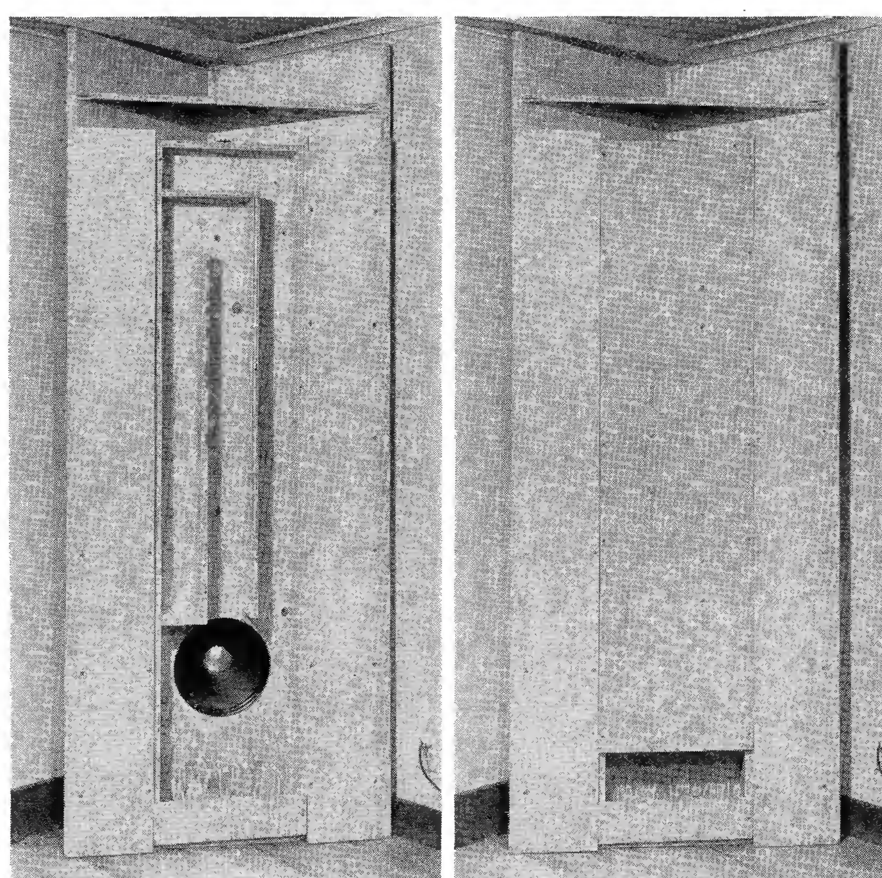
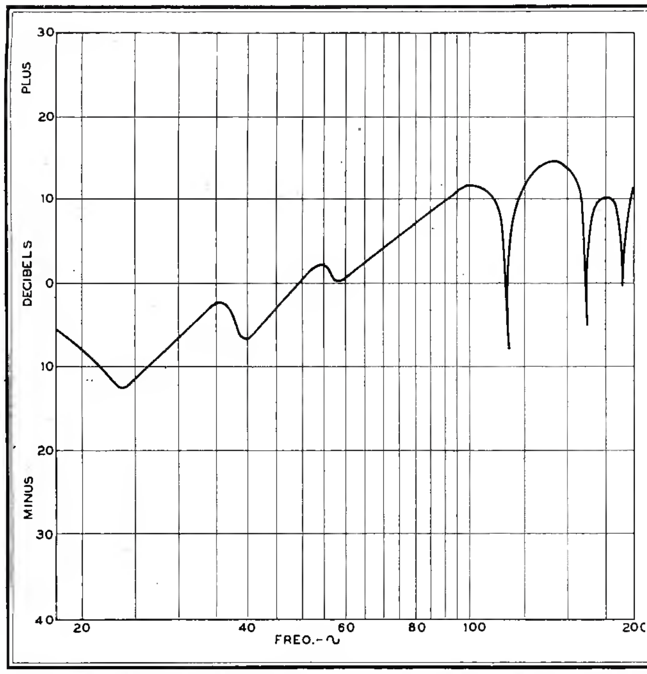


FIG. 12. ORIGINAL MODEL OF TRIPLEX AIR-COUPLER. FRONT PANEL IS SOLID IN NEW DESIGN



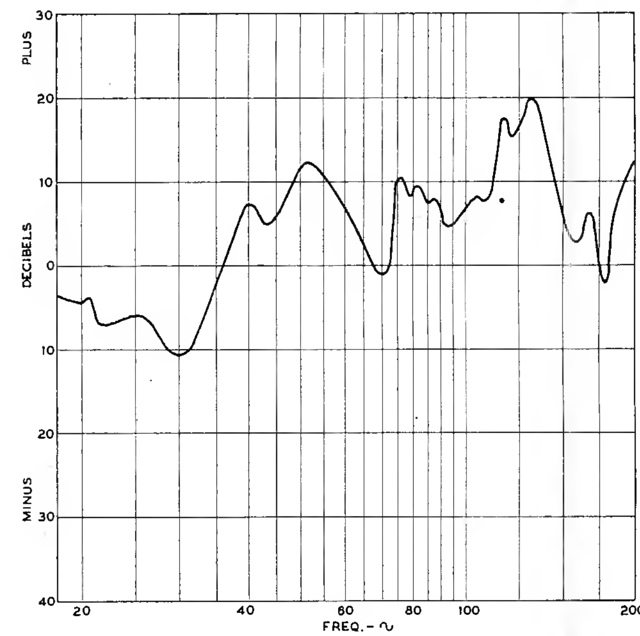


FIG. 9, LEFT: MEASURED RESPONSE OF THE DUAL AIR-COUPLER, DESCRIBED IN PART I OF THIS SERIES. IN ROOM HAVING FUNDAMENTAL RESONANCES IN REGION OF 35 TO 60 CYCLES. ABSOLUTE SOUND LEVEL IS CONSIDERABLY HIGHER THAN IN FIG. 9

FIG. 14, RIGHT: RESPONSE OF TRIPLEX AIR-COUPLER

tion and finish, and are left to the discretion of the reader. After installation, the panel can be painted, papered, or finished to harmonize with the furnishings of the room.

Ports can be covered with grillework and cloth, or cloth alone. There are no specific requirements for the covering other than that it be reasonably porous.

Triplex Performance:

The measured response of the Triplex Air-Coupler is indicated by the curve of Fig. 14. This should be contrasted with the performance of the Dual Coupler standing in a corner, as given in Fig. 7. It can be seen that a radical improvement is obtained by reflexing the back radiation. The curve obtained when the back wave is eliminated entirely is, of course, still better, as Fig. 9 shows. However, these curves do not show absolute values of sound output and, therefore, do not reveal that the Triplex Air-Coupler is considerably more efficient than the Dual Coupler. This is not partic-

(Concluded on page 35)

DESIGN DATA for AF AMPLIFIERS — No. 15 Multiple Speakers

PART 1 — SPEAKER ISOLATION — L-PAD COMPONENTS FOR VARIOUS SPEAKER IMPEDANCES — POWER DISTRIBUTION — AMPLIFIER POWER REQUIRED

WHEN two or more speaker systems are operated from a single amplifier it is desirable, in most cases, to provide individual level controls for each speaker. Unless suitable isolating networks are employed, however, the speaker volume controls will interact because they affect the relative impedance of the speaker lines and, therefore, upset the balance of power distribution. Isolating pads, or pad attenuators, are used to maintain constant amplifier loading by each loudspeaker line, no matter what the volume settings of the individual speakers. This is accomplished by designing attenuator pads so that the total impedance

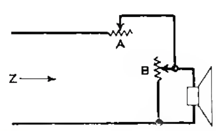


FIG. 1. L-PAD VOLUME CONTROL FOR SPEAKER

of a pad and its controlled speaker remains relatively constant, regardless of the amount of speaker attenuation.

The most popular attenuator for this purpose is the L-pad, shown schematically in Fig. 1. It consists of two potentiometers controlled by a common shaft, connected so that the contact arm of A moves to the right as that of B moves down. Thus, the resistance of A increases as that of the parallel combination of B and the speaker decreases, and the total is kept constant.

As with all simple solutions to general problems, there is a catch. These pads consume a certain amount of power even when set for maximum speaker volume. This is caused by the shunting effect of B, Fig. 1. The resultant decrease in available speaker power is called the pad insertion loss. It is the ratio of power into the line to the maximum power fed to the speaker, measured in db, and cannot be avoided simply.

Efficiency of isolation can be determined by the ratio of maximum variation in impedance to the maximum value of impedance, expressed in per-cent. Theoretically, the impedance variation should decrease as insertion loss increases. This does not always hold in practice, however, because of the difficulty of obtaining potentiometers of the exact optimum values.

The accompanying table gives the characteristics obtained with various combinations of values for potentiometers A and B, Fig. 1, for speaker impedances of 4, 8, 16, and 500 ohms. It can be seen that, invariably, the total impedance Z of the pad and speaker is less than that of the speaker alone. The value of Z must be used, of course, in making calculations of the total speaker load impedance for selection of the proper output transformer tap.

By suitable series and parallel combinations of speaker lines, and by varying the relative speaker impedances, it is possible to obtain either equal power division to each line or to distribute the total power in any way desired. Unequal power division might be desirable in a multiple-speaker home installation, for instance, where more volume would be required in the living room than in a bedroom.

Calculations of amplifier power requirements and of output connections for desired power distribution can be made by simple applications of Ohm's Law to experimental hookup diagrams. For instance, suppose that it is desired to have 4 speaker installations in a home — one each in a living room, a study, and two bedrooms. It is considered necessary to provide a maximum of 10 watts for the living room speaker, 4 or 5 watts for that in the study, and 1 watt for each bedroom speaker. Individual level controls are to be employed, each having an insertion loss of 3 db.

First, speaker impedances should be chosen that will facilitate obtaining the approximate power distribution desired. One possible solution would be to employ a 16-ohm speaker for the study, and 4-ohm speakers for the bedrooms, hooking these 3 in series. Another 16-ohm speaker could be used in parallel with this combination for the living room installation. It is obvious immediately that correct power distribution will be obtained in the series branch. However, it is found that when the total power to this branch is 12 watts (4 + 1 + 1 multiplied by 2 to allow for L-pad losses), the power to the living room speaker and pad is only 18 watts. This provides only 9 watts for the speaker. In order to supply the desired

L-PAD CHARACTERISTICS

Speaker Ohms	Potentiometer A, Ohms	Potentiometer B, Ohms	Loss, DB	Z, Ohms	Regulation, %
4	2	4	3	2	14.4
8	4	8	3	4	14.4
8	3	4	5.3	3	13.8
8	2	3	5.5	2.2	11.5
16	8	16	3	8	14.4
16	5	8	4.8	5.3	12.3
16	4	5	6.2	4	8.4
16	3	4	7	3.1	8.5
500	250	500	3	250	14.4
500	200	400	3.5	235	11.2
500	75	100	7.8	80	10.0

power to each speaker, the amplifier must have a capacity of at least (18 + 12) /.9; or 33 watts.

The total load impedance, calculated with values of Z obtained from the table, is 4.8 ohms. The 4-ohm output tap on the amplifier can be employed with very little loss. In some cases, it may be necessary to use more than one output tap to achieve the correct power distribution.

Potentiometers should be wire-wound, of a wattage rating sufficient to dissipate safely the total power fed to the speaker lines in which they are employed. Units are available in all values shown in the table.

Speaker line impedance and wire size will be discussed in Part 2 of this series, which will appear in a forthcoming issue.

FM-AM TUNER

(Continued from page 17)

cause undue complication and add to the expense. However, it is intended to provide another model at some later date which will include all controls necessary for operation with a straight power amplifier.

NEW AIR COUPLER

(Continued from page 34)

ularly important except when a speaker of low efficiency is employed.

Even a perfect response curve is meaningless unless it is substantiated by listening tests. We were fortunate in having the most critical and experienced audience in the Country available at the 1951 Audio Fair, where the Triplex Air-Coupler was first exhibited. This audience was composed of engineers, musicians, music critics, manufacturers, and audio-philes. Thousands came to hear the new Coupler and were astounded by its performance. Many returned again and again, to recheck their impressions of the bass reproduction, and the balance with the high-frequency end at both high and low volume. They employed superlatives so liberally in their comments that we feel certain the Triplex Air-Coupler will pass any listening-test creditably.

The Matter of Bass Boost:

We are inclined to view dimly the indiscriminate use of bass boost controls in efforts to extend the low-frequency response of speaker systems. Almost invariably, this practice results in response curves peaked in the neighborhood of 50 to 60 cycles, and produces muddy or boomy reproduction.

However, fixed compensating circuits, designed specifically to complement individual speaker systems, can be of real value in obtaining desirable response characteristics. A simple RC circuit has been developed for use on any amplifier employed with an Air-Coupler, to provide an overall amplifier-speaker system response essentially flat to 16 cycles. This will be the subject of Part 3 of the Air-Coupler series, which will appear in a forthcoming issue.

NTSC COLOR SPECS

(Continued from page 12)

standards now authorized for black-and-white television service. The second group consists of supplementary specifications relating to the transmission of color values.

The full text of the specifications follows:

(Continued on page 36)

NTSC COLOR SPECS

(Continued from page 35)

Test Specifications, Group 1:

1. The image is scanned at uniform velocities from left to right and from top to bottom at 525 lines per frame, 60 fields per second, interlaced 2-to-1.

2. The aspect ratio of the image is 4 units horizontally and 3 units vertically.

3. The black level is fixed at 75%, ± 2.5%, of the peak amplitude of the carrier envelope. The maximum white (brightness) level is not more than 15 per cent of the peak carrier amplitude.

4. The horizontal and vertical synchronizing pulses are those specified in Appendix I of the FCC Standards of Good Engineering Practice Concerning Television Broadcasting Stations (for black-and-white transmissions, dated Dec. 19, 1945, as amended Oct. 19, 1950), modified to provide the color synchronizing signal described in Specification 21 of Group 2.

5. An increase in initial light intensity corresponds to a decrease in the amplitude of the carrier envelope.

6. The television channel occupies a total width of 6 mc. Vestigial-sideband amplitude-modulation transmission is used for the picture signal, in accordance with Appendix II of the FCC Standards of Good Engineering Practice.

7. The sound transmission is by frequency modulation, with maximum deviation of ± 25 kc., and with pre-emphasis in accordance with a 75-microsecond time constant.

8. The radiated signals are horizontally polarized.

9. The power of the aural transmitter is not less than 50 per cent nor more than 150 per cent of the peak power of the visual transmitter.

Test Specifications, Group 2:

10. The color signal has the following composition:

$$Em = Ey' + 1/1.14[1/1.78 (Eb' - Ey') \sin \omega t + (Er' - Ey') \sin (\omega t \pm 90°)], \text{where}$$
$$Ey' = 0.59Eg' + 0.30Er' + 0.11Eb'$$

Em is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

Ey′ is the gamma-corrected voltage of the mono-chrome portion of the color signal, corresponding to the given picture element. This signal carries all of the luminance information.

Eg′, Er′ and Eb′ are the gamma-corrected voltages corresponding to the green, red, and blue signals intended for the color picture tube, occurring during the scanning of the given picture element.

(Continued on page 37)

NTSC COLOR SPECS

(Continued from page 36)

w is 2π times the frequency of the color carrier. The phase reference of this frequency is such that the color synchronizing signal, Specification 21, corresponds to an amplitude-modulated signal of the form cos wt.

t is the time.

The plus-or-minus sign near the end of the expression indicates that the phase of this component is alternately advanced and retarded by 90°, on successive scanning fields, with respect to the stationary color phase alternation axis. See Specification 20.

The portion of the expression between brackets represents the color sub-carrier signal which carries the chromatic information.

It is recommended that field-test receivers incorporate a reserve of 10 db gain in the chromatic channel over the gain required by the expression above.

11. The primary colors referred to by Er′, Eg′, and Eb′ have the following chromaticities in the I.C.I. system of specification:

	x	y
Red (r)	0.67	0.33
Green (g)	0.21	0.71
Blue (b)	0.14	0.08

12. The color signal is so proportioned that when the color subcarrier vanishes, the chromaticity reproduced corresponds to illuminant C (x = 0.310, y = 0.316).

13. Gamma correction is such that the desired pictorial result is obtained on a display device having a transfer gradient or gamma exponent of 2.75. However, the equipment used is capable of an overall transfer gradient of unity. The voltages Er′, Er′, Eg′, and Eb′ in the expression in Specification 10 refer to the gamma-corrected signals.

14. The color subcarrier frequency is 3.898125 mc. ±0.001%, with a maximum rate of change not to exceed 1/3 cycle per second per second.

15. The horizontal scanning frequency is 2/495 times the color subcarrier frequency. This corresponds to 15,750 cycles.

16. The bandwidth assigned to the monochrome signal Ey′ is in accordance with the FCC standard for black-and-white transmissions, as noted in Specification 6.

17. The bandwidth assigned to the chromatic signals Eb′–Ey′ and Er′–Ey′, prior to modulation, is not less than 1 mc. at 6 db attenuation. A gradual cutoff characteristic is used.

18. The bandwidth assigned to the modulated color subcarrier extends to at least 1 mc. at 6 db attenuation below the

(Concluded on page 40)

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for January to December, 1951

INDEX OF ADVERTISERS

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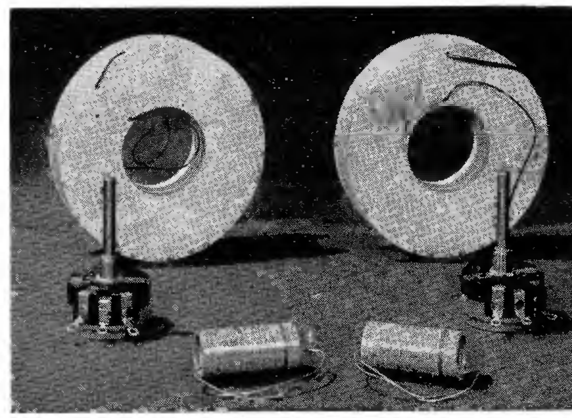

G. A. Crossover Networks for

Multiple Speaker Systems

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

RAPID ATTENUATION NETWORKS

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

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

SLOW ATTENUATION NETWORKS

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

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

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

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

As most everyone has found out by now, G.A. is headquarters for crossover networks. As far as we know, we're the only organization stocking networks **specifically designed** for use with Air-Couplers.

The standard 350-cycle network is our No. 4 or 8. The slow attenuation network described in the May, 1951 issue of **Radio Communication** is our No. 17 or 19. To get a rapid attenuation network operating at 175 cycles, recommended for the corner or Triplex Air-Coupler, order our Nos. 5, 9, or 13.

Air-Couplers . . .

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

And . . . **big news** . . . they are available either in knock-down form, ready for you to screw and glue together, or . . . **completely assembled!** Nothing for you to do but attach a 12-in. speaker to the back panel. Take your pick:

KNOCK-DOWN DUAL AIR-COUPLER ...... only **$34.50**

We've made a large production run on these, so we can keep the price down to the same low figure. Made out of solid ¾-in. fir plywood, all pieces carefully and accurately cut.

COMPLETELY ASSEMBLED DUAL AIR-COUPLER only **$47.50**

If you haven't the time, tools, or inclination to lay out the parts, drill the screw holes, and put the kit together, then here it is, completely finished in a truly professional manner and ready to put into immediate service.

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

General Apparatus Co.

South Egremont, Massachusetts

NTSC COLOR SPECS

(Continued from page 37)

color subcarrier frequency, and to at least 0.4 mc. at 6 db attenuation above the color subcarrier frequency.

19. To assure that all the components of the color signal shall coincide in time at the second detector of the receiver, delay compensation is used such that a sinewave, introduced at the transmitter color-signal input terminals, produces a radiated envelope having a relative time delay *vs.* frequency characteristic within plus 30% and minus zero% of that specified in Fig. 13 of RMA report TS 1.2-3005-A, except that the ordinate scale

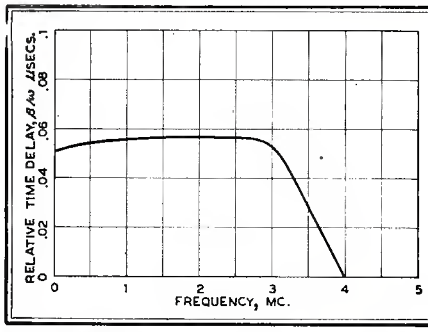

FIG. 1. DELAY COMPENSATION OF NTSC SIGNAL

may be multiplied by a factor of 1.0 to 1.5. This is reproduced here as Fig. 1.

20. The color phase alternation implied by the plus-or-minus sign in Specification 10 is such that the color subcarrier phasor representing Er′–Ey′ shall lead the phasor representing Eb′–Ey′ during the scanning field following the vertical sync pulse in diagram 1, Appendix I, FCC Standards of Good Engineering Practice Concerning Television Broadcasting Stations, Dec. 19, 1945, and shall lag following the vertical sync pulse shown in diagram 2 of the Appendix.

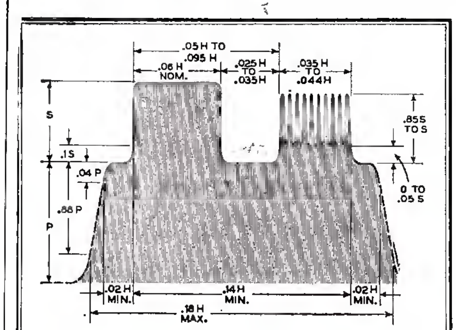

FIG. 2. ENVELOPE OF NTSC COLOR SYNC PULSE

The stationary axis of the color phase alternation corresponds to the Eb′–Ey′ phasor.

21. The color synchronizing signal is that shown in Fig. 2. This signal corresponds to amplitude modulation of a continuous sine wave of frequency $w/2\pi$

22. Signals outside the assigned channel shall be attenuated at least 60 db below the peak visual signal amplitude.

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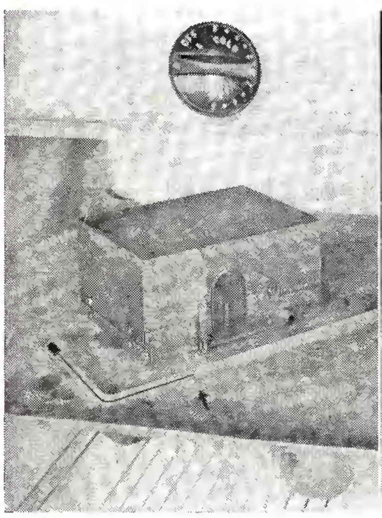
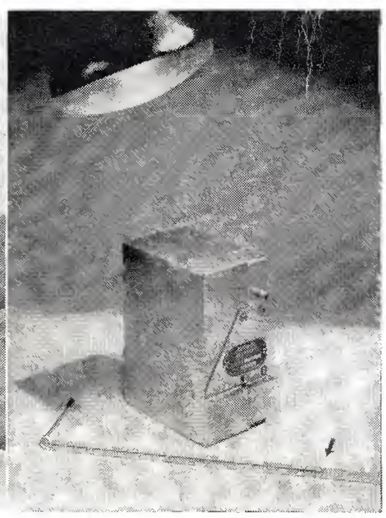
motorola 2-way radio

Weather Exposure

After eleven months of exposure, through one of the toughest winters on record, the two Permakay units (photographed on the roof of Motorola plant) showed no significant change in selectivity characteristic.



Thermometer reads —30° centigrade as the Permokay selectivity reading remains same as before this extreme cold test was started



In laboratory torture tests Permakoy goes through blistering +90° centigrade test without effect on selectivity readings.

Motorola first with Sealed-Unit Selectivity

In the exclusive *Sensicon* design of the Motorola *Permakay* wave filter, 15 nuisance tuning adustments are removed and permanent selectivity is guaranteed for the life of the set!

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

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

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

Over 22 Years of Leadership in Mobile Radio . . .

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

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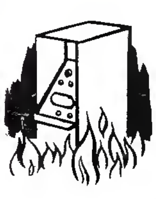
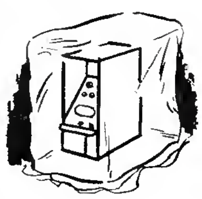
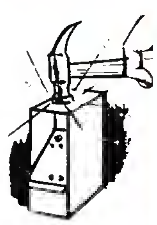


DUST AND HEAT-PROOF



WATER AND COLD-PROOF



TAMPER AND SHOCK-PROOF

motorola 2-way radio