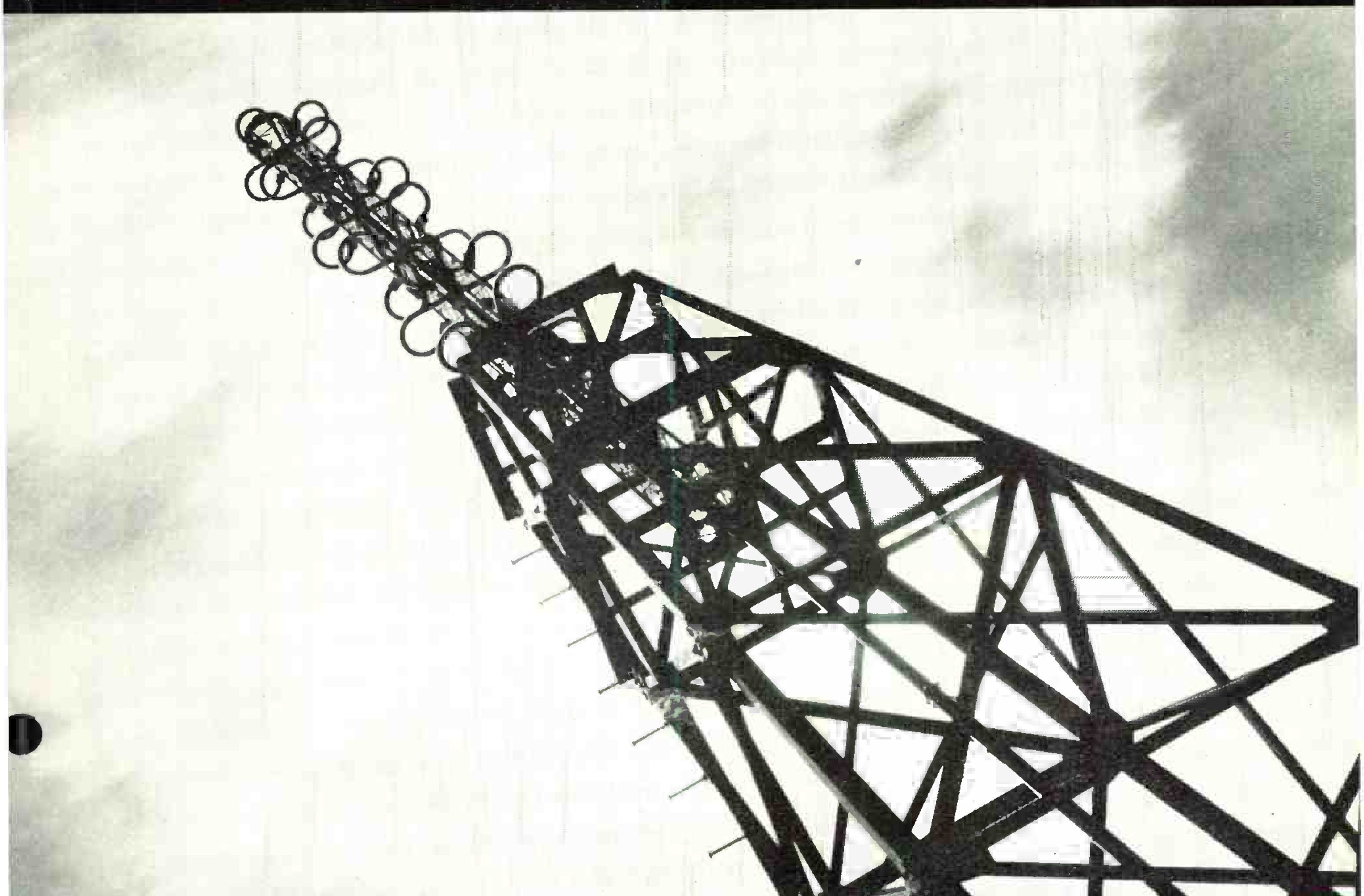
COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"



MAY

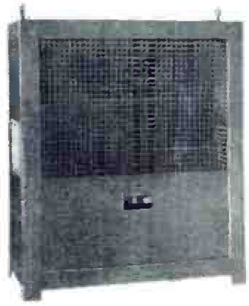
★ TV TRANSMITTER DESIGN
★ F-M TRANSMITTER FREQUENCY CHECKS
★ REMOTE BROADCASTING STUDIO CONSTRUCTION

1948

3-Phase Regulation

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
3P15,000	1500-15,000	0.5%
3P30,000	3000-30,000	0.5%
3P45,000	4500-45,000	0.5%

• Harmonic Distortion on above models 3%. Lower capacities also available.



Extra Heavy Loads

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
5,000+	500 - 5,000	0.5%
10,000+	1000-10 000	0.5%
15,000+	1500-15 000	0.5%

General Application

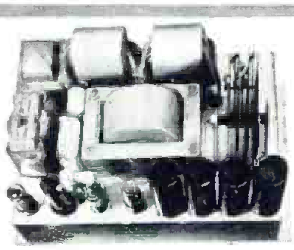
MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
150	25 - 150	0.5%
250	25 - 250	0.2%
500	50 - 500	0.5%
1000	100-1000	0.2%
2000	200-2000	0.2%

400-800 Cycle Line

INVERTER AND GENERATOR REGULATORS FOR AIRCRAFT.
Single Phase and Three Phase

MODEL	LOAD RANGE VOLT-AMPERES	*REGULATION ACCURACY
D500	50 - 500	0.5%
D1200	120-1200	0.5%
3PD250	25 - 250	0.5%
3PD750	75 - 750	0.5%

Other capacities also available



The NOBATRON Line

Output Voltage DC	Load Range Amps.
6 volts	15-40-100
12 "	15
28 "	10-30
48 "	15
125 "	5-10

• Regulation Accuracy 0.25% from 1/4 to full load.

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GENERAL SPECIFICATIONS:

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- Output adjustable bet. 110-120: 220-240 (—2 models)
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*S-LINE

of CRYSTAL Phonograph Pickup Cartridges . . .

Actual size of unit approximately 2".

The first two cartridges in this entirely new line are the S-1 and S-2. Both use an American Model S needle which was engineered in conjunction with the cartridge to produce the characteristics described below. Outstanding features of "S" type cartridges are:

1. **A novel needle guard which protects the needle when tone arm is handled or accidentally dropped.**
2. **Conventional needle set screw making replacement easy.**
3. **Needle chuck designed so that Model S needle can be replaced by any conventional straight or offset needle. (Use of needles other than Model S will modify operating characteristics of the cartridges.)**

MODEL S NEEDLE

Extremely low needle talk from Type S cartridges is due almost entirely to the performance of this newly developed needle. The precious metal stylus (osmium) does not chip and is mounted to a highly compliant vane, assuring maximum needle life and minimum record wear.

MODEL S-1 CARTRIDGE

The first cartridge of the new "S" series has an output of 1¼ volts at 1000 cps on Columbia 10003-M test record (0.5 megohm load resistor). Needle force for best tracking is one ounce.

The S-1 cartridge is an ideal replacement unit for modernization of installations where increased brilliance in tonal quality is desirable. Frequency response flat to 4000 cps discriminates against hiss and objectionable surface noise. This characteristic is especially noticeable when old or worn recordings are played. Cartridge low frequency response to less than 50 cps requires no external equalization.

MODEL S-2 CARTRIDGE

The S-2 is a one-volt cartridge which has a "rolled-off" high frequency response for pleasant listening to all types of recordings and transcriptions. Output tapers gradually from 1000 to 5000 cps. Recommended needle force is one ounce. All the other desirable features of the Model S-1 cartridge are incorporated in the S-2 design.

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Dept. 5A, 370 So. Fair Oaks Ave., Pasadena 2, Calif.

MAY, 1948 VOLUME 28 NUMBER 5

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.

LEWIS WINNER
Editor

F. WALEN
Assistant Editor

Bryan S. Davis, President
Paul S. Weil, Vice Pres.-Gen. Mgr.
F. Walen, Secretary
A. Goebel, Circulation Manager

Cleveland Representative:
James C. Munn
2253 Delaware Dr., Cleveland 6, Ohio
Telephone: Erieview 1726

Pacific Coast Representative:
Brand & Brand
1052 W. Sixth St., Los Angeles 14, Calif.
Telephone Michigan 1732

315 Montgomery St., San Francisco 4, Calif.
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COVER ILLUSTRATION

Six-bay clover-leaf antenna of 10-kw WQXR-FM, mounted atop the Chanin Building in midtown in New York, opposite Grand Central Terminal.

(Courtesy Western Electric)

Published monthly by Bryan Davis Publishing Co., Inc.
52 Vanderbilt Avenue, New York 17, N. Y. Telephone MUrray Hill 4-0170

Link FM—With Sylvania Lock-Ins—Covers New Jersey For Its State Police Radio System

Drivers of both emergency trucks and patrol cars can maintain two-way communication with fixed stations.

Automotive equipment of the New Jersey State Police includes vehicles always on the alert to deal with every emergency. Fleet is spearheaded by 180 patrol cars of the department in addition to 42 patrol cars of the State Motor Vehicle Department which is served by the State Police. These vehicles are constantly in touch with fixed FM stations located at 26 strategic points throughout the state. In addition, emergency trucks carry complete radio equipment equivalent to that of a fixed station!

Link Radio Corporation, manufacturer of the communications equipment, makes extensive use of Sylvania Lock-In tubes to assure unfailing efficiency of this statewide network. Lock-In tubes stay put through vibration and jarring. They have few welded joints . . . no soldered ones. Elements cannot warp or weave . . . connections are short and direct. Top location of getter reduces losses . . . separation of getter material from leads cuts down leakage.

Radio equipment in emergency trucks duplicates the set-up used in fixed transmitting stations.

See Sylvania Distributors—or write Radio Tube Division, Emporium, Pa.

SYLVANIA ELECTRIC

The superior mechanical and electrical features of Sylvania Electric's famous Lock-In tube make it the ideal choice for equipment on the road, in the air, on the rails, marine radar, FM and television.

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

Announcing A NEW LINE OF SPRAGUE ELECTROLYTIC CAPACITORS

Designed for Television Use
(for operation up to 450 volts at 85° C.)

With some 7 times as many components in a television receiver as in the average radio, the possibility of service calls is greatly increased. The new SPRAGUE ELECTROLYTIC line offers the first practical solution to this problem.

Designed for dependable operation up to 450 volts at 85° C. these new units are ideally suited for television's severest electrolytic assignments. Every care has been taken to make these new capacitors the finest electrolytics available today. Stable operation is assured even after extended shelf life, because of a new processing technique developed by Sprague research and development engineers, and involving new and substantially increased manufacturing facilities. More than ever before your judgment is confirmed when you *SPECIFY SPRAGUE ELECTROLYTICS FOR TELEVISION AND ALL OTHER EXACTING ELECTROLYTIC APPLICATIONS!* Sprague Electric Company invites your inquiry concerning these new units.

WORTHY COMPANIONS FOR THE NEW ELECTROLYTICS! SPRAGUE MOLDED TUBULARS . . .

Highly heat- and moisture-resistant
Non-inflammable • Moderately priced
Conservatively rated for −40°C to +85°C operation
Small in size • Completely insulated
Mechanically rugged

Write for Engineering Bulletin No. 210A

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASS.

SPRAGUE

Capacitors
* Koolohm Resistors

P I O N E E R S O F ELECTRIC AND ELECTRONIC PROGRESS

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20,000 Ohms per Volt D.C.
1,000 Ohms per Volt A.C.

Volts, A.C. and D.C.: 2.5, 10, 50, 250, 1000, 5000.

Milliamperes, D.C.: 10, 100, 500.

Microamperes, D.C.: 100.

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Decibels (5 ranges): —10 to 52 D.B.

Ohms: 0-2000 (12 ohms center).
0-200,000 (1200 ohms center).
0-20 megohms (120,000 ohms center).

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*Both complete with test leads and 32-page Operator's Manual**

ASK YOUR JOBBER

WORTH MORE...
...COSTS NO MORE!

For what it buys in sensitivity, precision, and useful ranges, the price of Model 260 has always purchased value far beyond that of even remotely similar test instruments. Today this famous volt-ohm-milliammeter is a finer instrument than ever, with added ranges and with a new sub-assembly construction unmatched anywhere in strength and functional design. The price is the same. That means, of course, that your investment today buys even more in utility and the *staying* accuracy that distinguish this most popular high-sensitivity set tester in the world.

*No other maker of test instruments provides anything to approach the completeness of the pocket-size 32-page Operator's Manual that accompanies Simpson Model 260. Illustrated with 12 circuit and schematic diagrams. Printed on tough map paper to withstand constant usage.

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• *Why is it vital—to you, your company, and your country—that you personally get behind the Payroll Savings Plan this month?* You and your business have an important stake in wise management of the public debt. Bankers, economists, and industrialists agree that business and the public will derive maximum security from distribution of the debt as widely as possible.

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For any help you want, call on your Treasury Department's State Director. Savings Bonds Division.

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COMMUNICATIONS

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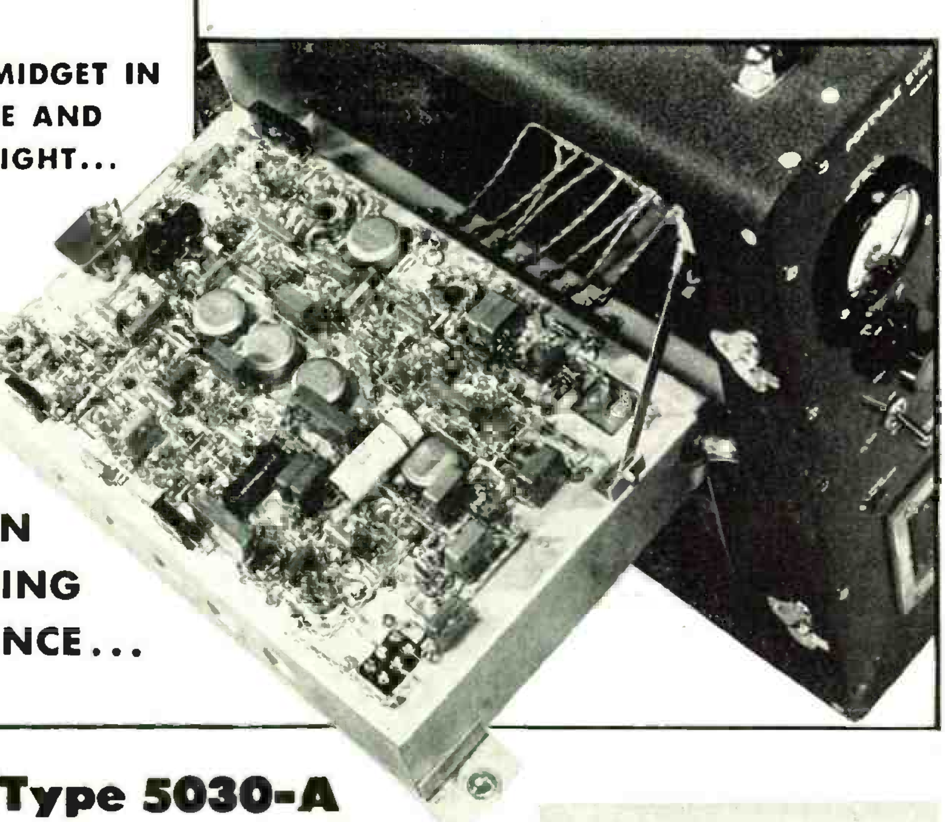
A MIDGET IN SIZE AND WEIGHT...



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DU MONT Type 5030-A

Portable Synchronizing Generator

Here's the smallest commercially available R.M.A. type television synchronizing generator. Notwithstanding its small size, it embodies the most advanced engineering design currently featured in equipment of this type.

No compromise in performance has been made in order to obtain portability. Also, its inherent stability, performance standards and ease of operation make it ideally adapted for field use.

In addition, it can serve as the source of synchronizing signals for all types of television work, such as testing transmitters, experimental television development, and laboratory work of an allied nature.

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Technical details on request. Let us collaborate on your television problems and requirements.

FEATURES . . .

Completely self-contained. Requires only a-c power. Provides mixed driving, blanking and synchronizing signals.

Master oscillator can be locked to the 60 cycle line or run completely free.

Complies with all important R.M.A. recommendations for television synchronizing generators.

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Stability of countdown and pulse width of composite signal are essentially independent of tube changes.

Rise time of pulses equal to or better than that of all other commercially available equipment of this type.

Regulated power supplies and autotransformer primary inputs make the unit independent of line voltage variations.

Construction techniques and availability of components without equal for portable synchronizing generators.

Dimensions: 9¼" w., 17⅛" h., 19½" l. Weight: approx. 50 lbs.

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COMMUNICATIONS

LEWIS WINNER, Editor

MAY, 1948

At the NAB Technical Sessions in Los Angeles

VALUABLE DATA on tv lighting systems and lightweight broadcast-field equipment were disclosed at the recent broadcast-engineering NAB sessions in Los Angeles.

Describing the remote control method of lighting in tv studios, Captain W. C. Eddy, director of WBKB, said that the telelite system now in general use is an excellent lighting tool. This method is built around a standard spindle unit operated remotely by means of manual control lines. Ceiling mounted on the studio gridiron with a quick release clamp, the units can be positioned and operated at any point in the studio providing the desired flexibility required in tv work. Each spindle carries the selected type of light required for the job . . . bank lights for flooding and key lighting, spots for contrast and fluorescent for general illumination. Manual control facilities permit each unit to be rotated through 360° of azimuth and elevated through a complete arc of approximately 170°.

In a discussion of tv lighting sources, Richard Blount of the G.E. Lamp Department, revealed that both tungsten filament and fluorescent sources have important advantages for studio lighting, each complementing the other. Fluorescent lamps can supply the basic level of cool, color-corrected general illumination with either the 3500 or 4500 white fluorescent lamps being satisfactory for the 5655 image orthicon. The tungsten-filament sources provide the control of beam pattern useful in modeling lighting. The tungsten-filament sources produce about 12% visible light, 70% short-wave infrared and 18% long-wave infrared. The fluorescent sources produce 20% visible light and twice as much long-wave as short-wave infrared.

Blount pointed out that the fluorescent lamps may produce noise which varies in amplitude over a wide range of frequencies. Generally, the peak appears at about 400 kc and decreases slightly over the 350 to 1200-kc range, appearing at random frequencies up to and above 5 mc. Some a-c line filters have been designed to eliminate this interference, but none are yet commercially available. There is also interference directly from a lamp bulb but this is ineffective when 10 feet from the lamp.

The ultimate in compactness appeared in a miniature field amplifier with a 60 to 8500-cps response, described by J. L. Hathaway of NBC. Contained in an ordinary brief case, together with microphones and monitoring equipment, the amplifier, complete with batteries, weighs only 12½ pounds. Provision is made for three low level, low-impedance microphones, each of which is amplified in a pre-amp stage prior to mixing. High level mixing is used to obtain optimum signal-to-noise ratio and at the same time permit the use of simple potentiometer type faders.

Among the other unusual features of the amplifier are a built-in line-equalizing oscillator and an automatic audio-gain control. The oscillator is of the phase-shift type and feeds tone into one of the faders during equalizing. The aagc is highly active in restricting peaks which would, if not controlled, cause the vu meter to go off scale and also introduce distortion in the output stage. The aagc system exerts little control on subnormal peaks, but through its use the entire level may be safely increased several db by way of the safety valve action at high levels.

The three faders constitute the only on-the-air controls. There are two low-impedance output monitoring jacks and the telephone line is connected to the amplifier output pad by way of a conventional 3-way plug. A level of +8 vu is fed into a 600-ohm line, the amplifier being capable of delivering +18 dbm to such a line with low distortion.

TV Loses Channel One

Tv after June 14th will no longer have the 44 to 50-mc *channel one*. FCC has ruled that this channel will be set aside for fixed and mobile services. F-m stations operating on this band will be allowed to use the channel until the end of the year.

As a result of this decision, there will be a hearing on the revisions that will have to be made to accommodate the thirteen channels below 216 mc. This hearing will begin on June 14 in Washington.

Another important tv allocation hearing will be conducted on September 20 when the 475 to 890-mc bands will be reviewed with a view to authorizing these channels for black and white or, perhaps, color, too.

USAF Communications Expansion

A SUBSTANTIAL EXPANSION in air force communications facilities was forecast by Major General F. L. Ankenbrandt, Chief of Air Force Communications, at the recent Armed Forces Communication Association meeting in Dayton. He pointed out that about $55,000,000 will be spent this year for heavy duty radar, GCA and airport surveillance equipment.

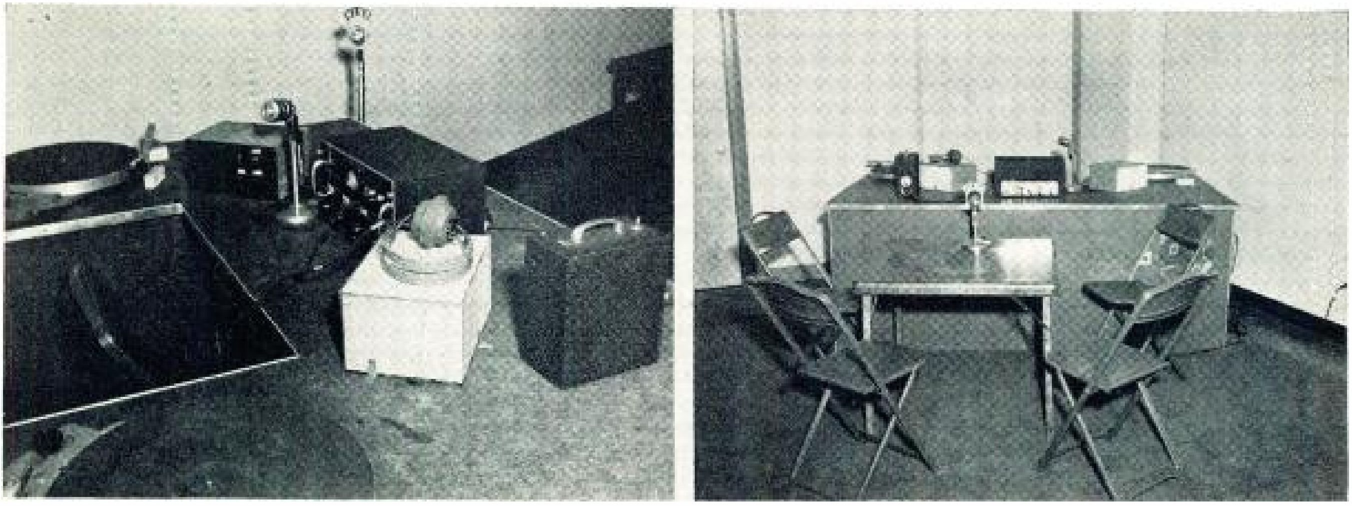
It was also learned that this appropriation will be increased substantially during the next few years as a part of a five-year peace-time mobilization program recently initiated.

Pike Receives Award

OTIS WILLIAM PIKE of G.E., was awarded a silver plaque by RMA, JETEC and NEMA at the recent IRE-RMA Transmitter Meeting in Syracuse, for his services as chairman of the Joint Electronics Tube Engineering Council from 1944 to 1947.

The industry is truly grateful to you OWP for a job well done. Congratulations.—L. W.

Design and Construction of a



Equipment employed in the secondary broadcasting studio.

In the construction of a broadcasting studio, the selection of a suitable location and proper facilities is usually of prime importance. However, when constructing a secondary studio in a small city, particularly today, there's not always too much of a choice in locations. In addition there's the problem of installation cost which must not reach too great proportions, because such a studio, being only a supplement to the main studios, is operated for only a small portion of the station's daily operating schedule, and the income is not too substantial.

Currently WIMS is a *daytime* station with our main studios located in Michigan City, Indiana. We were desirous of having a supplementary studio in LaPorte, Indiana, about 13 miles from Michigan City, the studios to be in operation for about 1½ hours per day.

One of the few places available, in the business section of town where we were anxious to have the studio, was a basement floor with a 16'x20' room. Remodeling the room, three of the inner walls were made up with celotex, while the fourth was smooth plaster. The floor was covered with a rug. The combination produced a studio with surprisingly good acoustics, not too live, and not too dead.

Since space was a limiting factor, it was decided to place a console desk in the studio itself, and not make a separate control room. This arrangement would enable one man to announce and operate nearly any type of program, live, recorded, or combination live and recorded. A small office and record library was set up next to the studio, entrance to the studio and office being made from a hallway which runs the length of the building. Other equipment placed in the studio included a piano, small table for roundtable discussions of sports, debates, etc., and twenty chairs to accommodate small audiences, or people participating in programs.

Console Desk

For mounting of the turntables, a remote type amplifier, monitor amplifier, switch boxes, etc., a desk was designed and constructed. The exterior

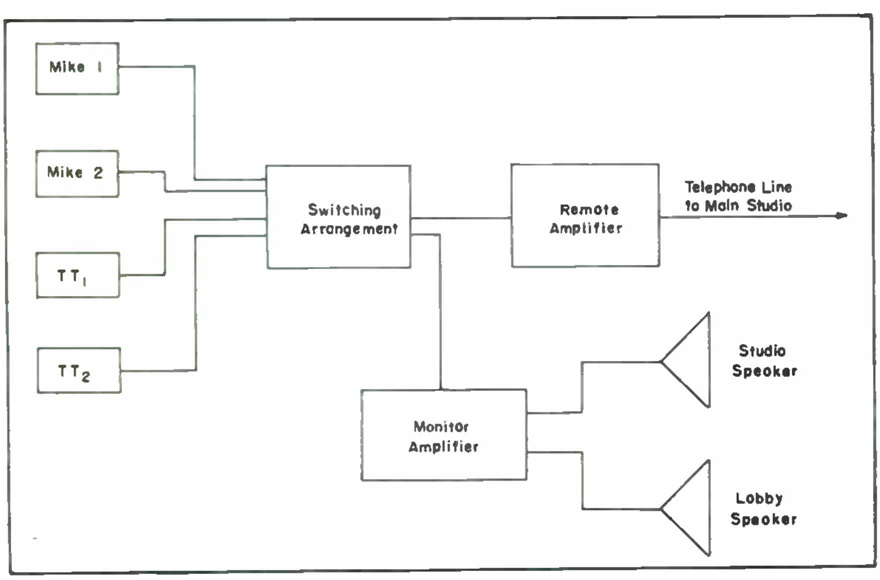
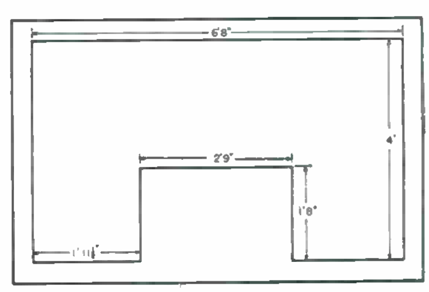


Figure 1
Block diagram of the equipment setup for the secondary studio.

Figure 2
Design and dimensions of the console desk.



Secondary Broadcast Studio

by ROBERT J. SCHILLING, ARTHUR STARK and WARREN SHERWOOD

Chief Engineer — Engineers
WIMS, Michigan City, Indiana

Compact Second Studio, 16 x 20 Feet, Uses Station-Built Console With a Remote -Type Amplifier Which Can Be Removed and Used As a Spare Remote Unit. Other Studio Features Include Monitor Amplifier, Dual Turntable Setup and Two Dynamic Microphones.

of the desk was made of fiber board, with stainless steel molding around the edges. The framework of the desk was made quite heavy to provide sturdy support for the equipment.

The remote amplifier was mounted in the center of the desk, with the turntables on either side of the operator's position. Between the remote amplifier and each turntable was placed a small wooden box, housing the terminal strips and switching facilities. A monitor amplifier was mounted in the lower right hand corner, below the right turntable. This was an effective *out of the way* arrangement for the operator, simplifying monitor controls adjustments. The studio monitor speaker, a 12" p-m.[1] was mounted on the front side of the console desk.

Console

In place of a conventional console, it was decided to employ a remote type amplifier, together with a separate amplifier to serve as a monitor amplifier, and a suitable switching arrangement, to give near-console performance and versatility. The remote amplifier,[2] serving as the *console*, has been set up so that it can be removed from the console desk and studio in a few minutes, and taken out and employed in its regular capacity, as a remote amplifier. The *console* amplifier, which is essentially flat from 30 to 12,000 cycles, has three input channels, with a choice of 30- or 250-ohm input impedances. In the design of our studio we planned for two microphones and two turntables. Accordingly a dpdt switch was incorporated (S_5) to provide a choice of turntable *2* or mike *2*, on one of the remote amplifier inputs.

This proved entirely satisfactory, since in the usual type of recorded program two turntables and only one microphone are required, and the switch (S_5) can be left in the TT_2 position. In the case of a live program, where two microphones are required, chances are that both turntables will not be required. In the event that a program does require both microphones and both turntables, it is simple to switch over from M_2 to TT_2. In the case of a large studio audience participation program, a third microphone might be required. To accommodate this, turntable *1* can be removed from the remote amplifier by merely removing the proper plug from the amplifier and substituting for it a third microphone.

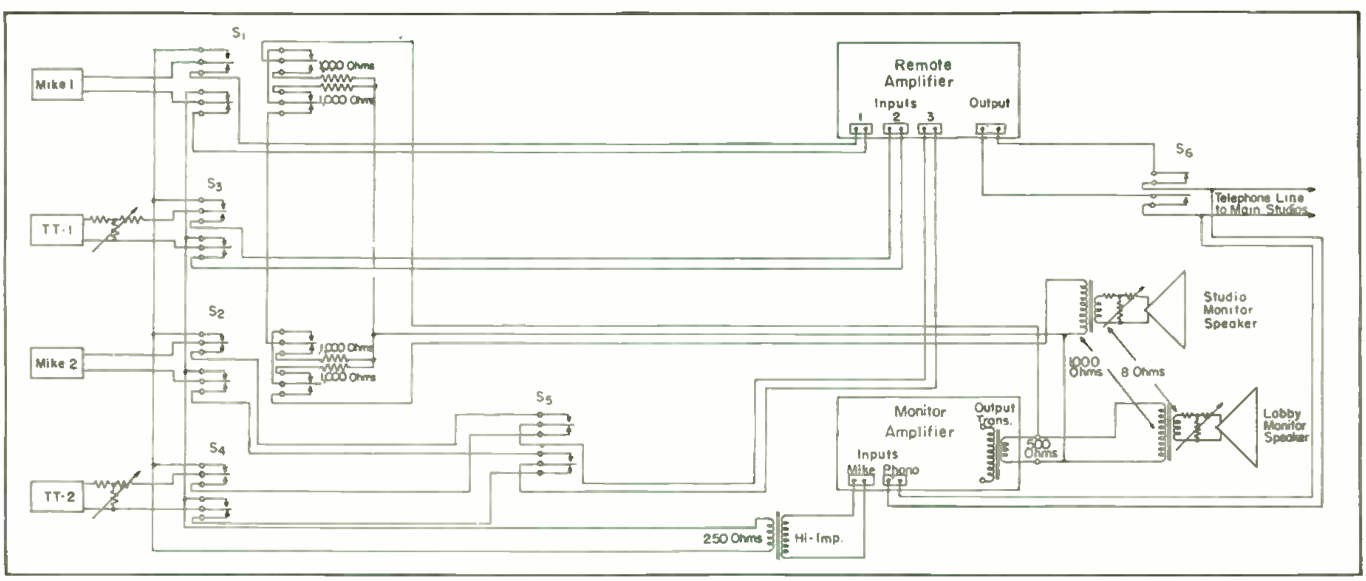
Normal Use of Equipment

Under normal use mike *1* is a desk mike on the console desk, mike *2* is on a tripod base stand in the center of the studio, turntable *1* is to the right of

(*Continued on page* 38)

[1]Jensen.
[2]Gates Dynamote

Figure 3
Switching setup for the remote-amplifier system.



TV Transmitter Design

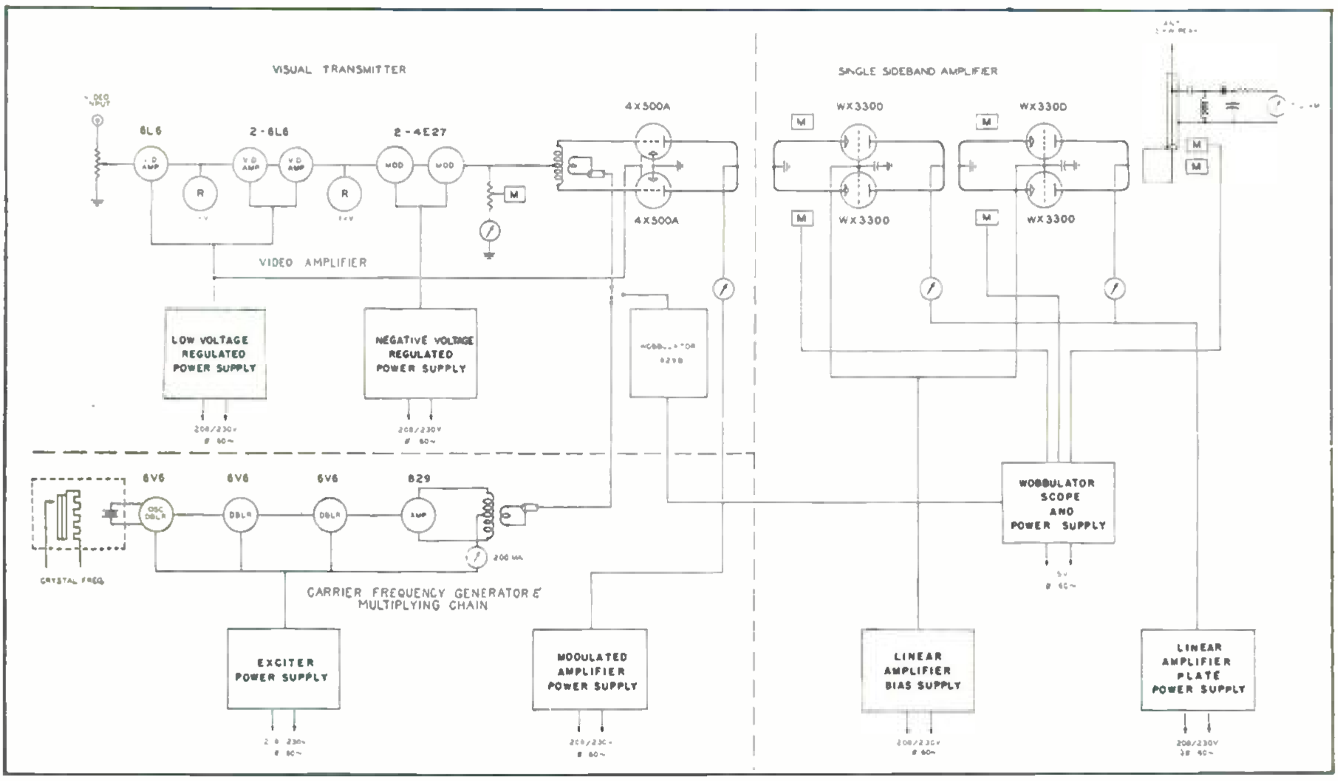


Figure 1
Block diagram of the master series tv transmitter. Dotted lines indicate three unit separation.

THERE ARE three prime aspects of tv transmitting equipment, which, when functioning properly, fit together into a smoothly integrated unit, namely: (*1*) generation of the carrier frequency, (*2*) modulation, and (*3*) amplification subsequent to modulation. That there are many ways of accomplishing this integration is evidenced by the difference in various design patterns.

The three important considerations concerning design are video power required for modulation, the number of linear r-f amplifiers, and the use of a vestigial sideband amplifier. Obviously, wide-band video amplifiers capable of supplying voltage and power required for *high level* modulation are costly and inefficient since tubes capable of delivering sufficient power have relatively high interelectrode capacitances. This condition results in the necessity for special h-f compensation and low value load impedances (for high-power installations water-cooled load resistors are required for the video modulator plate load). Where a large number of wide band linear r-f amplifiers are employed, great care must be exercised to maintain perfect neutralization, and to keep the band-pass characteristic adequate for satisfactory picture resolution. In addition, class *B* linear amplifiers are inherently low in their efficiency characteristic.

Since single sideband transmission has been standardized, means must be provided for suppression of the unwanted portion. *Progressive circuit attenuation* or vestigial sideband filtering[1] is currently employed for this suppression. In this method the r-f band-pass characteristic of all amplifiers following the modulated stage are adjusted so the upper sideband only is passed.

From the foregoing summary it is obvious that both the high and low level modulation systems have specific merits and disadvantages. The recently-developed *master** series tv transmitter is midway between the two limits; high power video amplifiers are not required and a minimum number of class *B* linear r-f amplifiers are required. Figure 1 shows a block diagram of this series where the dotted lines indicate the three unit separation and the manner in which the circuit functions are related.

Generation of the carrier frequency is accomplished by means of a crystal oscillator and a frequency multiplying chain with a total multiplication factor of eight. A double-ended amplifier stage is used as a straight-through amplifier on the carrier frequency to drive the modulated amplifier.

The modulator unit employs a three-stage wide-band video amplifier, the last stage of which operates as a direct-coupled amplifier with the cathode at a negative potential in order that bias and d-c reinsertion may be applied to the modulated amplifier. Video signal (from the modulator) and r-f drive (from the exciter) are applied to the grids of the modulated amplifier which when properly adjusted, results in a modulated r-f envelope in the plate circuit of the modulated amplifier. The resultant energy may be used to drive an antenna system directly if low power is desired, or to drive subsequent class *B* amplifier stages.

Amplifiers following the modulated stage must operate as class *B* linears

[1]The vestigial sideband filter is a tuned filter adjusted to dissipate the unwanted sideband in a water cooled load and is installed after the last amplifier.

*DuMont

since deviation from a linear characteristic will provide amplitude distortion, resulting in either sync compression or white saturation. The Figure 1 block diagram shows two class *B* amplifier stages employing identical tube types both of which operate in grounded-grid circuits resulting in tuning simplification and minimum neutralizing problems. The output impedance may be connected for either 72/51 ohm unbalanced or 144/102 ohm balanced pair transmission line.

Generation of Carrier Frequency

Exciter Unit: The circuit arrangement for carrier frequency generation is shown in Figure 2. The principal problem of generating the carrier is maintaining the required frequency stability, namely, ±.002% of the assigned value as specified by FCC. The crystal frequency is one-eighth the frequency of the carrier. A temperature-controlled low-frequency crystal is employed to assure high order of thermal and operational stability (as may be attained with crystals ground for use below 15 mc).

The oscillator is a 6V6 connected in a conventional *tri-tet* circuit. The plate circuit is resonant at twice the fundamental frequency. Two 6V6 doublers follow, resulting in the carrier frequency being applied to an 829B operating as a buffer amplifier.

Trends in Design. Features of Systems, With Special Consideration of Video Amplifier and Modulator Requirements, Modulated Amplifier and Class B Linear Amplifier Stages. D-C Restorer Operation Also Analyzed.

by G. EDWARD HAMILTON

Head, Television R-F Development Section
Television Transmitter Department
Allen B. Du Mont Laboratories, Inc.

The 829B plate circuit is coupled to modulated amplifier grids, a pair of 4X500A tetrodes. All stages in the exciter operate as conventional class *C* amplifiers and doublers and use lumped circuit constants. Provision for metering each stage is accomplished by a switching arrangement for grid-current indication. The cathode current is metered in the 829B. Tuning circuits are proportioned so that the correct harmonic falls within the variable capacitor range. Resonance of each tuned circuit is shown by maximum grid current in its driven stage.

The 4X500A modulated amplifier grid is loaded with a non-inductive resistor which serves two purposes: (*1*) It loads the 829B driver stage resulting in a relatively constant r-f driving voltage, and (*2*) loading the grid circuit broadens the response curve so that any sum and difference frequencies developed in the grid circuit (by virtue of modulation) will not be attenuated. As in previous stages, the grid tuning control is adjusted for maximum grid current in the 4X500As.

Modulation

Video Modulator Unit: Circuit of the modulated amplifier and its video-

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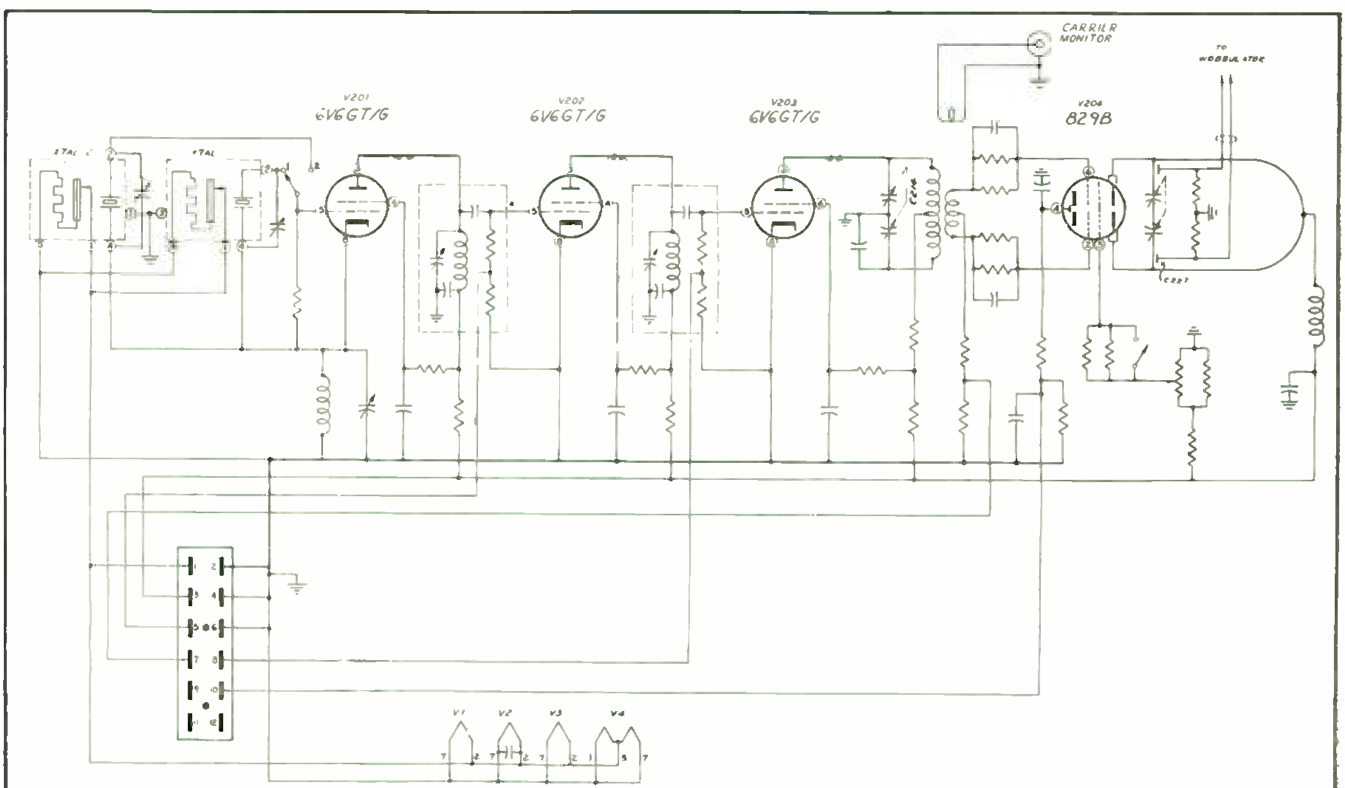
*Power supplies in this series provide effective voltage and current regulation between totally black and totally white modulation.

Forced air cooling is employed throughout the transmitter, including tube seal points, to minimize the problem of maintenance.

Figure 2
Circuit arrangement for carrier frequency generation.



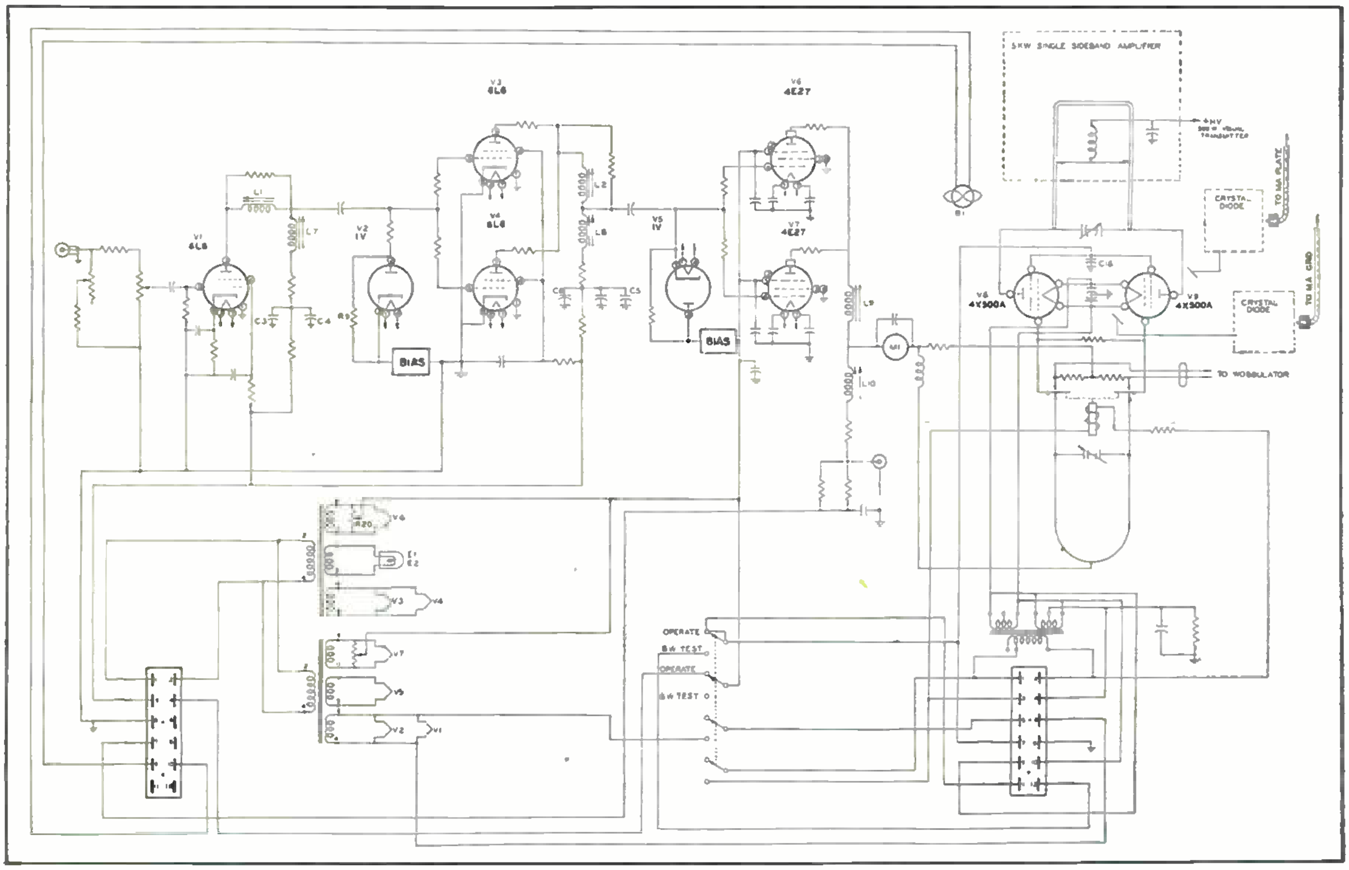


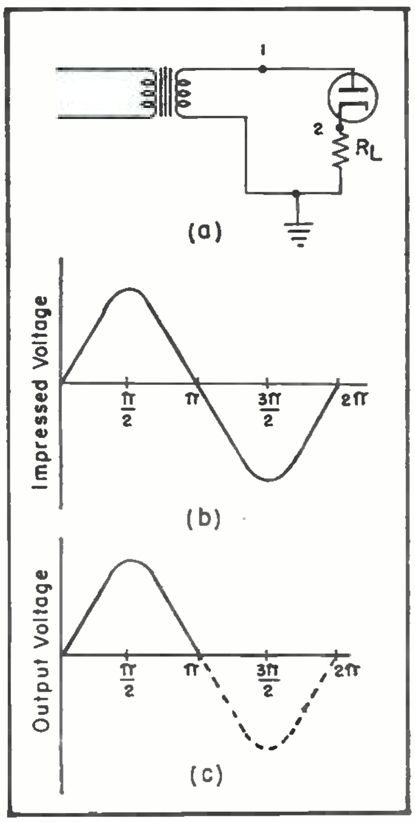
Figure 3
Modulated amplifier and its video-amplifier-modulator.

amplifier-modulator appears in Figure 3. It will be noted that provision is made for substituting an r-f frequency swept, or wobbulation signal for the r-f exciter output.[5]

The video amplifier uses three stages to provide the proper phase-modulating signal and sufficient voltage amplitude to assure full modulation capability. A minimum of one volt input will drive the modulated amplifier to cutoff. A single 6L6, series-shunt peaked, drives a pair of 6L6s in parallel, also series-shunt peaked.

It will be noted that the parallel 6L6 stage incorporates a type 1V d-c restorer. This technique serves to refer the video signal to the bias level of this stage, making it possible to realize the full range of available grid base without distortion for high signal levels. A pair of 4E27s function as the video modulators. The plate load of the modulator serves two purposes: (*1*) Furnishes video signal to the modulated amplifier, and (*2*) produces a negative d-c voltage as bias for the modulated amplifier. Since the grids of the modulated amplifier (4X500) must be negative with respect to their filament (which are at ground potential), it is necessary that the plates of the 4E27s be negative with respect to ground. This is accomplished by connecting the plate load return and the positive plate voltage of the 4E27 to ground, making it necessary to refer the 4E27 cathodes to a negative potential with respect to ground. A variable negative voltage regulated power supply furnishes this potential. The modulated amplifier bias is adjusted by means of the variable plate potential which changes the quiescent plate current, thereby altering the voltage drop across the plate load. The 1V is used at the grid of the modulator to restore the video *sync* signal to the bias reference level. Since the modulator operates as a direct-coupled amplifier, the *restored* signal is carried through to the plate load and serves to maintain sync tips at the quiescent bias level of the modulated amplifier, for changing signal amplitudes. The overall frequency response of the video modulator-amplifier is essentially flat between 10 cycles and 5.5 mc.

Figure 4
A simple half-wave diode circuit with resultant scope pattern. In *b* appears a reference pattern for alternating voltage and in *c*, a reference pattern for the rectified portion of applied voltage.



Operation of the D-C Restorer

The operation of the d-c restorer is of utmost importance in the tv transmission system since it vitally effects the following parameters:

(*1*) Holds peak power constant.

(*2*) Controls average brightness of transmitted picture.

(*3*) Fixes blanking level at receiv-

[5]Complete data on this unit will appear in a subsequent discussion.

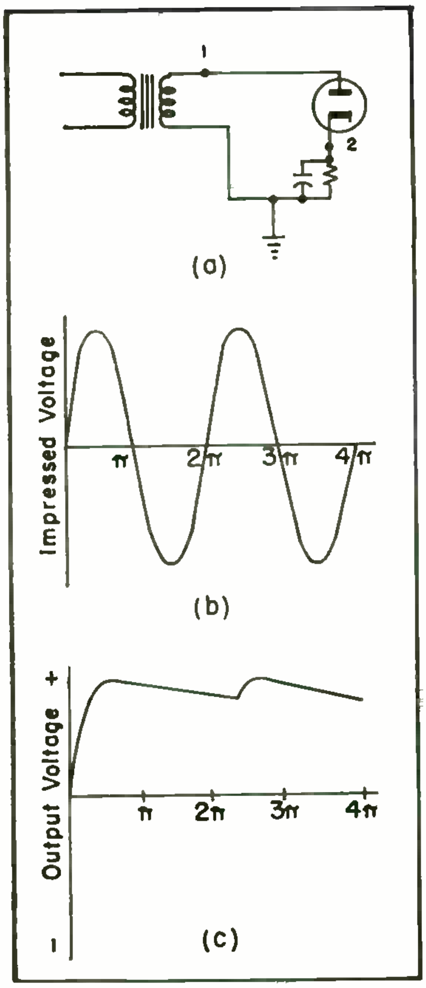


Figure 5
Effect of introducing capacitors across the load resistor.

ers, provided the input sync level is constant.

In tracing d-c restorer operation, the well-known diode phenomenon serves well as a basis of evaluation and comparison. Figure 4 shows a simple half-wave rectifier circuit with the various scope patterns referred to a ground potential. Reversing the diode polarity will result in the negative portion of the cycle shown in (*c*), being produced. It will also be noted that the output load circuit (R_L) contains no capacitance. Figure 5 shows the effect of introducing capacitance across this load resistor; however, since the resulting wave shape decays (*c*), it may be assumed that the *rc* product is too low. The circuit shown in Figure 5 may be altered by changing the position of the load resistor and capacitor to that in Figure 6. The same wave shapes are shown in Figure 6 as in Figure 5 except that the d-c voltage produced is of opposite polarity. Analysis of current flow through the circuit shows this condition to be normal. Figure 6 (*b*) and (*c*) shows the voltage across each element, namely: an a-c input voltage and a d-c rectified component. Since these two voltages are in series, when measured across the diode, the effect is to superimpose the a-c component on the d-c component resulting in a shift of the zero a-c axis to a new value, that of the d-c rectified component. Figure 6 (*d*) shows how these two voltages add resulting in the peak of the a-c signal being restored to the zero axis position.

Figure 7 shows how the load resistor may be relocated without upsetting the foregoing conditions outlined above. It may be changed further to that of Figure 8 where the transformer is replaced by a video output source such as the plate load of a video amplifier.

Discussion to this point has been limited to symmetrical wave shapes; however, it is well known in a rectifier, such as shown in Figures 5, 6 and 7 that the peak voltage is the maximum voltage above or below the zero reference position. When the *rc* time constant is sufficiently large, the developed voltage is essentially equal to the peak value. The time constant should be sufficiently long to maintain the bias substantially constant for the field interval, but sufficiently short to enable the d-c restorer to follow relatively rapid variations in the average illumination. In order that this criteria be met, it has been found that the time

(*Continued on page* 30)

Figure 6 (right)
Alteration of Figure 5 by changing position of load resistor and capacitor; *B* and *C* show the voltage across each element (a-c input voltage and d-c rectified component). *D* illustrates how the two voltages add, resulting in the peak of the a-c signal being restored to zero axis position.

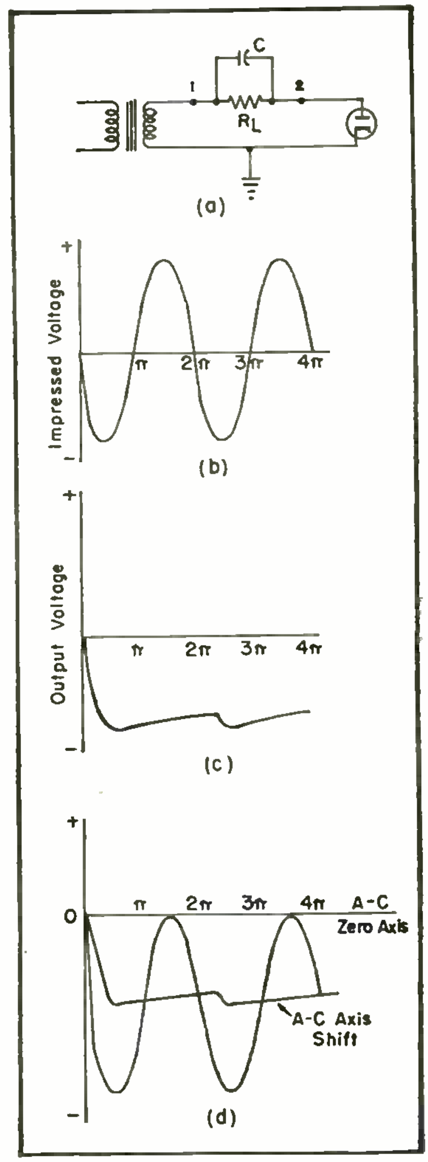


Figure 7 (below)
Circuit modifications from Figure 6.

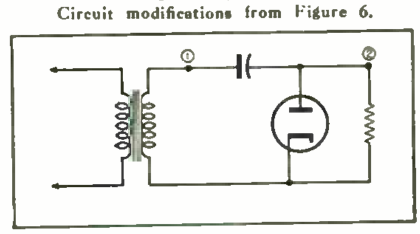
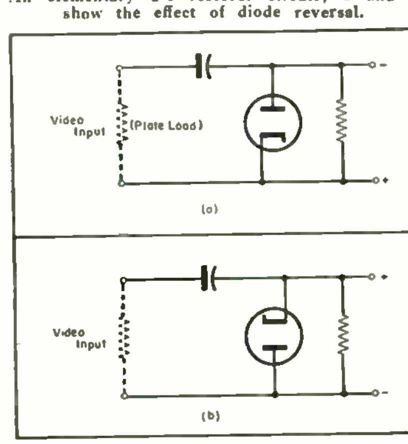


Figure 8 (below)
An elementary d-c restorer circuit; *a* and *b* show the effect of diode reversal.



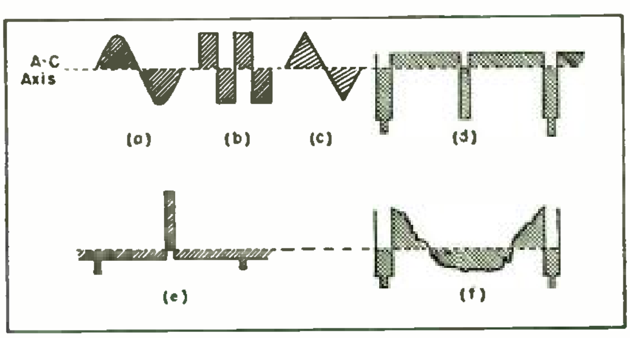


Figure 9
Various wave shapes and manner in which equal areas are established about zero a-c reference axis: *a* is the sinewave; *b*, square wave; *c*, triangular wave; *d*, negative white picture with black spot; *e*, negative black picture with white spot and *f*, typical single line scanning information.

Checking F-M Transmitter Frequencies With WWV

Measurement Technique Employs Specially Designed Secondary Standard With 6F6 Oscillator Driving a 10-kc Multivibrator, Which in Turn Drives a 2-kc Multivibrator. Two Stages of Amplification Provide Harmonic Outputs Of Up To 110 Mc.

by ROYDEN R. FREELAND

Chief Engineer
KOCY-FM, Oklahoma City, Oklahoma

TRANSMITTER FREQUENCY checks are a *must* item on every broadcast-engineering calendar. In f-m v-h-f operation, these checks cannot be conducted in the standard manner. Accordingly, a v-h-f procedure was devised, which has proved quite effective.

As stated by the FCC[1], the primary standard for frequency measurements are the transmissions of WWV, operated by Central Radio Propagation Laboratory of the National Bureau of Standards in Washington, D. C. WWV now has seven or more transmitters operating day and night, insuring reliable coverage of the United States.

The general method of measurement consists of zero-beating a secondary standard with WWV and comparing the output of this secondary standard with the transmitter frequency. A block diagram of this setup is shown in Figure 1.

There are two possible ways to determine the transmitter frequency: (*1*) Measure the final frequency of the carrier; or (*2*) measure a sub-harmonic of the final frequency somewhere in the early stages of the transmitter and then calculate the final deviation from assigned frequency.

Since the crystals used in f-m transmitters in general have a frequency of 5,000 kc or lower, it is sometimes more convenient to measure the crystal fundamental or a sub-harmonic of the final frequency. The highest possible harmonic must be checked, however, to reduce multiplication of any error made. An error of 50 cycles in a measurement at 5mc will be an error of 1,000 cycles at the 20th harmonic or at 100 megacycles. The exact harmonic to measure will depend on the equipment being checked.

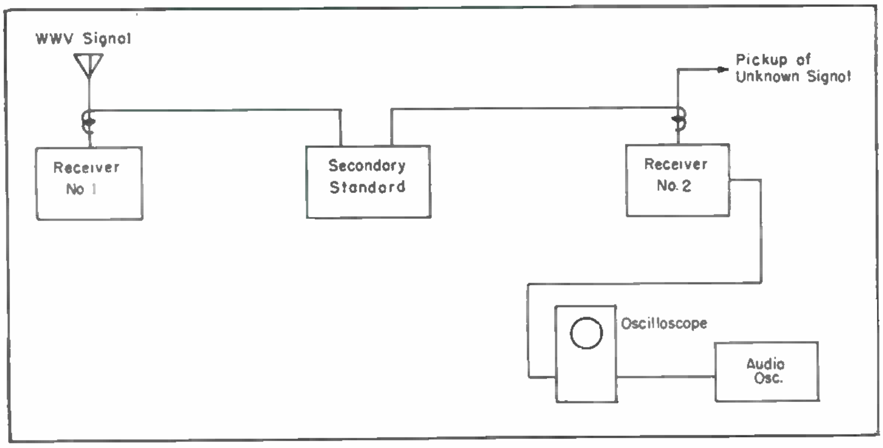
The frequency to be measured should be a multiple of 100 or 10 kc. Although it is possible to measure any harmonic by using an audio signal generator, it is necessary that the signal generator be extremely well calibrated. This leaves open considerable chance for error in the measurements. Where transmitter and monitor crystals have odd frequencies such that the harmonics cannot be conveniently measured, the final frequency must be measured, since it will always be a multiple of 100 kc.

The important piece of equipment in the system is, of course, the secondary standard, the accuracy of measurements depending upon the secondary standard being zero-heated with WWV. It is therefore necessary that the standard be fairly stable and that the frequency of the standard crystal be variable over several cycles. In the case of measuring sub-harmonics, the harmonic output of the standard will normally not fall in such a relationship to the transmitter frequency to make possible a direct comparison. However, by feeding the output of the crystal to a multivibrator, it is possible to have a standard signal which will zero-beat with the frequency being measured.

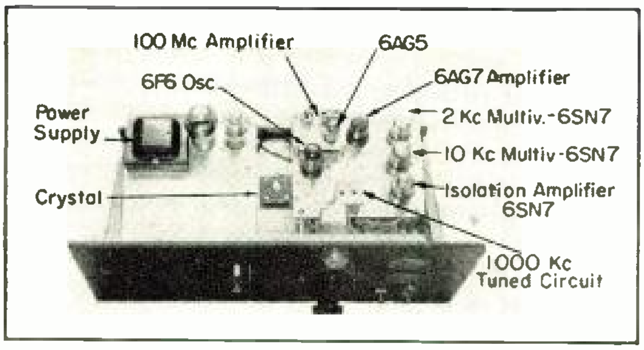
The secondary standard constructed at KOCY-FM is illustrated in Figures 2 and 3 and diagrammed in Figure 4. The standard consists of a 6F6 oscillator driving a 10-kc multivibrator which in turn drives a 2-kc multivibrator. The harmonic output is increased by two stages of amplification. The first amplifier stage (6AC7) amplifies satisfactorily up to approximately 40 mc, and a second amplifier (6AG7) increases the harmonic output of the standard up to 110 mc. Isolation amplifiers are used between the oscillator and the 10-kc multivibrator, and between the two multivibrator to insure more stable operation.

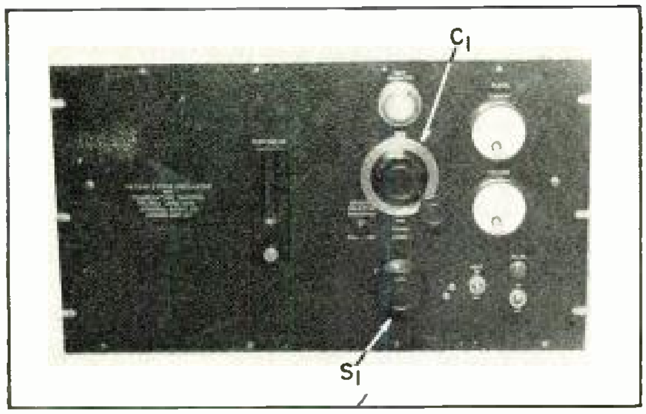
The crystal[2] provides either 1,000 or 100-kc signals. The 1,000-kc signal is

Figure 1
General setup for the frequency-check measurement system at KOCY-FM.



[1]Section 2.76





Figures 2 and 3
Front and interior views of the secondary standard built KOCY-FM.

used only for reference as it cannot be zero-beat with WWV; crystal specifications state that no capacitor be used across the crystal when oscillating it in the 1,000-kc mode. However, when oscillating the crystal in its 100-kc mode, exact zero-beat with WWV can be obtained by varying a capacitor, C_1.

A ganged switch, S_1, controls the output of the standard. Setting the switch in its various positions makes available three 1,000-kc harmonics: 100, 10, or 2 kc. The 2-kc multivibrator was included in the circuit for experimental use and is not required for measuring the f-m equipment.

The tuned circuit for the 100-mc amplifier is made up of a 7-plate midget variable capacitor, C_2, and a 4½-turn coil, L_1, ⅝" in diameter and ¾" long. This amplifier tunes roughly from 60 mc to 110 mc.

The component of the power supply will vary with the builder and therefore the value of resistor, *R*, should be calculated in each case for the correct operation of the *VR* tube. The circuit requires a maximum of approximately 20 ma at 105 volts.

The entire standard including power supply was constructed on the oscillator chassis of an old 50-cycle a-m frequency monitor.

Adjustment of the multivibrators is done by the *cut and try* method. For the 10-kc multivibrator the potentiometer R_1 is set arbitrarily and the output of standard is applied to a communications-type receiver. With the bfo in the receiver on, the number of beats between two adjacent 100-kc beats must be counted. When the multivibrator is adjusted correctly there will be nine beats between two adjacent 100-kc beats. It is normally easier to count these beats in the low end of the broadcast band; i.e., between 600 kc and 700 kc. Adjustment of R_1 is not critical. When operating properly a fairly wide variation in the setting of R_1 will not change the multivibrator frequency. If the multivibrator tends to jump out of step, the signal drive should be reduced by varying capacitor, C_3.

The setup for measurements, shown in Figure 5, includes the standard and

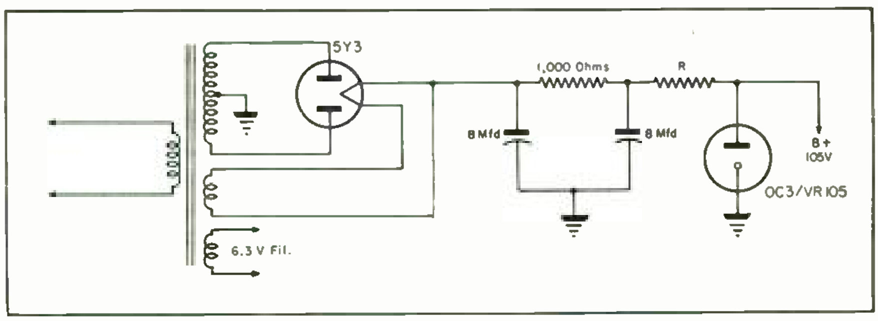
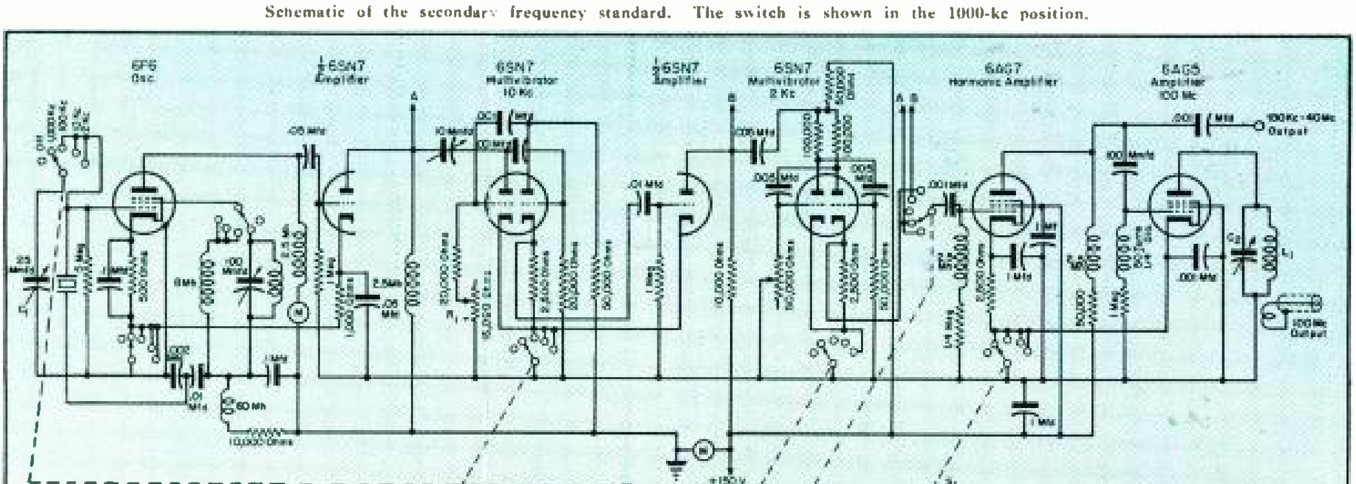
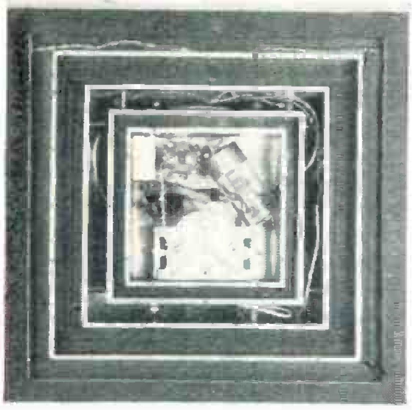


Figure 4a
Power-supply system used with secondary frequency standard.

*Bliley SMV-100

Figure 4
Schematic of the secondary frequency standard. The switch is shown in the 1000-kc position.





Interior view of one of the National Bureau of Standards 100-kc standard frequency oscillators, which provide frequency and time interval standards for continuous broadcast to all parts of the world. The quartz crystal unit, in an evacuated container, and part of the oscillator circuit arrangement are shown in a temperature-controlled compartment. Layers of aluminum and felt are used to obtain extremely uniform temperature. In addition to this some of the oscillators are located approximately 25′ below the surface of the earth.

Figure 5
Setup for frequency measurements using the standard and two receivers.

two receivers. The receiver used to compare the standard signal with WWV may be any good type of communications receiver. The second receiver used to compare the standard signal with the signal being measured may be a communications type receiver with an extended tuning range.[3] Where measurements are made at the final frequency, it is possible to use a standard type f-m receiver to beat the standard and unknown signals. A satisfactory beat can be obtained by tuning the f-m receiver slightly off center frequency. A 'scope and audio oscillator may be used if it is desired to measure the frequency difference for comparison with frequency monitor readings.

If the measurements are being made close to the transmitter, the easiest and perhaps the best system is to adjust the transmitter to zero frequency rather than determine the frequency deviation. Where measurements are made remotely from the transmitter it is usually more practical to determine the deviation and then check this with the monitor reading.

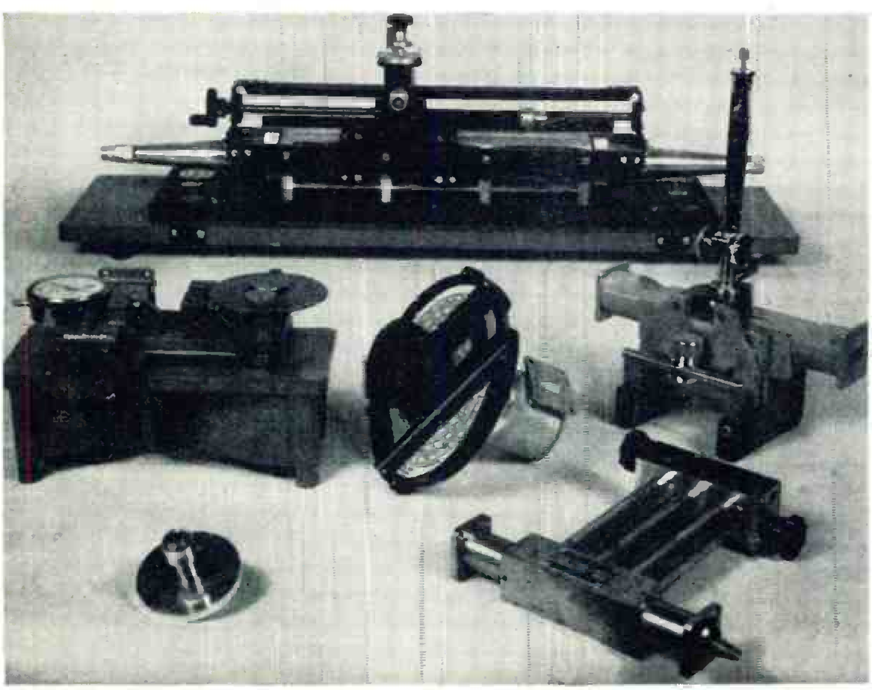
Measurement Procedure

After the standard has been warmed up for several hours, receiver *1* is turned on and one of the WWV eight standard frequencies is tuned in . . . 2.5, 5, 10, 15, 20, 25, 30, and 35 mc, and the standard is zero-beat against one of these frequencies. The zero-beat should be with the WWV carrier and not one of the modulating frequencies.

After the standard has been adjusted receiver *2* is tuned to the frequency of the signal being measured. A beat should be heard, the frequency of which will depend upon the deviation of the transmitter from the assigned frequency.

To adjust the transmitter to zero frequency, the transmitter oscillator should now be tuned for zero-beat in receiver *2*. To measure the frequency deviation, the audio output of receiver *2* is fed to the vertical plates of the 'scope and the output of the audio oscillator applied to the horizontal plates. Both signals are adjusted for equal amplitude on the 'scope. Then the audio oscillator frequency is adjusted until a circular pattern appears

(*Continued on page* 31)

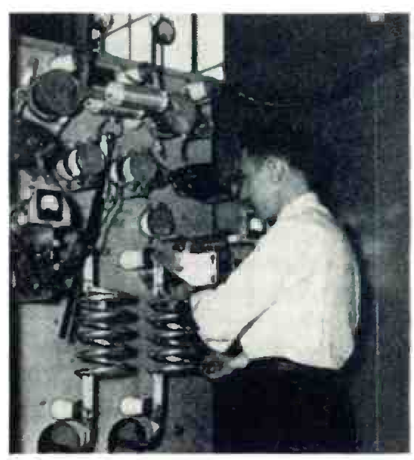


(Left)

A group of measuring instruments and secondary standards in the micro-wave frequency range used at the National Bureau of Standards. Top, coaxial slotted line. Center, left to right; wave-guide metallized-glass attenuator; cavity frequency meter; slotted-line waveguide. Bottom, coaxial thermistor load impedance (left) and three-stub coaxial impedance transformer (right).

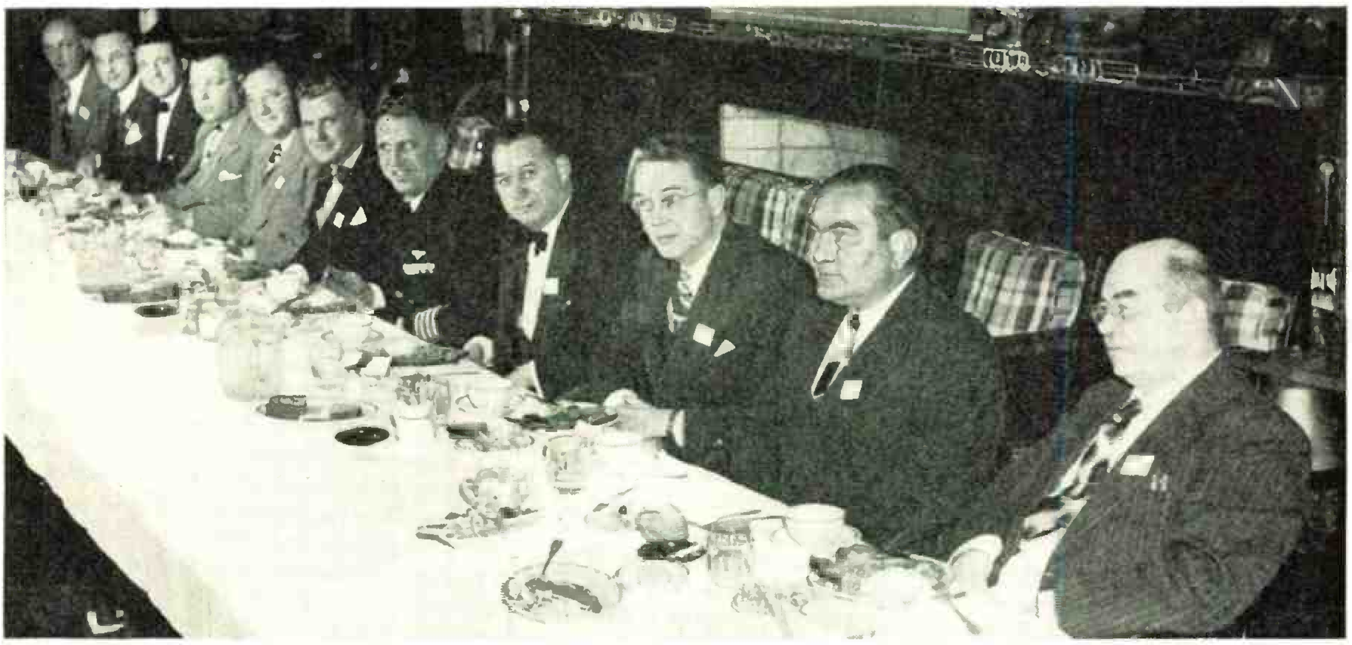
(Below)

Equipment used at the National Bureau of Standards for accurately determining the loop constant of a radio field intensity meter in terms of a standard r-f field.



VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

RCA BUILDING 30 Rockefeller Plaza, New York, N. Y.



At the speakers table of the VWOA Chicago Chapter annual dinner cruise, which was held in the Adventurer's Club. Left to right: George Martin, RCA Marine (VWOA committee); Fritz Franke, Hallicrafters; Joe Wallace; Louis Baer, Standard Metal Products (VWOA committee); Bill Halligan, president, Hallicrafters; Les Gnrder, American Television Institute (VWOA committee); Capt. H. R. Horney, U.S.N., Commanding Officer, Combat Information Center Training School, who was guest speaker; Thomas L. Rowe of WLS, who was chairman; Royal Higgins (VWOA committee); Walt Marsh, Allied Radio Corp. (VWOA committee) and H. Herndon, Regional Director, FCC.

Personals

VWOA VETERAN MEMBER Delos Wilson Rentzel has been nominated by President Truman for the post of CAA Administrator to succeed T. P. Wright.

Rentzel will resign several top-level positions in activities related to communications including his post as president of Aeronautical Radio, Inc., and the airlines, to step into governmental circles. He was formerly chairman of the Radio Technical Planning Board's aeronautical radio panel, and was vice chairman of the Radio Technical Commission for Aeronautics, the government-industry organization which formulated the basic plan for the currently-accelerating research, development, and installation program designed to provide more efficient airways. He was a director of Airborne Instruments Laboratory, Inc., of Mineola, N. Y.

Prior to joining AR Inc. in 1943, he was director of communications for American Airlines and associated with that organization and its predecessor companies for more than 12 years.

Born in Houston, Texas, in 1909, Rentzel is a graduate of Texas A & M College. He lives with his wife and two young sons in Park Fairfax, Va. He has held a private pilot's license and owns part interest in a two-place aircraft.

D. W. Rentzel, who has been named by President Truman, to become the new CAA Administrator.

MEMBERS OF VWOA were shocked to hear of the death of Mrs. Fred Muller, wife of VWOA life member, Capt. Muller, U. S. N. R. . . . George Bailey, president of ARRL and executive secretary of the IRE, addressed the boys on UN radio communications at the recent Spring meeting held at the Fireplace Inn in New York City. . . . VWOA life member Commander Arthur F. Van Dyck attended the recent annual RMA-IRE Spring transmitter meeting at Syracuse. . . . Life member Brig.-General David Sarnoff, president of RCA, delivered the keynote address at the Armed Forces Communications Association meeting at Dayton, Ohio. DS, who is prexy of the association, described the ultra important role of communications in peace and war. . . . Honorary member W. A. Ready, president of the National Company, attended the recent IRE Convention in N. Y. City.


The 5-KW AM
TRANSMITTER*...
* The RCA 10-KW AM transmitter, Type BTA-10F, is identical in size and appearance to the BTA-5F you see here. Over 125 transmitters of this series now in operation.
(Photo courtesy of Radio Station KOOL, Phoenix, Arizona)
RCA
BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.
In Canada: RCA VICTOR Company Limited, Montreal

with 10-kilowatt insurance

BTA-5F. The one 5-KW AM Transmitter that insures easy increase to 10 KW at any time! Power changeover is simple . . . inexpensive . . . quick. *Because it was planned that way.*

When you install the BTA-5F Transmitter for 5-KW operation there is just one tube in the power amplifier stage (left-hand cubicle in view below). But note the additional tube socket already mounted in place. To increase power to 10 KW, you need only buy the simple modification kit (described in box at right). With the parts contained in this kit...and the few simple circuit changes required, changeover can be made "overnight." It's easy...it's inexpensive. You need lose no air time.

Naturally, you can also buy this transmitter originally for 10-KW operation (specified as Type BTA-10F). Both models—the BTA-5F for 5-KW operation, and the BTA-10F for 10-KW operation—have the same sleek, well-finished, business-like appearance shown by KOOL's installation on the opposite page. Both models have the true unified front . . . an *exclusive feature* of RCA high-power AM transmitters. This front is an integral piece *separate from the compartment enclosures.* It greatly facilitates flush-mounting...and improves appearance of the installation by several times.

And careful planning like this goes right on through. For instance, this transmitter is equipped with one of the most complete centralized control systems ever designed for *any* transmitter . . . with all the necessary controls, circuit breakers and relays needed for fully automatic operation or step-by-step manual operation. It has push-button motor-tuning for its high-power stages...and instantaneous power control reduction. It can be furnished with matching cabinet end-extensions for housing antenna phasing, monitoring, test and audio equipment. These extensions have front sections that become an integral part of the overall unified front—another exclusive RCA feature of great importance in station appearance. And note this too: the 5-KW BTA-5F uses only 24 tubes (6 different tube types); the 10-KW BTA-10F uses only 27 tubes (6 different types).

• • •

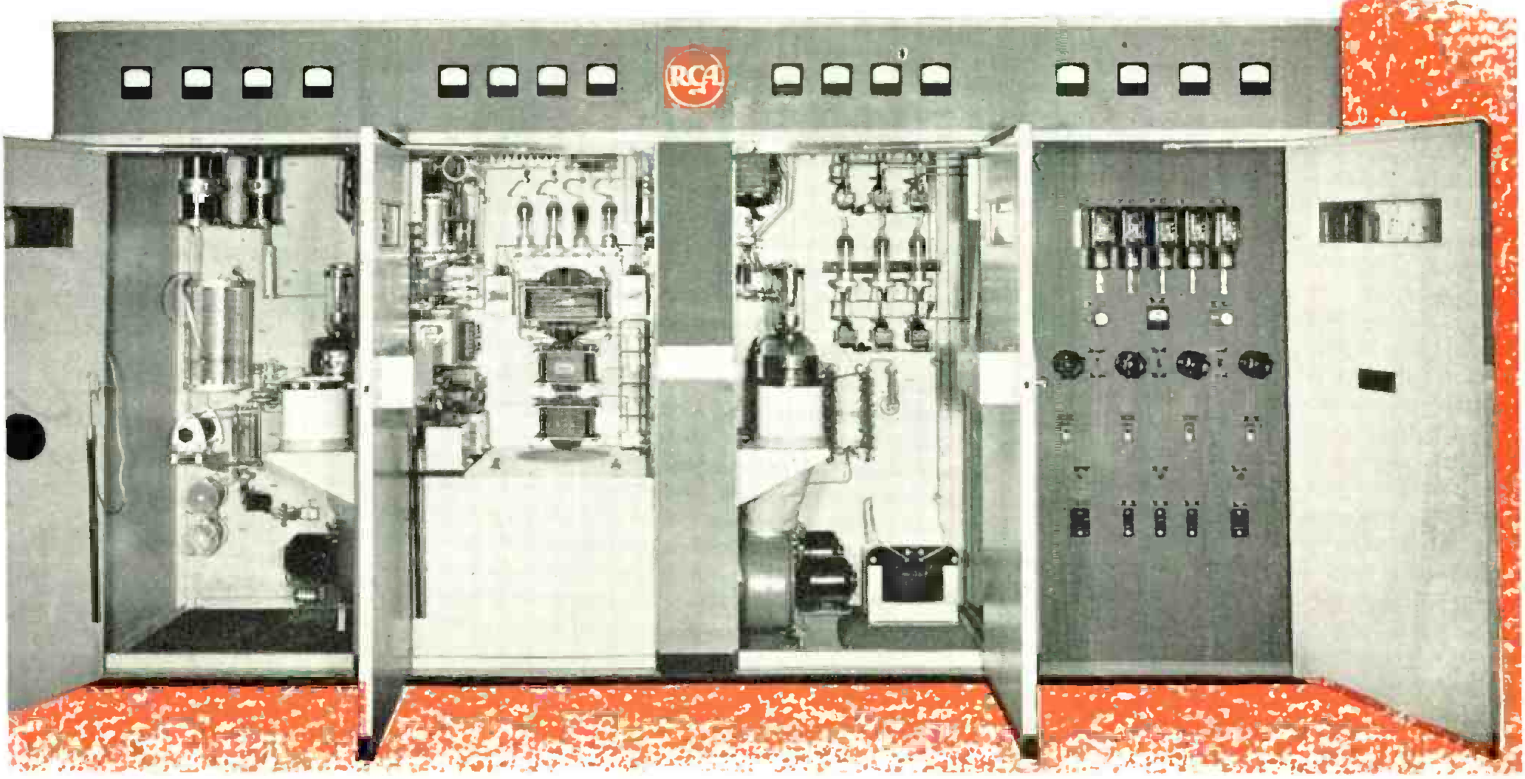
Here, we believe, is the finest streamlined station installation ever engineered for standard-band broadcasting . . . with all basic circuits proved in more than 125 transmitters of this series now operating throughout the world. Get the details from your RCA Broadcast Sales Engineer, or write Department 23-E.

This simple kit (MI-7267-A) takes the BTA-5F to 10 KW . . . inexpensively and without one change in station layout.

- One blower
- Two filament transformers
- One 10-KW modulation transformer
- One reactor
- All necessary hardware

The Transmitter Control Console — standard equipment with every BTA-5F and BTA-10F.

THE 5-KW BTA-5F *(open view).* **Sweet and simple . . . with everything up front where you can reach it.**



Relaying telephone calls to radio police cars patrolling the streets of Philadelphia. Cabinet at left houses remote control relay system for duplex operation.

Philadelphia police-emergency car equipped with duplex radiotelephone system.

Philadelphia Police Duplex Two-Way F-M System

Three Police Boats, and 239 Prowl Cars, Patrol Wagons and Official Cars Equipped With Two-Way Setup, With Talk-Out on 74.06 and Talk-Back on 155.97 Mc.

by RALPH G. PETERS

Two-way F-M systems have become priority police-department requirements throughout the country, in large and small cities and townships. Complete coverage, an acute problem in large metropolitan areas, is rapidly being solved through the careful application of many advanced design and installation features.

An interesting example of a metropolitan-area solution is the recent 250-car installation[1] in Philadelphia to patrol 130 square miles. Official cars, prowl cars and patrol wagons, and three police boats are among the radio-equipped mobile units. In addition, cars of the fire chief, two deputy chiefs and two rescue squads, and three fireboats are also equipped with tiein setups. Mayor Bernard Samuel's car is also tied in with the two-way system.[2]

In excess of 330,000 calls a year, 800 to 1,000 a day, are being routed over the system, which features the duplex method of operation.

System coordination is organized and followed through in the radio dispatching room, on the seventh floor of City Hall. Here four men answer constantly-buzzing telephones and jot down notes on the nature and location of a disturbance, accident or possible crime. Their notes are passed through a slot into a sound-proof dispatcher's booth. A large electrically controlled map on the wall of a phone room indicates the location of various cars at all times. Within the dispatcher's booth is a microphone and remote console plus an elaborate set of toggle-switch panels that aid the dispatcher in keeping track of the cars, and learning if they are in or out of action.

The dispatcher assigns squads and answers incoming calls.

In a disaster the first two-way radio-equipped police car to arrive at the scene automatically takes over as the headquarters for transmitting and receiving messages pertaining to the affected area. A blue and yellow triangular sign is placed atop the car, reading, *Police Radio*. The commanding officer at the scene of a disaster may establish as many mobile sub-communication stations as necessary.

The establishment of a communication headquarters in emergencies permits coordination of all incoming and outgoing messages, thereby eliminating confusion, which would result were orders coming in from many police cars, often simultaneously. During such emergencies as many as 100 calls an hour, almost continuous conversation, have been logged.

Duplex Operation System

Talk-out is accomplished on 74.06 mc, and talk-back is on 155.97. A

(Continued on page 30)

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[1] Motorola.

[2] Two-way system is under the direction of James H. Malone, Director of Public Safety. Associates include Harry M. Simon, Chief of the Electrical Bureau; Frank O. Schierff, Superintendent of Fire Alarms and Radio Systems; Anthony Repici, Supervisor of Radio Maintenance; Thomas P. Burns, Assistant Superintendent of Police in Charge of Operation of Police Radio and Communication, and Captain Charles News of the Police Radio Division.

Test Instruments In The Broadcast Station

Part III of Series, Covering Uses of R-F Bridge, Decade Resistance Box and Field-Strength Meter in Broadcast Measurement Work.

Eidson at the controls of the field-strength meter used at WIS.

by HERBERT G. EIDSON, Jr.

Chief Engineer, WIS and WISP
Technical Director, WIST

IN THIS, the concluding installment, three more important pieces of measurement equipment will be discussed: the r-f bridge, decade resistance box, and the field-strength meter.

The R-F Bridge

At our stations a 400-kc to 60-mc type r-f bridge[1] is used.

The bridge (Figure 1) is used with a series-substitution method for measuring an unknown impedance in terms of its series-resistance and series-reactance component. The resistance is read from a variable capacitor dial directly calibrated in ohms (0-1,000), the reactance being read from the variable capacitor dial directly calibrated in ohms (0-5,000) at a frequency of 1 mc. The resistance dial reading is independent of frequency, and the reactance dial reading increases linearly with frequency. For frequencies other than 1 mc the reactance dial reading must therefore be divided by the operating frequency in mc.

As will be noted in the circuit, the resistance of the unknown depends upon a change in capacitance C_{R1}; the reactance upon a change in capacitance C_{x1}.

In normal practice the reactance control C_{x1} is set at some value above zero ohms, say 200, and the bridge is balanced initially. If the unknown reads below this setting the sign is negative; if above 200 then the reactance is inductive. In measuring a great amount of capacitive reactance the initial balance is made with C_{x1} set at the extreme end from zero (5,000). In addition, a small switch is thrown from *L* to *C* which changes the values of the *C* and *R* in two legs of the bridge.

A measurement is made by first balancing the bridge with the *unknown* terminals shorted, then rebalancing with the short circuit removed and the unknown impedance connected to the *unknown* terminals.

If the resistance or reactance component of the unknown impedance falls outside of the direct reading range of the bridge indirect measurements can be made through the use of an auxiliary parallel capacitor and the use of formulas.

Any well shielded r-f oscillator having an output voltage of 1 to 10 and an adequate frequency stability will serve as generator.

For detector work, any well-shielded receiver having a sensitivity of 1 to 10 microvolts will serve. It should have an adequate r-f sensivity control and a local oscillator to beat against the i-f produced by the generator. It has been found much easier to balance the bridge when the *LO* is turned off and a modulated wave is obtained from the generator, the modulation being in the order of 400 cycles.

We use a bridge for:

(*1*) Measuring *R* and *X* of antennas.

(*2*) Measuring different points in

(*Continued on page* 36)

[1] G-R 916-A

The r-f bridge used by Eidson.

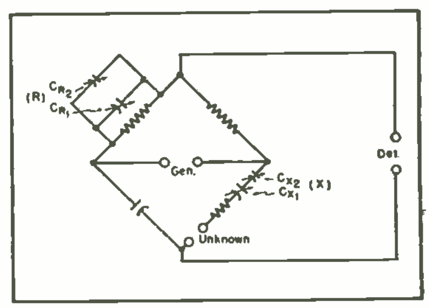
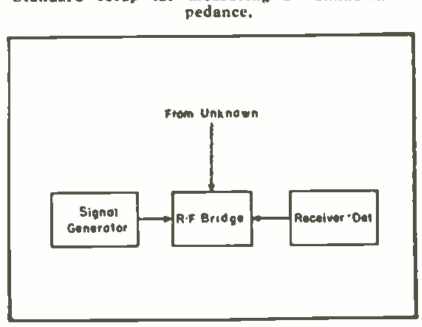


Figure 1
Basic circuit of the r-f bridge used at WIS.

Figure 2
Standard setup for measuring an unknown impedance.



TUBE *Engineering News*

The Dyotron Microwave Oscillator . . . Low-Noise Amplifier With Grounded-Cathode Triode in First Stage And Grounded-Grid Triode in Second Stage.

A NEW TYPE of s-h-f tube, the dyotron, which is unusually stable, has a very wide tuning range, and can be used in local oscillators or signal generators at frequencies up to 3,700 mc, was described at the recent IRE National Convention by E. D. McArthur.

The tube, developed under a U. S. Navy Bureau of Ships contract, is essentially a triode in that it uses the same physical method for producing an alternating component of plate current, i.e., the current flow from the cathode varies with the electrode field at the cathode just as does any conventional triode or tetrode.

The electrical distinction between the dyotron and the triode lies in the method of obtaining the varying electric field at the cathode and in the method of utilizing the resulting high-frequency current.

The dyotron is based on the thesis that ordinary grid excitation voltage can be abandoned and enough a-c current derived from the anode field to support oscillations. To do this, the phase of this current component must be reversed and the tube so designed that the current is large enough to supply the output circuit power consumption.

To realize these conditions, the usual excitation or feedback voltage between grid and cathode must be zero. This was accomplished in the dyotron by building into the tube a capacitor of about 70 mmfd which effectively short circuits the grid and cathode.

With the built-in capacitor, which must be as close as possible to the active grid and cathode area, the tube becomes a two-terminal device. The grid and cathode act as one a-c electrode and the anode is the other. It is still possible, of course, to have a d-c bias voltage on the grid. Thus we find that, if an a-c voltage exists between these two terminals, most of the electric field lines which start at the anode will terminate on the grid, but some will reach through the grid to the cathode. This anode field, reaching through the grid, creates the voltage term, $e_p\mu$ sin ωt. Since this cathode field does not depend on there being any impedance between grid and cathode, the input bypass capacitor, while eliminating the usual grid-cathode field, has no effect on the penetrating field from the anode.

Electrically, therefore, the need for a feedback circuit as well as the usual tuned input circuit has been eliminated, and there is nothing left but the single output circuit. The dyotron thus becomes a simple two-terminal oscillator whose frequency is determined by resonance in a single circuit which is connected between grid and anode and which can be tuned by one control.

Most of the experimental work was done with tube models which were simple modifications of the standard 2C39 triode.

Since performance was based on the use of the electron transit angle, a wide tuning range would not ordinarily be expected. Experiments showed, however, that there was a considerable spread in transit angle at any frequency and voltage due to the non-uniformity of the grid. Despite this the negative conductance was great enough so that with circuits of moderate Q the transit angle varied about ±30 before oscillations ceased.

Three experiments were conducted to study wide tuning ranges of the tube. In the first, oscillation characteristics were taken using a single coaxial cavity with a piston tuner with two types of tubes identical in all respects except for interelectrode spacing. With this one circuit and the two

Band-center, Mc	Overall noise factor ratio	Overall noise factor db	R. opt. ohms	Bandwidth, Input circuit	Bandwidth, Mc, overall	Tubes used in cascade	Degradation of noise-factor when L_n is omitted, db
6	1.06	1.25	15,000	2*	1	6AK5-6J4	Not measured
30	1.35	1.35	2,500	12*	6	6AK5-6J4	0.2
180	3.5	5.5	400	30**	2.5	6J4-6J4	2.5

*Double-tuned.
**Single-tuned.

Table 1. Results obtained experimentally using the cascade circuit at the input of 100 db amplifiers at 6, 30, and 180 mc.

types of tubes, oscillations were obtained over the continuous range from 370 to 3,700 mc, a ratio of 10:1. In another experiment, the oscillation range was explored using one tube and one cavity. Nothing was varied except cavity piston position. No voltage nor output coupling adjustments were made. Under these conditions the oscillator tuned over the range from 1,800 to 2,800 mc. For this range the total supply voltage was 300 volts, the plate current was 60 ma and the power output varied from 100 to 350 milliwatts. If the voltage was varied to keep the transit angle approximately constant, the tuning range became 1,400 mc to 3,200 mc.

A signal generator has been built for general laboratory work using the same type of tube which, with a single tuning control, covers the range from about 1,100 to 2,900 mc. Throughout this range the power varies considerably although the plate voltage is constant and there are no mode shifts nor spurious oscillations.

The frequency stability seems to be due to a combination of circuit simplicity and the fact that capacity variations due to grid or cathode expansion no longer affect the frequency much since these two electrodes are thoroughly bypassed.

Cold Cavity Response

In a typical experiment it was found that the cold cavity response was about 1,600 mc with no power whatever on the tube. After switching on cathode and plate voltages, the total frequency shift mounted to about 1.2 mc and occurred in the first ten minutes. After this period the frequency variation was in the order of ±10 kc and was almost entirely a function of cavity temperature. Additional measurements over a period of a few hours at 2,600 mc showed that the frequency variation with temperature was about 40 kc per degree and that with temperature and voltage control it was possible to get an oscillator frequency stability of one part in 10^6.

Low-Noise Amplifier

The application of triodes in low-noise cascade circuits has been widely studied. In 1944, Henry Wallman, A. B. Macnee and C. P. Gadsen instituted a series of experiments with such systems at M. I. T., developing an amplifier which employed a grounded-cathode triode first stage and grounded-grid triode second stage. They obtained noise factors as low as .25 db at 1 mc, 1.35 db at 30 mc and 5.5 db at 180 mc.

An analysis of the unique low-noise circuit was offered, for the first time, at the IRE National Convention.

In Figure *1* appears a basic circuit diagram of the amplifier.

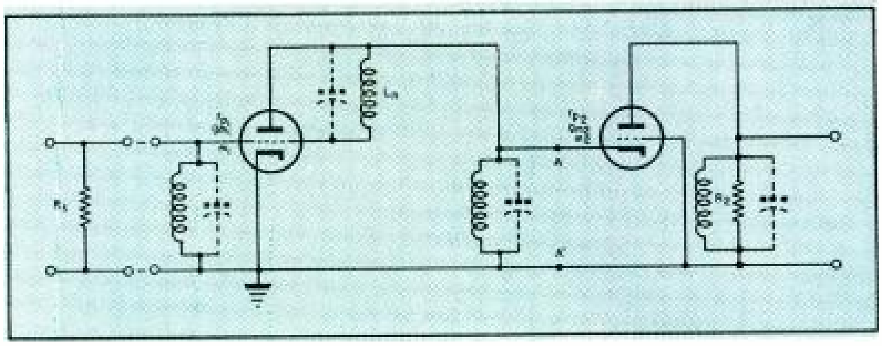


Figure 1

Basic circuit of the Wallman-Macnee-Gadsen low-noise amplifier, which consists of a grounded-cathode triode in the first stage and a grounded-grid triode in the second stage.

The inductances in the circuit are adjusted to be midband resonant with their associated capacities. The coil, L_n, which is parallel resonant with C_{gp}, is not necessary for stability, but is used to achieve low noise-factor. In amplifiers operating at a midband frequency, as high as 180 mc, it was possible to omit L_n with complete preservation of stability, although its omission increased the noise-factor from 5.5 to 8 db.

Bandcenter Behavior

In studying the bandcenter behavior of the amplifier, it can be assumed that R_2, the load resistance of the grounded-grid stage, is considerably smaller than r_{p2}, as is usually the case for wideband amplifiers. Thus the input resistance of the grounded-grid stage is $1/g_{m2}$; this is the resistance at the right of AA'.

The resistance, looking to the left at AA' is, r_{p1}. (Typical values are about 200 ohms for $1/g_{m2}$ and 6,000 ohms for r_{p1}. It is this combination of a very low resistance to the right and a high resistance to the left at AA' that provides the crucial characteristic of the grounded-cathode grounded-grid combination, with regard to both stability and noise-factor. In particular, the voltage amplification of the grounded-cathode stage alone is thus g_{m1}/g_{m2}. For usual tubes this is about unity. This very low amplification makes the first stage very stable.

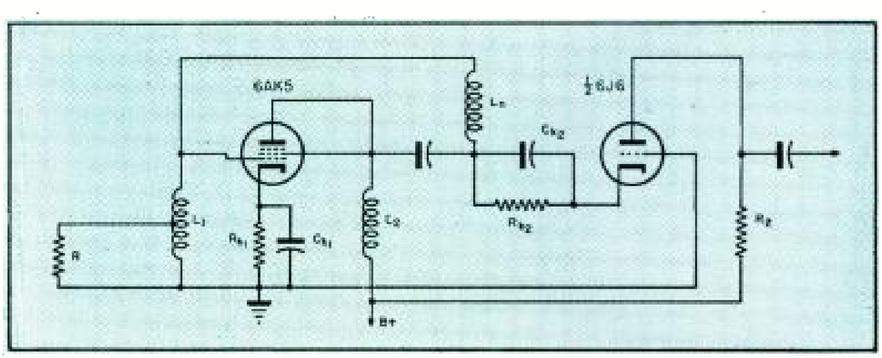
The voltage amplification of the grounded-grid stage is $g_{m2}R_2$. Therefore the overall voltage amplification of the cascade is $g_{m1}R_2$. It will be noted that this amplification is independent of g_{m2}. It is desirable to have a large g_{m2} to keep the voltage amplification of the first stage small and thus assure its stability.

30-Mc I-F Amplifier

By using a 30-mc i-f amplifier with cascade low-noise input, it has been possible to build a 3,000-mc receiver with an r-f noise factor of 7.4 (= 8.7 db), as measured with a 3,000-mc klystron noise source.

Figure 2

A typical cascade low-noise circuit. The d-c from the grounded-grid stage flows through R_{k2}, L_2 and L_1.



Short Receiving-Antenna Design Factors

Major Problems Involved in the Design of Short Receiving Antennas (With An Electrical Length of Less than 10°, Roughly Under 10′, At Standard Broadcast Frequencies), Particularly For Aircraft Application.

by HARVEY KEES

Chief Engineer
Engineering Services, Inc.

ON AIRCRAFT, short antennas are commonly employed with 200-500 kc radio range and 200-1600 kc radio-compass receivers, where satisfactory performance is usually obtainable with symetrical wire *T* antennas having eight-foot horizontal and one-foot vertical sections. Both sets are used for the reception of vertically-polarized signals, and the optimum receiving antenna is a non-directional, vertical one which is insensitive to horizontally-polarized fields. Ambiguous information is more likely to obtain from range-receiver installations which respond to other than vertically-polarized signals, and when used with radio-compass receivers such antennas tend to reduce bearing accuracy as a result of a broadening of the nul in the directional pattern obtained from the loop and sense-antenna combination used with this set.

Broadcast Reception

Since broadcast stations employ vertical antennas, maximum receiver sensitivity to the vertically-polarized transmitted signals is obtained with vertically-polarized receiving antennas. Any horizontally-polarized pickup in a broadcast antenna serves only to increase background noise and selective fading.

Antenna Theory

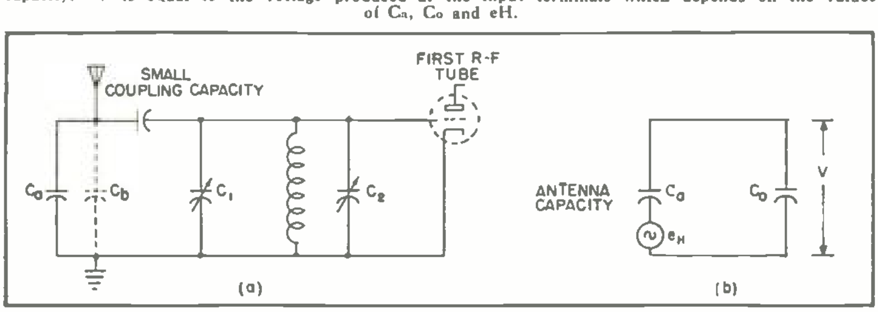
At this point it may be well to review some of the basic principles of antenna operation and generally-accepted definitions. Let us consider the hypothetical case of a short, say, two foot, vertical rod used as an antenna in the standard broadcast band.

If such an antenna is used for transmission, the lower end of the rod is connected to one terminal of an r-f signal generator, and the other terminal of the signal generator is grounded. The current that flows from the signal generator is due to the capacity of the rod to ground. This is so because the rod obviously has negligible series resistance and inductive reactance at broadcast frequencies. In fact, the current flowing at any point in the rod depends on the capacity-to-ground of the section of rod above that point. Thus the most current flows at the base of the rod, and the current tapers off to zero at the tip of the rod. The situation that obtains in practice is graphically illustrated in Figure 2.

The term *effective height* of an antenna is an arbitrary one which probably would be better understood if it were called *effective length*. At any rate, it is merely a measure of the receiving effectiveness of an antenna structure, as compared to that of an antenna which has uniform current distribution throughout its length. By definition, the *effective height* of a two-foot vertical rod, surmounted by a large top-loading capacity plate so that the currents at the base and at the apex of the rod are approximately equal, is two feet. The *effective height* of a two-foot rod with no top-loading plate, whose current tapers off linearly to zero at the apex, is one-half its actual physical height, because the average current in the rod is one-half that of the top-loaded rod with uniform current distribution.

Figure 1*a* (left) and 1*b* (right)

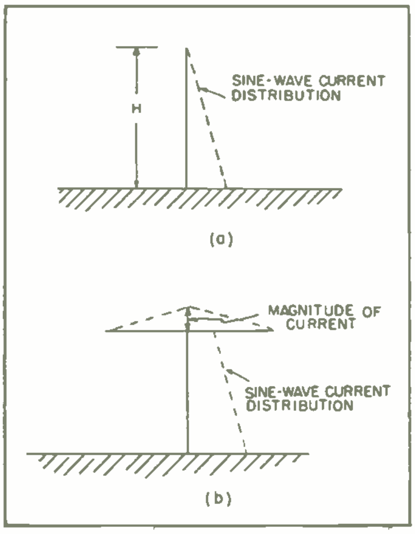
At *a* is a typical receiver input circuit used with a short antenna. Capacity of leadin between antenna and receiver is shown at C_a and at C_b, we have the stray lead capacity in a receiver. The trimmer, C^1, is used to compensate for variation in antenna and leadin capacities. The tuned circuit with C^2 presents a very high impedance to the antenna. In *b* appears an equivalent circuit for a short antenna and capacitive load. The voltage induced in the antenna by the r-f field, which is directly proportional to the antenna height, is indicated at eH. C_o is the receiver input and leadin capacity. V is equal to the voltage produced at the input terminals which depends on the values of C_a, C_o and eH.



The strength of an r-f field is usually given in volts per meter, meaning volts per meter of *effective height* of the receiving antenna. That is, in a field strength of 100 volts/meter an antenna with one meter *effective height* will have 100 volts induced in it and have an open-circuit voltage of 100 volts. Similarly, the same antenna would have an open circuit voltage of 100 millivolts where the r-f field strength was 100 millivolts/meter. This is simply an arbitrary, and commonly used, way of describing the intensity of an r-f field.

It follows from elementary circuit theory that the voltage any antenna is capable of delivering to a load is dependent upon the internal impedance of the antenna. For example, actual measurements show the *effective height* of a two-foot vertical rod is one foot and that its internal impedance is approximately that of a 5-mmfd capaci-

Figure 3 (right)
Symmetrical 7' antenna performance.



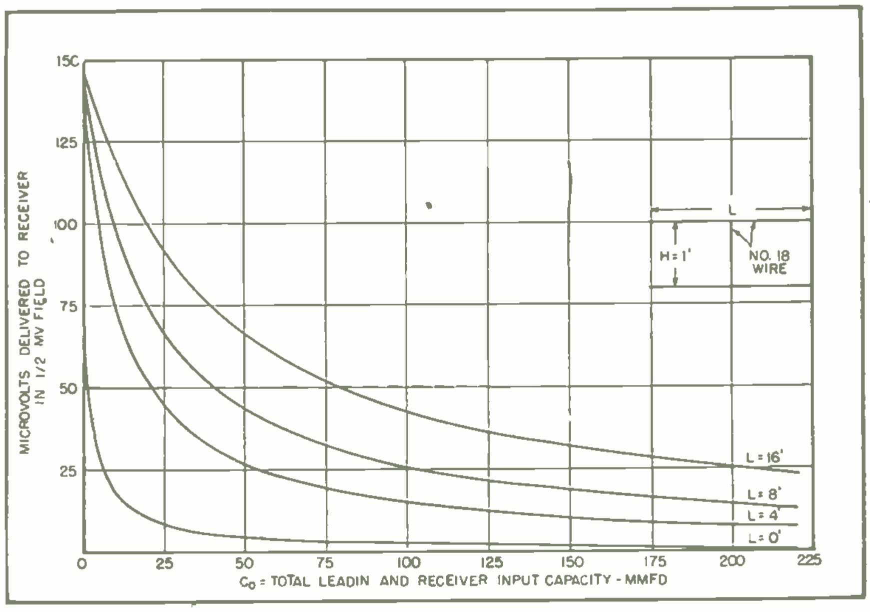


Figure 2 (left)
Current distribution on short antennas, with and without top loading. In top view, we have a short vertical antenna with no top load. The sinewave current distribution is a straight line function for angles under 5°. At the bottom is a drawing of a short antenna with top loading. The magnitude of current is proportional to the top load capacity, since the sine-wave current distribution is linear for antenna lengths under 5°.

tor. It is possible to devise another type of antenna structure also having an *effective height* of one foot, but whose internal impedance is considerably less than that of the two-foot rod: for example, a one-foot rod surmounted by a symmetrically located horizontal rod eight-feet long. Actual measurements show this latter antenna has an *effective height* of one foot and the impedance of a 25-mmfd capacitor. Thus, the latter antenna, which has the same *effective height* as the former, is capable of delivering considerably more power from an r-f field to a finite load (such as, say, a receiver with a 500-ohm resistive input).

In Figure 1*a* appears the schematic of the antenna circuit of a receiver designed for use with short antennas. The antenna feeds a load consisting of the lead-in and receiver—input capacity. The input capacity of a well-designed receiver is usually under 20 mmfd, and open-wire lead-in capacity is approximately 5 mmfd for each foot of length.

The equivalent circuit of a short antenna connected to a receiver is shown in Figure 1*b*, where the antenna is considered as a signal generator whose impedance is the capacitive reactance of the antenna, and internal emf is equal to the product of the effective electrical height of the antenna and the field strength of the impinging signal. The load on this generator consists of the receiver-input and leadin capacities in parallel.

Thus

$$E = (e)(h)$$

Where:

E = voltage induced in antenna by r-f field
e = r-f field strength
h = effective electrical height of antenna

However, not all the voltage induced in the antenna reaches the receiver input terminals, because of the internal impedance of the antenna.

$$V = (E)\ (C_a)/(C_a + C_o)$$
$$= (e)\ (h)\ (C_a)/(C_a + C_o) \qquad (1)$$

Where:

V = receiver input voltage
C_a = total antenna capacity
C_o = receiver-input and leadin capacity

Now, if it is assumed that the current at the top of the vertical section of a symmetrical *T* antenna is directly proportional to the top-loading capacity and that the current distribution is a straight line, as illustrated in Figure 2, an equation can be written relating the actual physical height and effective electrical height of the structure in terms of the capacities involved.

Thus

$$h/H = (C_a + C_1)/(2)\ (C_a) \qquad (2)$$

Where:

H = physical height
C_1 = top-load capacity

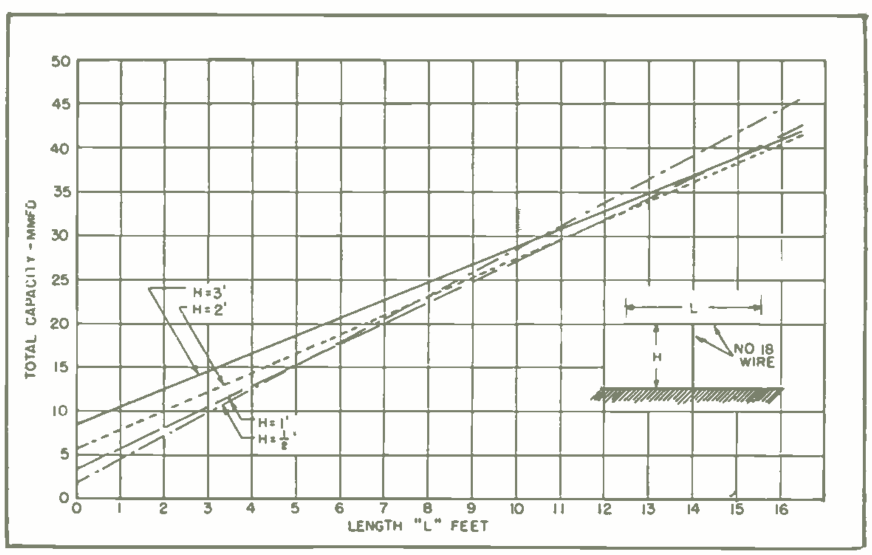
Combining equations (*1*) and (*2*)

$$V/e = (H)(C_a + C_1)/(2)(C_a + C_o). \qquad (3)$$

Equation (*3*) describes the performance of short symmetrical *T* antennas in terms of easily determined quantities: the antenna capacity, C_a; the top load capacity, C_1; the leadin and receiver input capacities, C_o; and the physical

(*Continued on page* 34)

Figure 4
T antenna capacity plot.



The Industry Offers

RADIO RECEPTOR ADAPTABLE TRANSMITTING UNITS

Transmitting units, known as the Telepak, have been announced by Radio Receptor Co., Inc., 251 W. 19th St., New York City.

Units use a basic frame and a series of separately removable units or cells which can be accommodated in this basic frame. The cells are of standardized construction and proportions and range in physical size from 1/3 of the stack height of the basic frame to a full stack, as may be required for the power requirements involved.

Cells are individually removable from the cabinet, and are individually ventilated. They are supported in the cabinet by means of removable shelf supports.

NEW EIMAC PRODUCTS

Three new products have been announced by Eitel-McCullough, Inc., San Bruno, Calif.

One item is a 10-60 mmfd variable vacuum capacitor VVC60-20, which will handle 40 amperes r-f current at 20,000 volts.

The second item is a 4-400A power tetrode for power amplifier service in 1 kw f-m broadcast transmitters in the 88-108 mc band.

The third product is a 4-400A 4000 air-system socket designed for use with the type 4-400A power tetrode.

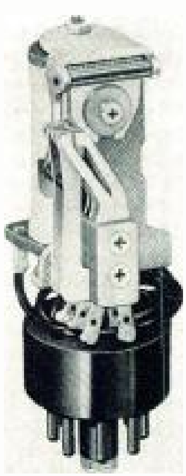
* * *

CLARE D-C RELAY

A plug-in type d-c relay, type J, has been developed by C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois.

Supplied with standard octal base plug. Overall length of relay and plug is 3⅝". Length of relay installed is 2 15/16" from the panel.

Features of the relay include independent twin contacts, high current carrying capacity, large armature bearing area, high operating speed and large contact spring pileups.



RCA FLYING SPOT C-R TUBE

A *Flying Spot* cathode-ray tube, 5WP15, for use in a video-signal generator which permits the telecasting of individual station call letters, test patterns, or picture material from interchangeable film slides or opaque material, has been developed by the RCA tube department.

Tube is 5" in diameter. It is a source of intense actinic energy for scanning slides or opaque material.

A new phosphor is used in the tube. The phosphor which has a metallized back to double the effectiveness of the flying spot, emits very strongly in the near-ultra-violet region of the spectrum. In addition, the ultra-violet radiation has extremely short persistence, reducing to a single network the amount of equalization needed to minimize blurring or *trailing* in the reproduced picture.

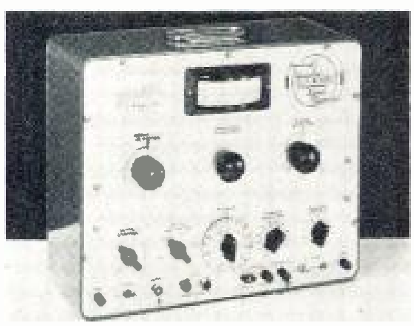
* * *

HICKOK TV ALIGNMENT GENERATOR

A tv alignment generator, model 610, has been developed by The Hickok Electrical Instrument Company, 10521 Dupont Avenue, Cleveland 8, Ohio.

Unit permits alignment on any of the 13 tv channels from 44 to 216 mc, alignment of all traps with a calibrated signal—modulated or unmodulated, and insertion of an accurate marker at any point along the i-f response curve.

Other features include facilities for aligning i-f or r-f sections by single stage method, aligning of tv receiver independent of any local tv station, and aligning of channels 5 through 13 directly by calibrated f-m oscillator. Instrument also provides a crystal-controlled frequency, modulated or unmodulated, from 1 to 216 mc.

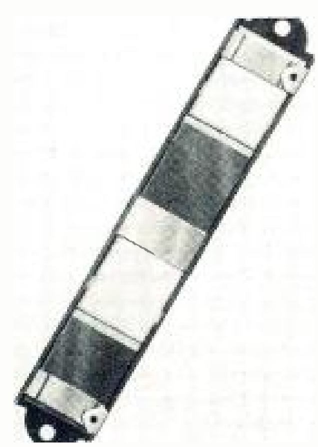


* * *

KOTRON SELENIUM RECTIFIER

Kotron half-wave selenium rectifiers, in 75, 100 and 200-ma units, have been announced by Standard Arcturus Corporation, Kotron Division, 54 Clark Street, Newark 4, N. J.

Rectifier is constructed flat, all the elements mounted in one plane.



STEPHENS MICROPHONE

A *Tru-Sonic Phase Modulated* microphone, type C-1, has been developed by Stephens Manufacturing Corporation, 10416 National Blvd., Los Angeles 34, Calif.

Microphone is said to employ the principle of *carrier frequency phase modulation.*

The pickup assembly is ovoid in shape and 1" x 1¼". Features of the microphone are said to be true and absolute linearity of response, pressure-operated at all frequencies, polar pattern at all frequencies, and almost completely one-half sphere -down 5 db at 90° off the axis.

* * *

LANGEVIN 8-WATT AMPLIFIER

An 8-watt dual channel amplifier has been announced by the Langevin Mfg. Corp., 37 W. 65th Street, New York 23, N. Y.

Has two low-gain high-impedance input channels. Three sockets in each of the two-input channels permit the use of various combinations of plug-in, equalizers, transformers and voice filters.

Unit can be used with crystal pickup or high impedance tuner; crystal microphone; G.E., Pickering pickup or equivalent; low-impedance microphone or phono reproducer; or 150/600-ohm line.

Has two volume controls, one for each channel.

* * *

KINGS MINIATURE CONNECTORS

Miniature connectors, handling up to 50 watts of r-f power and requiring no soldering of braid wires or inner connector when used with co-axial connector cable, have been announced by Kings Electronics Co., Inc., 372 Classon Avenue, Brooklyn 5, N. Y.

* * *

MILLEN SINGLE-SIDEBAND SELECTOR

A single-sideband selector, 92105, made under an exclusive patent license from the McLaughlin Research Laboratories of LaJolla, California, has been announced by the James Millen Mfg. Co., Inc., Malden, Mass.

Utilizes two crystals, four tubes complete with their own power supply, r-f and a-f gain controls, and telephone type lever switch for shifting between upper and lower side bands.

Bendix REGULATED DYNAMOTORS

MAKE A BIG DIFFERENCE IN RELIABILITY . . . ECONOMY . . . WEIGHT

Under the most severe conditions in which your electronic installations are expected to operate, Bendix* regulated dynamotors will deliver dependable, uniform voltage. You can count on them to last longer, too, because they are manufactured with the same painstaking care which has made Bendix Aviation equipment famous for quality all over the world. Before you design, write our engineering department for detailed information on Bendix regulated dynamotors.

- Output voltage constant within plus or minus 2.5% at rated load, with as much as 30% input voltage variation.
- Consistent efficiency of associated equipment under extremes of temperature, humidity, altitude and vibration.
- Allows the use of smaller, lighter, less expensive components in design of electronic equipment.
- Tube life materially lengthened due to narrow voltage tolerances.

Dynamotors · Inverters · Convertors · D.C. Motors · Carbon Pile Voltage Regulators

RED BANK DIVISION of Bendix AVIATION CORPORATION
RED BANK, N. J.

*TRADEMARK

TV Transmitter

(*Continued from page* 15)

constant should be at least $10T$, i.e.,

$$RC \geqq 10T$$

Where: T = the television picture field interval

Wave shapes non-symmetrical in character establish their a-c reference axis at the level about which the area above the axis is equal to the area below it. Figure 9 shows various wave shapes and the manner in which equal areas are established about the zero a-c reference axis.

•

Police F-M

(*Continued from page* 22)

single *hat-pin* antenna is used on the mobile units for transmission and reception. An ingenious line-matching and stub-filter network is used between the mobile transmitter and receiver.

In operation these stubs create open circuits so that outgoing transmission signals follow only the closed circuit path to the antenna and cannot cross over into the receiver. In reception the reverse is true; the signals coming from the antenna find an open circuit to the transmitter and follow only the closed circuit path to the receiver.

A duplicate setup is used as insurance against breakdowns. Two complete central stations are housed under the dome of City Hall, with a set of relay circuits cross-linking the various receivers and transmitters. It is possible to select any one of them for operation by remote control from the broadcast booth. If a unit breaks down, a flip of the switch activates another.

This *double* system also includes the remote control console in the broadcast booth. A standard upright central station cabinet has been equipped with two complete remote controls, and interconnected to provide switching of the pre-amp and line-amp units in case of a breakdown.

The antenna installation is on the City Hall dome, 547′ above sea level. Because of the unusually high-noise level in the downtown area, talk-back signals are picked up on receivers located on a hill approximately 470′ above sea level, and about four miles northwest of City Hall. From the hill talk-back is carried by telephone wires to the broadcast booth. An auxiliary transmitter to cover emergencies is now being installed in the transmitter station on this hill.

F-M Frequency Checks

(*Continued from page* 18)

on the screen of the 'scope indicating a 1:1 frequency ratio. The setting of the audio oscillator tuning dial will now indicate the frequency deviation. Where sub-harmonics are being measured, the deviation indicated by the audio signal generator is multiplied by the number of the sub-harmonic to determine the deviation at the final frequency. For example, if the signal measured is 1/10 the final frequency the measured deviation should be multiplied by 10 to determine the final frequency shift.

To determine whether the transmitter frequency is high or low, the standard frequency is shifted in a known direction and whether the frequency difference with the transmitter increases or decreases is noted.

Throughout the measurements, *the zero-beat between the standard and WWV must be maintained carefully.*

During transmitter measurements, the audio input to the transmitter should be short-circuited so that no modulation occurs. The short-circuit is recommended because any random noise modulating the transmitter, whether audible or not, will make a distinct beat note impossible.

If the measurements are made in the close vicinity of the transmitter, difficulty may be had in reducing the signal pickup to such a value as to obtain a satisfactory beat. It was found when making the measurements in a strong signal field, considerable signal was introduced into the receiver through the speaker and power cords. At the KOCY-FM transmitter measurements could be made in the near vicinity of the transmitter only if the exciter was operated without the final amplifiers.

Frequency monitor crystals can be checked in a similar manner as that described for the transmitter. Normally a loop of wire placed near the monitor oscillator tube will pick up sufficient signal to obtain a beat. In the case of one monitor,[4] the 5,400-kc calibrate crystal can be checked very easily by direct comparison to 100-kc harmonics. The *running* crystal usually has such an odd fundamental frequency that it is best to check it at its final frequency (transmitter frequency plus 5,400 kc). Of course, when adjusting or measuring the transmitter frequency, an indirect check is made on the monitor. Therefore the one measurement will generally be sufficient.

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[3]Hallicrafters SX-42
[4]G.E.

News Briefs

INDUSTRY ACTIVITIES

Plans for professional groups within the IRE were announced recently.

Groups whose organizations are now being actively promoted include an audio, video and acoustic group, and one for the broadcast engineering field.

Two types of groups are visualized under the new system: vertical, illustrated by the broadcast engineering group, horizontal, as in the audio, video and acoustic group.

Each group will elect its own chairman, vice chairman, and executive committee.

Gray Research and Development Company, 16 Arbor Street, Hartford, Conn., has opened a sales office at 565 Fifth Avenue, New York City.

The Emeloid Company, Inc., is now at its new plant at Hillside, N. J., a suburb of Newark.

WSBA-FM, York, Pa., has increased its transmitter output to 10 kw by adding an RCA grounded-grid amplifier unit, employing two 7C24s in parallel.

The station uses a two-section pylon transmitting antenna, radiating an effective output power of 20 kw.

A preliminary RMA committee on problems of industry mobilization and military production was recently appointed by Max F. Balcom, RMA president.

Fred R. Lack, vice president of Western Electric, was named chairman of the new RMA government liaison committee. Other members of the committee, are Frank M. Folsom, executive vice president of the RCA Victor Division, and W. A. MacDonald, president of Hazeltine Electronics Corp.

KDTH-FM, Dubuque, Iowa, is now installing a 10-kw W.E. f-m transmitter and an 8-bay cloverleaf antenna on top of one of the bluffs along the Mississippi River. Effective radiated power will be 40 kw.

The Fairmount Park Commission in Philadelphia is equipping the motor vehicles of the park guard with 22 two-way Philco mobile radiotelephones.

Equipment includes a transmitter-receiver, microphone, control unit and antenna.

PERSONALS

P. B. Reed and C. A. LaHar have been appointed field sales administrators in the Eastern and Western regions, of the RCA engineering products department. Reed will make his headquarters in Camden, while LaHar will maintain an office at 621 S. Hope Street, Los Angeles.

Dr. Robert A. Millikan, retired director of the California Institute of Technology, and winner of the Nobel Prize for Physics in 1923, will address the IRE West Coast convention, which will be held on Sept. 30, Oct. 1 and 2, at the Biltmore Hotel in Los Angeles.

Lt. Commander R. E. Trapeur (U.S. Navy, retired), has joined FTR as sales representative in northern California.

Richard Reimer has also joined FTR as representative in southern California.

James Edward Everett has been appointed Measurements Corp. sales representative for the States of Illinois, Indiana and Wisconsin.

Everett's office will be at 615 Davis Street, Evanston, Illinois.

J. E. Everett

James J. Tynan has been named sales manager of the commercial products division of Raytheon. Kenneth V. Curtis has been named product manager. William A. Gray continues as assistant sales manager.

Melville Eastham, chief engineer and former president (1915-1944) of the General Radio Company, received the 1948 New England Award, at the annual meeting of the Engineering Societies of New England, at Boston.

M. Eastham

Marcus A. Acheson is now chief engineer for the radio tube division of Sylvania Electric Products Inc. Acheson was formerly manager of the advanced development department of the Sylvania Central Engineering Laboratories at Kew Gardens, N. Y.

Raymond K. McClintock has become assistant to Acheson. McClintock was formerly engineering manager for Sylvania's international division.

Irving Rose, who was president of Remco Electronic. Inc., New York City, died recently.

Charles F. Stromeyer, vice president of the Hytron Radio and Electronics Corporation of Salem, Massachusetts, has become president of Remco. William W. Roberts, chief engineer, will continue as vice president.

LITERATURE

Allied Control Company, Inc., 2 East End Avenue, New York 21, N. Y. have prepared a relay guide.

Data presented include maximum contact arrangements; contact rating current, d-c and a-c; coil operation, a-c and d-c; coil data in volt amperes a-c or watts d-c; maximum d-c ohms of standard coils; maximum rated volts of standard coils; dimensions, including length, width and height; weight in ounces.

Sorensen & Company, Inc., Stamford, Connecticut, have released a 20-page catalog describing electronic control of voltage and current.

A *key chart* which permits a basic regulator to be modified to fit an unusual set of conditions appears in the catalog.

Catalog also contains photographs of applications, circuit diagrams, efficiency and performance curves.

The Industrial Photographic Division, Eastman Kodak Company, Rochester 4, New York, have released a 4-page catalog describing Kodak Imagraph films and papers for use in instrument recording.

The booklet describes 11 films and papers used to record oscillograph traces and similar phenomena. Complete information is given regarding speed, contrast, color sensitivity, etc.

P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., have prepared a 80-page **manufacturer's catalog, Number 1**, which covers the Mallory line of capacitors, contacts, rectifiers, resistors, switches, vibrators, welding tips and holders, special metals and alloys, as well as their line of special metallurgical products.

Hazard Insulated Wire Works, division of the Okonite Co., Wilkes-Barre, Pa., have prepared a 48-page building wire guide, with data on insulations, wires and cables, splicing tapes and insulating finishes.

Engineering tables on characteristics of stranded and solid copper wire, current carrying capacities, temperature conversion, etc., are also offered.

Lenkurt Electric Co., 1124 County Road, San Carlos, California, have prepared a 24-page booklet, **Trancors by Lenkurt** describing their line of molded magnetic cores, core assemblies, coil assemblies, and filters.

Discussed are properties of powders; mechanical considerations related to the parts; performance notes on finished units; and frequency, permeability, Q, and temperature stability characteristics of the three standard powders listed.

Audak Tuned-Ribbon Pickup

The tuned ribbon reproducer, Audak's model 79-G, described in the *New Products* column of April COMMUNICATIONS was specifically designed for use in Garrard record changers.

Receiving Antennas

(Continued from page 27)

height, H. The ratio V/e, receiver input voltage to r-f field strength, can be considered as a measure of the efficiency of an installation.

Performance Graphs

The antenna performance curves of Figure 3 were calculated by equation (*3*). The graphs give the voltage delivered to a receiver by the indicated antennas, as a function of leadin and receiver-input capacity, in the presence of a ½ millivolt/meter r-f field. The curves are for antennas having a vertical height of one foot, but the abscissa can be multiplied by the antenna height in feet to obtain approximate answers for antennas with heights of other than one foot. Equation (*3*) should be used where greater precision is desired.

Figure 4 gives the capacity of wire *T* antennas, calculated from equations (*129*) and (*134*), section 2, paragraph 31 of *Radio Engineers' Handbook* (First Edition) by F. E. Terman. In some instances, such as on aircraft, flat, horizontal metal plates may be used to advantage as top-loading elements; however, it is rather difficult to calculate capacity curves for them because their capacity depends on the shape, as well as the area, of the plates. From the standpoint of capacity/area, long narrow top-leading elements are the most effective. The use of flat, vertical top loading sheets is not generally recommended as it is desirable to concentrate the top-loading capacity at the top of the antenna structure.

Practical Applications

The following information should be obtained before an antenna design is attempted:

(*1*)—The field strength of the weakest signal it is desired to receive. A value of ½ millivolt/meter is considered by the FCC as the minimum useful signal from standard broadcast stations.

(*2*)—Receiver sensitivity, expressed as the minimum r-f input voltage required at the antenna terminals to produce satisfactory receiver output.

(*3*)—Receiver input capacity, which can be estimated from an inspection of the mechanical layout of the receiver, or measured on a Q meter with the receiver tuned to the Q meter frequency.

(*4*)—Leadin capacity. This is the capacity-to-ground of the leadin wire from the input terminals of the receiver to the base of the antenna. Open-wire lead-in capacity can be determined from Fig. 76, section 2, paragraph 31 of Terman's *Radio Engineers' Handbook* (First Edition). A value of about 5 mmfd/foot is obtained with #18 wire, ½" off a metal surface.

Sample Computation

As an example, suppose in an antenna for an aircraft radio-range receiver, (*1*) it is desired to receive ½ millivolt/meter signals, (*2*) an input voltage of 25 microvolts is required for the receiver, (*3*) the receiver input capacity is 25 mmfd, and (*4*) the leadin length is five feet of open wire having a total capacity of 25 mmfd.

It will be noted that the combined leadin and receiver-input capacity is 50 mmfd, and that 25 microvolts are required to operate the receiver satisfactorily. Figure 3 shows that a wire *T* antenna one-foot high requires a four-foot horizontal section to deliver 25 microvolts to the receiver. The rough estimate made from Figure 3, by multiplying the abscissa by ½, will show that an antenna ½-foot high with a 12-foot horizontal section will also do the job.

A more precise prediction can be made for the ½-foot antenna by use of equation (*3*). From Figure 4 it will be noted that the total capacity of a ½ by 10-foot wire *T* has a capacity of 28 mmfd and that the capacities of the vertical and horizontal sections are 2 and 26 mmfd, respectively. By equation (*3*) the voltage delivered to the receiver is

$$V = [(28 + 26)/(2)(28 + 50)] (½)(.305)(½) = 0.026 \text{ millivolts}$$

which is sufficient for the receiver.

Broadcast Reception

It seems to be the general consensus that a long wire stretched out in a random manner is a good broadcast receiving antenna. On the other hand, a consideration of equation (*3*) and antenna theory indicates that a vertical wire of the maximum practical height will give optimum results. A simple experimental check will prove the theory. If a broadcast receiver with an output indicator is set up in an open area and connected to a ten-foot wire antenna, it will be found that much more voltage is delivered to the receiver when the wire is stretched vertically than when the same wire runs horizontally. It requires only a little careful experimentation to confirm that best broadcast reception is obtained with antenna having the maximum possible vertical height and capacity concentrated at its top. Attention is called to the fact that many so-called all-wave *noise-reducing* antenna systems actually provide little noise reduction in the broadcast band where what is supposed to be the leadin actually functions as the antenna, top loaded by a short-wave doublet.

Test Instruments

(*Continued from page 23*)

our three-tower phasing unit and recording them so that future checks can be made.

(*3*) Initially tuning the r-f amplifier[2] of our transmitter. These values are also recorded.

(*4*) Measuring accurately the *R* and *L* of our composite dummy load.

(*5*) Checking *Q* of capacitors in stock.

(*6*) Measuring any unknown in terms of X_L, X_C and *R* within the limits of the bridge.

The Decade Resistance Box

The resistor box can be secured in almost any combination of variable losses desired. The most common one is a three-decade box having three potentiometers, the first giving a total resistance of 1 ohm in steps of .1 ohm. The second has a total resistance of 10 ohms in steps of 1 ohm, and the third a total of 100 ohms in steps of 10 ohms. To increase the range of the box, another decade can be added so that the total *R* available would be over 1,100 ohms in steps of .1 ohm.

The improved-type decade boxes are designed to be used with r-f in the broadcast band, i.e., there is a negligible amount of inductance in the windings.

We have found three uses for the decade resistance box:

(*1*) Measurement of antenna resistance (substitution method).

(*2*) Use as a standard.

(*3*) Application as the *known* arm on a bridge.

Field Strength Meter

The field intensity meter[3] we use covers a range of 200 to 7,000 kc, using four different electrostatically-shielded loop antennas. The loop for 530 to 1,600 kc is in the top cover of the instrument, a small toggle switch being used to select the lower portion or the upper portion of the standard broadcasting band.

Measurements can be made on signals as low as 20 microvolts per meter or as high as 10 volts per meter.

Facilities are provided for operating an external 5-ma recording milliammeter.

It is possible to operate the set from batteries mounted within the unit, but

[2]Doherty circuit.
[3]Federal 101C

it is usually operated from a six-volt storage battery. A vibrator type power supply provides the plate voltage.

In application, the radiated field to be measured is tuned in on the shielded loop antenna and noted.

The amplitude of the unknown voltage is determined by comparison to a signal of the same frequency and known voltage, which is also introduced into the loop.

A superhet receiver, which serves as a means of comparison, is used in conjunction with a calibrated attenuator.

The following formula is used to determine the strength of the received signal in microvolts per meter:

$$e = \frac{K\,A\,M}{f}$$

Where:

e = Microvolts per meter

K = A constant found in table of instruction book

A = Attenuator setting

M = Output meter reading in microamperes

f = Frequency of received signal in kc

The field intensity meter is used to determine the strength in exact figures of a given radiated signal. Thus after a series of readings is made, the total area of a radio station's primary coverage may be plotted and measured with a planimeter to obtain the final figure in square miles.

The radiation efficiency of a given antenna may be found by measurements with this meter and with the use of charts and tables. The general efficiency of an antenna system is gauged by millivolts per meter, per kilowatt, unattenuated, at one mile. The rules and regulations set forth the figure of 265 to be an antenna of practically perfect radiating characteristics.

There are two stations, to our knowledge, that have exceeded this figure: WLW and WISH.

Here at WIS the figure is 199. (Our antenna height is .204 wavelength which is below the optimum of .625 λ).

Test Equipment Rock

The test equipment rack shown in the photos was constructed of ¾" angle iron for the supporting corner legs and ½" angle iron for the framing of the five shelves. All shelves are 20" x 28" and made of ⅜" plywood; they are spaced 16" apart except for the bottom shelf, this being 12". The whole frame is all-weld construction and was made locally at a cost of $19.00. The frame is painted black, the shelves medium gray.

Secondary Studio

(*Continued from page* 11)

the operator, and turntable *2* is to the left of the operator.

Microphones, Pickups, And Turntables

At present two dynamic microphones[3] are in use. A velocity (ribbon) microphone is on order, and will be used for certain program applications. Several types of microphone stands are kept available for use in different program applications.

Two turntables[4] are employed, while the pickup arms are tuned-ribbon type.[5] The output level of the pickups is considerably greater than that of the microphones. This caused some difficulty, because with the master gain on the amplifier set sufficiently high for microphone operation, the output level of the pickups was so high that records could not be faded down smoothly with the individual faders used on the remote amplifier. This difficulty was overcome by placing a 250-ohm constant impedance *T* pad in each turntable line to lower the output level of the pickups.

Switching Arrangement

The switches employed are of the lever action, anti-capacity type. S_1 and S_2 are associated with the two microphones, the *up* position being monitor (auditioning or cueing), the *down* position being program. Placing S_1 or S_2 in either monitor or program position opens the line to the studio speaker, so that there's no possibility of feedback. When the studio speaker line is opened a 1,000-ohm resistor is placed across the monitor amplifier output, thus keeping a correct impedance match. Using this switching arrangement for cutting the speaker, when microphones are in operation, eliminates the expense of installing a relay system. S_3 and S_4 tied in to the two turntables, in the same manner as S_1 and S_2 are employed with the microphones, except, of course, that S_3 and S_4 do not cut the studio speaker line when placed in monitor or program positions. S_5, as previously mentioned, provides a choice of using mike *2* or turntable *2*. S_6 is a *program out* switch, which merely opens or closes the remote-amplifier output circuit to the telephone line. Terminal strips[6] were used as a means of conveniently

[3] Electro-Voice 635
[4] Rek-O-Kut
[5] Audax 74A

connecting the various leads going to the turntables, mikes, switches, etc.

Monitor Amplifier

A 14-watt p-a amplifier[6] was chosen as the monitoring amplifier. This particular amplifier has two separate input channels, one microphone and one phonograph, each having its own gain control. The mike input channel is employed for monitoring and cueing purposes, while the phono channel is connected across the telephone line going to the main studios. The phono channel thus serves to monitor programs originating in the LaPorte studios as well as programs originating in the Michigan City studios, since the line is cued at all times at the main studios, when the Michigan City studios are in operation. A matching transformer is used ahead of the microphone (cueing) channel of the amplifier to effect an impedance match from the 250-ohm mikes and turntables to the high-impedance amplifier input. No matching transformer is used on the phono channel. Being a high resistance unit, bridging it across the phone line does not affect the phone line characteristics, and the gain and quality of the amplifier are satisfactory, even though there is an impedance mismatch.

The monitor output is fed to two monitoring speakers; the 500-ohm tap on the monitor output transformer was used, and associated with each speaker is a line to voice-coil matching transformer, and an 8-ohm T pad for varying each speaker's volume separately. An 8" p-m,[8] mounted in wall baffle, is used as a lobby speaker.

Installation Comments

Some hum difficulties were experienced in the original installation. However, proper placement of a-c lines, and common grounding of all the equipment, brought the hum down to a very low level. The frames of the lever action switches were grounded to eliminate hand capacity effects. While the power supply for the remote amplifier is well shielded, it was found that it must be kept some distance away from the desk microphone to completely eliminate hum pickup from this source.

This installation has definitely increased our listening audience, since we can now give adequate service to schools, religious organizations, local news coverage, and the like, in both Michigan City and LaPorte.

[6]Jones
[7]Knight
[8]Jensen

MASTER AUDIO SYSTEM

Center section of the master audio control setup being built for WHN. Equipment with six studio-control consoles and twelve audio racks will be installed in the new WHN studios at 711 Fifth Avenue, New York City. At the controls are H. J. Lavery (left) and J. F. Palmquist of the RCA broadcast audio section.

TV TRANSMITTER INSPECTION

J. Leonard Reinsch, kneeling (left), managing director of the James M. Cox radio stations, and chief engineers of three Cox stations inspecting one of the three RCA 5-kw tv transmitters purchased for each of the Cox stations. Left to right: E. L. Adams, WHIO, The Miami Broadcasting Company, Dayton; C. F. Daugherty, WSB, The Atlanta Journal, Atlanta; P. G. Walters, of RCA's Atlanta office; M. C. Scott, WIOD, The Isle of Dreams Broadcasting Corp., Miami; Reinsch; and M. A. Trainer, manager of RCA Television Equipment Sales.

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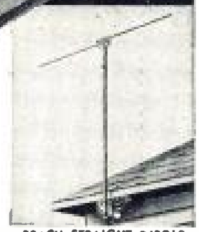

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Accessory Reflector Kit—For FM #334-R
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BRACH FOLDED DIPOLE
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FOR TV #337 44-88 MC
Accessory Reflector Kit—For FM #335-R
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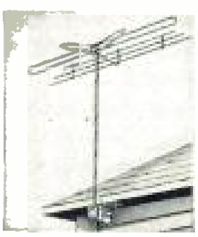

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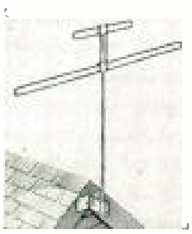

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COMMUNICATIONS INDEX

MAY, 1948

TO MEASURE

- RESISTANCE
- INDUCTANCE
- CAPACITANCE
- STORAGE FACTOR
- DISSIPATION FACTOR

IN

ANY LABORATORY

COMPLETELY self-contained, portable and always set-up for immediate use, this impedance bridge is indispensable in any laboratory where electrical equipment is used. No hastily putting together a circuit, finding an oscillator and a detector and then a power supply . . . they are all here permanently assembled in an accurate instrument . . . always ready to use at any time.

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STORAGE FACTOR (X/R): .02 to 1000
DISSIPATION FACTOR (R/X): .002 to 1

The bridge includes built-in standards, batteries, a 1000-cycle tone source for a-c measurements, a zero-center galvanometer d-c null detector, and terminals for a headset for 1000-cycle detection. Provision is made for use of an external generator for measurements over a wide range from a few cycles to 10 kilocycles. Direct-reading dials add greatly to the ease and rapidity with which measurements can be made.

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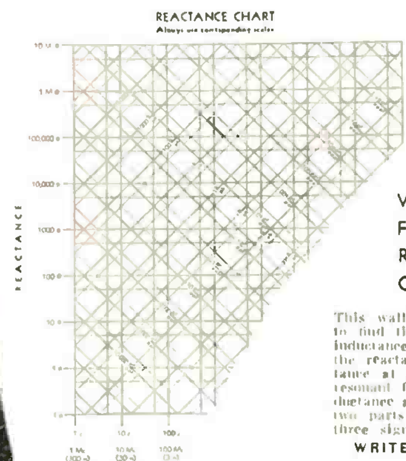

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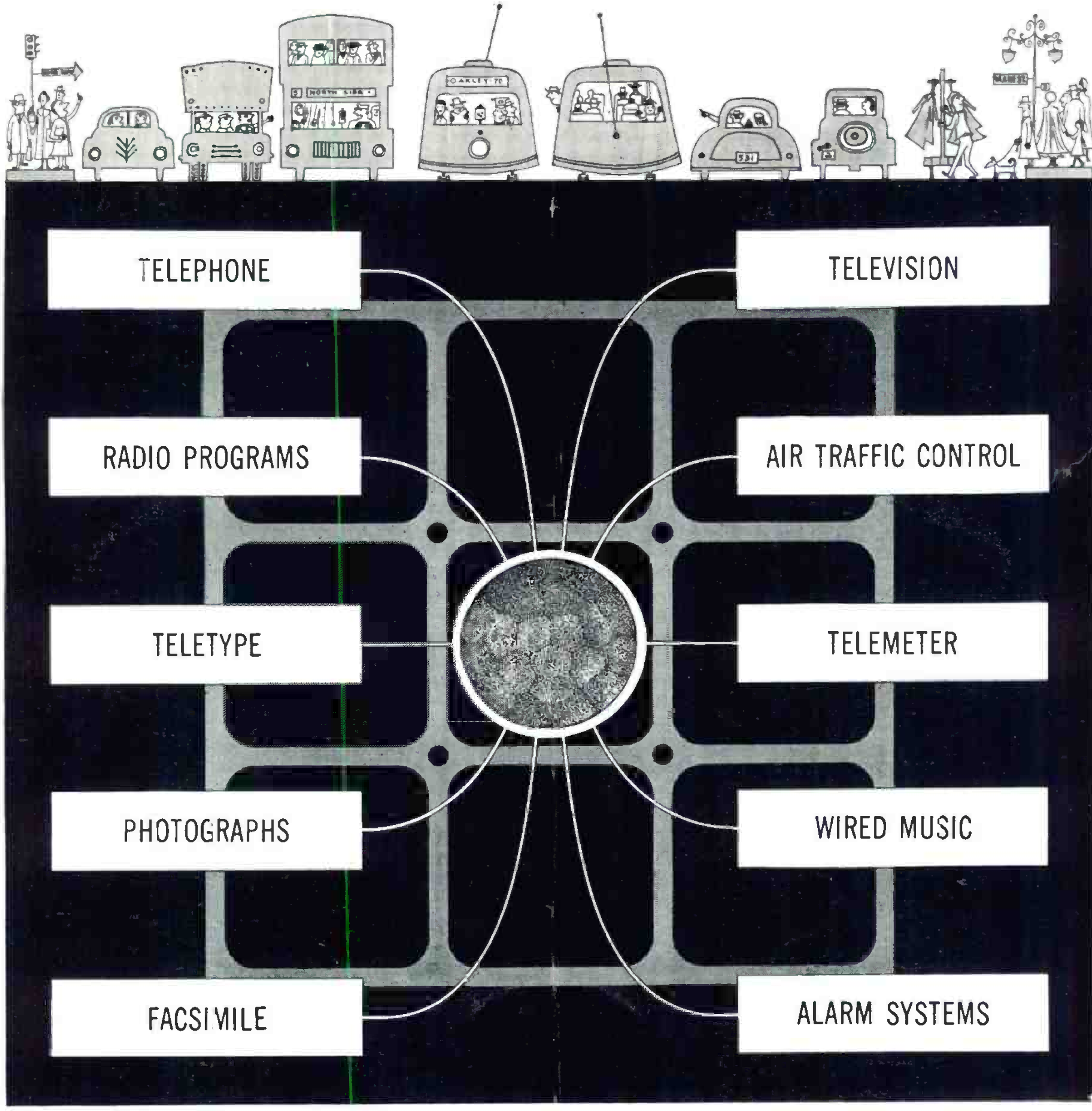
Each one of these presents its own problems to Bell Laboratories scientists and engineers: for the telephone differs from television, and television differs from a radio program. And yet they have an essential unity: they involve transmission of alternating currents, with frequencies from zero up to several million cycles. Each calls for new thinking, new ideas, new goals of accomplishment.

The diversity of the cable's many services speaks for the unity of Bell Laboratories' purpose. That is, to know the theory of communication so thoroughly, to practice the art so skilfully, that any transmission of sight or sound can reach its destination clearly, quickly, economically.



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