# COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"

APRIL

★ CAA V-H-F OMNIDIRECTIONAL RANGE
★ PHASING OF REMOTE TELEVISION SIGNALS
★ REPORT ON THE 1948 IRE NATIONAL CONVENTION

1948

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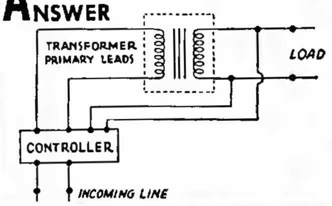
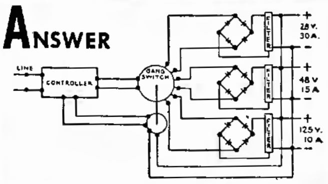


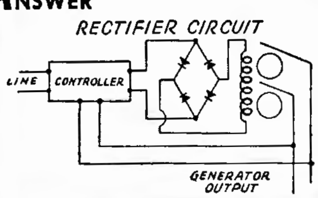

**Q.** Can you selectively regulate a number of DC voltages and currents?

**ANSWER**




**Q.** Can the CONTROLLER stabilize a generator field to regulate its output?

**ANSWER**

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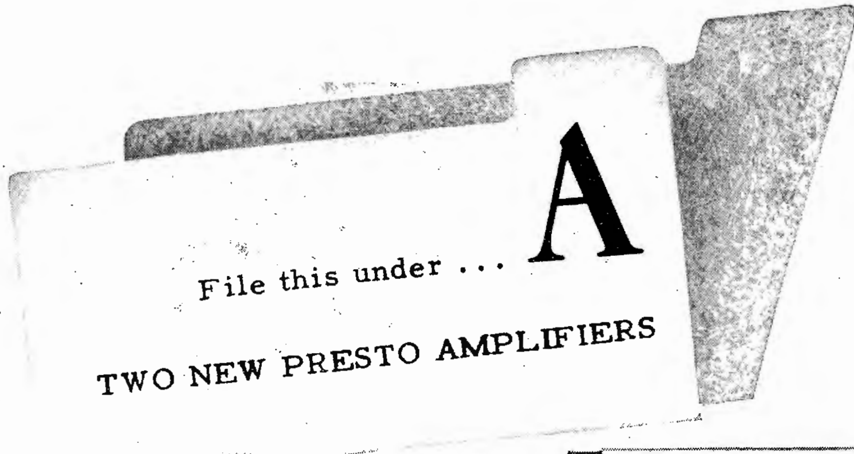


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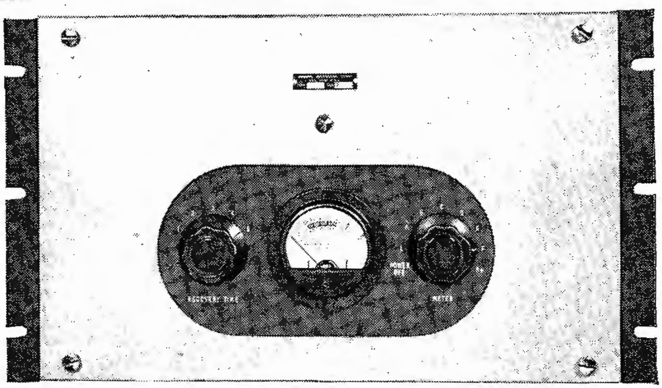

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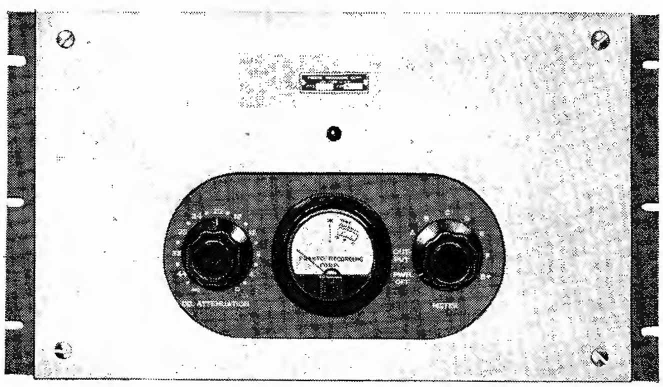

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**APRIL, 1948** **VOLUME 28** **NUMBER 4**

# COMMUNICATIONS

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



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## COVER ILLUSTRATION

V-h-f antenna installation on the smoke stack of the Philadelphia Fire Boat Rudolph Blankenburg. Boat is equipped with two-way duplex f-m system similar to that used by the Philadelphia Police Department.

*(Courtesy Motorola)*





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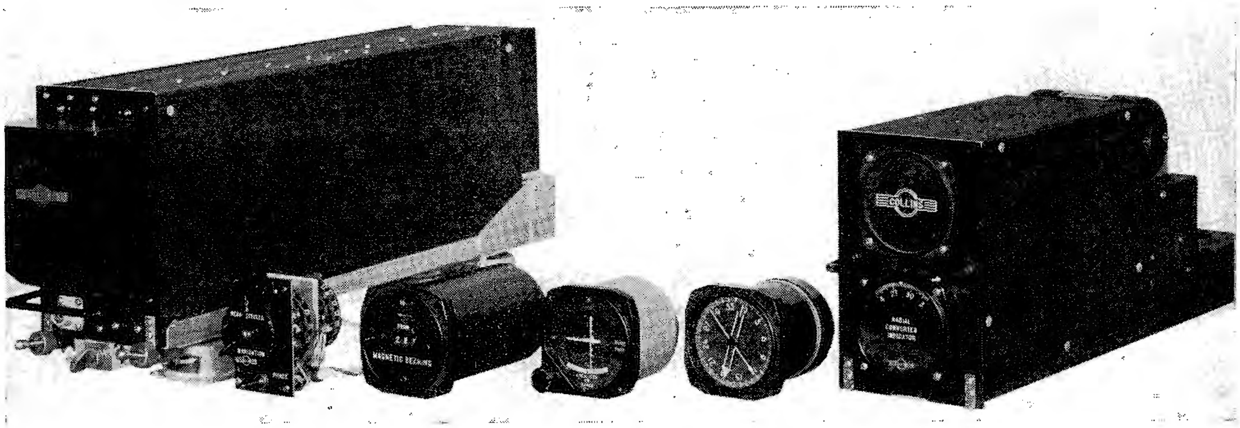



**Figure 4**

Left to right: VOR receiver, frequency selector, radial selector, deviation indicator, radio magnetic indicator and accessory unit with radial converter indicator.

to permit the use of 90/150-cycle tone or phase-comparison localizer stations.

(*3*)—*Radial selector* capable of being manually set to any desired angular reading from 0° to 359°. This instrument also includes a pointer which indicates the radial *to* or *from* the *VOR* station. A shutter-type switch is provided which automatically gives the reciprocal bearing when desired.

(*4*)—*Course deviation indicator,* which incorporates a vertical pointer indicating left or right deviation from the selected radial. A flag alarm indicator also warns of loss of signal or equipment failure.

(*5*)—*Radial converter indicator* which combines information from a remote-indicating magnetic compass with *VOR* station information to give a heading sensitive reading of the actual bearing to the station. This instrument need not be seen by the pilot and is normally installed in the accessory unit.

(*6*)—*Radio magnetic indicator,* which includes a rotatable card scale driven by the magnetic compass and a pointer driven by the radial converter indicator.

(*7*)—*Accessory unit,* in which are combined the radial converter indicator, servo amplifier for the radio magnetic indicator and dynamotor power supply.

A single basic-aircraft *VOR* installation requires a receiver, radial selector, deviation indicator, frequency selector, and power supply. The indication given by this minimum basic installation is not aircraft heading sensitive, but shows only the radial on which the aircraft is flying to or from the *VOR* station, regardless of the heading of the plane. The full instrumentation version requires the addition of the radial converter indicator, radio magnetic indicator, and servo amplifier. It is also essential that a source of magnetic information, such as a gyrosyn or fluxgate compass, be available to drive the magnetic scale card of the *RMI*. The type of indication obtained with the full instrumentation version is very similar to that obtained with present *ADF* installations, since the *RMI* needle points to the *VOR* station regardless of aircraft heading and therefore gives, in effect, a v-h-f *ADF,* which has so long been sought.

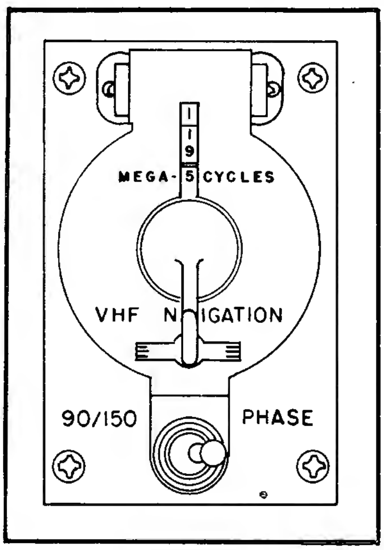
In the basic installation, only three operations are necessary:

(*1*)—Select the desired *VOR* station frequency;

(*2*)—Adjust the radial selector to the desired radial; and

(*3*)—Fly the deviation indicator for zero right-left deflection.

**Figure 3**
Frequency selector.




For full instrumentation, no additional operations by the pilot are required to obtain the *ADF* type of presentation.

The total weight of units required for a basic installation is approximately 45 pounds, exclusive of plane wiring. The full instrumentation feature adds approximately 10 pounds per installation, exclusive of the gyrosyn or fluxgate units which are normally installed in large aircraft.

The airborne navigation receiver includes the following facilities in addition to those required for *VOR* operation:

(*1*)—Provision for use of present (90/150 cycle) tone localizer facilities;

(*2*)—Provision for use of phase comparison localizers if this type eventually replaces tone localizers;

(*3*)—Provision for reception of approach control communications transmitted by simultaneous voice on either localizer or *VOR* stations;

(*4*)—Provision for reception of voice communications from control towers; and

(*5*)—Provision for auxiliary reception of airline VHF ground stations.

The *VOR* system will eventually replace the present low-frequency four course range over the majority of domestic air routes. However, it is probable that for the next 3 to 5 years, the *VOR* will actually supplement the low-frequency range system by providing parallel airway facilities, new airways, and extensions of existing airways. Incidentally, the new receiver will permit the removal of the military type RC-103 localizer receiver presently used with instrument landing facilities.

The *VOR* system is well suited to the implementation of the ultimate

(*Continued on page* 34)

# A Report On The 1948

## Highlights of Papers Presented by D. E. Norgaard, W. G. Tuller, and John C. O'Brien.

WITH CHANNEL AVAILABILITY becoming a more acute problem daily, there has been an accelerated interest in the development of systems, which will expand the usefulness of the currently assigned channels. This trend was emphasized in several papers presented at the IRE National Convention at the Hotel Commodore and Grand Central Palace. An interesting example was the D. E. Norgaard study on *Selective Sideband Transmission and Reception.*

Mr. Norgaard, who is with G.E., reported that the application of wide band a-f phase-shift networks, disclosed by R. B. Dome, has made it possible to develop a practical and simple single-sideband communications system.

In the Norgaard system, two channels of intelligence can be transmitted as upper and lower sidebands by simultaneous modulation of a r-f carrier with the use of two sets of phase-shift networks similar to those described by Dome. The carrier may be suppressed or attenuated to any desired degree.

The transmitter may be operated to produce a-m, p-m, double sideband with carrier suppressed or attenuated, single-sideband, dual single-sideband, and f-m.

In any of these modes of operation, there appears to be no restriction on the bandwidth of the modulating signal. For example, a bandwidth covering the a-f spectrum from 30 to 15,000 cycles may be used to produce any of the signal types with response uniform to within 0.1 db.

Modulation is accomplished at low level with subsequent r-f amplification to any desired level.

### Norgaard System Receiver

The receiver consists of conventional superhet circuits up to the second detector. The i-f signal is fed into two detector circuits which are also supplied with a locally generated carrier signal which locks automatically with the carrier. The outputs of the two detectors drive a pair of wide-band a-f phase-shift networks similar to those used in the transmitter. The algebraic sum of the signals appearing at the output of these two networks contains the intelligence received on one sideband, while the difference contains intelligence received on the other. These sum and difference signals drive two audio amplifiers for dual-channel operation or a single amplifier may be switched to *listen* to one or the other of the other of the sidebands.

The receiver, in addition to its use for dual channel single-sideband reception, can be used to pick up conventional double sideband signals (a-m or p-m) with exalted carrier detection, double sideband signals (a-m or p-m) using, however, either one of the sidebands, and single sideband signals where the carrier is suppressed or attenuated.

When using either one of the sidebands, it is possible to reject interference existing on either side of the desired signal without impairing the audio bandwidth. This mode of operation also materially improves reception where selective fading is encountered.

The ability of the transmitter to generate single-sideband signals is based on the performance of the a-f phase-shift networks. The unwanted sideband can be made 40 db below the desired sideband with networks of present design.

Similarly, the ability of the receiver to reject unwanted sideband energy depends on the phase-shift networks, a 40 db ratio being practical with simple configurations.

### Bandwidth Reduction

IN ANOTHER BANDWITH PAPER, W. G. Tuller of Melpar, Inc., analyzed a method of *Bandwidth Reduction in Communications Systems.*

He pointed out that there are two possible methods of bandwidth reduction. One of these takes advantage of the coherence of the message or the fact that from a knowledge of the past behavior of the message, it is possible to predict its future behavior with a fair degree of accuracy. In the second method, bandwidth is exchanged for signal-to-noise ratio in accordance with the relation:

$$H = BT \log (1 + S/N)$$

where $H$ is quantity of information; $B$, bandwidth; $T$, time of transmission; and $S/N$, the signal-to-noise ratio in the transmission link.

Tuller indicated that in the first method of bandwidth reduction, if it is possible to predict the content of the message in the future to a greater accuracy than that required, working only on a knowledge of the behavior of the message in the past, then the message contains useless information, information which need not be transmitted. In particular, if one can predict the message for a time equal to the reciprocal of twice the system bandwidth then useless information is contained within the message.

### Eliminating Useless Information

If such a prediction is possible then further operations on the message can be arranged to eliminate the useless information, leaving only that information which could not be deduced by mathematical means. This remaining information, the basic information content of the wave, will then require less bandwidth, power, and time to transmit than the original message.

The signal resulting from this process has the statistical properties of random noise filtered through the band pass of the transmission system; in other words, the message is within the accuracy of transmission, uncorrelated over a period equal to the reciprocal of twice the system bandwidth. A corollary of this statement is that the message has a uniform spectrum, one whose amplitude is essentially independent of frequency over the pass band of the communication system. This technique has already been applied in the use of preemphasis and deemphasis in broadcast systems and in recording.

The technique has interesting possibilities in tv. For it has been recognized that there exist many correlations within the television picture and from picture to picture. Evidence is given by the average spectrum of the television stations which is relatively weak in high-frequency components.

The second method of bandwidth reduction is only applicable when excess signal-to-noise ratio is available. For example, if we wish to halve the bandwidth and can square the signal-to-noise ratio by transmitter improvements or noise-reduction schemes, then it is possible to use techniques analogous to those of pulse code modulation. However, in this instance the coding would be carried out in the inverse direction from that usually employed, that is instead of converting a signal of many possible levels into one of a few, or as in the p-c-m system two possible levels, a system could be converted to allow signal levels into one with even more allowed signal levels. This requirement of many more allowed signal levels implies that either signal will be increased or noise decreased according to the relations of the equation.

Another possible method for trading signal-to-noise ratio for bandwidth makes use of the fact that the output of the filter may be predicted if its input wave form in transient response is known.

### Combined F-M and A-M

ANOTHER UNIQUE WAY of expanding the usefulness of channels was revealed by John C. O'Brien of the General Railway Signal Co., who analyzed *A Combined F-M and A-M Communications System.*

O'Brien showed that the possibility of simultaneously *duplexing* two intelligence channels, one by a-m and the other by f-m, on a r-f carrier, appears in the expression for the instantaneous voltage of such a carrier:

$$e = E_o\ (1 + m_a \sin 2\pi f_A t) \cdot \sin\ (2\pi f_c t + M \sin 2\pi f_F t)$$

Where: $e$ = instantaneous amplitude of modulated carrier

# IRE National Convention

At the press luncheon, during the IRE National Convention in New York City, left to right: T. T. Goldsmith, Jr. (*DuMont*), R. M. Bowie (*Sylvania*), L. J. Chu (*MIT*), E. M. Deloraine (*I. T. & T.*), ye editor, and K. McIlwain (*Hazeltine*).

$E_o$ = maximum amplitude of unmodulated carrier

$m_a$ = degree of amplitude modulation

$f_A$ = frequency of amplitude modulation audio signal

$f_c$ = frequency of unmodulated carrier

$M$ = modulation index ($\frac{\Delta f_c}{f_F}$ for f-m) or ($\Delta\theta$ for p-m).

$f_F$ = frequency of f-m audio signal.

The bandwidth required for satisfactory transmission and reception of the *duplexed* carrier is equal to the sum of the modulation side bands of the same signals modulating two separate carriers, by frequency and amplitude modulation, respecttively.

However, at u-h-f, the frequency drift tolerances, .005% to .01% of the carrier frequency, and the separation guard bands required for adjacent channel operation, equal or exceed the total useful modulation bandwidth. For example, in the 152 to 162-mc mobile communication band, individual channels are 60-kc wide, of which 16 kc represent drift tolerance, and approximately 10 kc more constitute inter-channel separation guard bands. The application of a signal channel, suitable for speech, or for control, telemetering, identification, checking, selective calling, or other similar purposes, by a-m, to a f-m carrier in this band, can be accomplished with approximately 10% increase in channel bandwidth. If a slight reduction in maximum deviation of the f-m carrier can be tolerated, it is possible to obtain additional intelligence channel without exceeding existing r-f channel limits.

Although the susceptibility of a-m transmission to noise, flutter fading, and interfering signals is much greater than that of frequency modulation, O'Brien pointed out that the advantage of an additional intelligence channel should be sufficient in many cases to justify its use, with somewhat inferior performance, at the cost of a small percentage of the channel bandwidth.

### Simplex Problem

Unless the transmissions by both methods are synchronized or widely separated in time, two-way simplex communication will tend to create conflictions. Citing an example, O'Brien said that it would be impossible for a station to receive an f-m signal, while its carrier is transmitting a-m, on the same frequency. However, it is possible that the facility of *break in* provided by an auxiliary a-m transmission channel, will be a worthwhile addition to such a system. Two-frequency duplex operation can, however, make full use of additional speech channels without difficulty. It was pointed out that simultaneous frequency and amplitude modulation of the carrier by two individual audio channels does not introduce any unusually difficult problems. Any reasonably constant-amplitude frequency-modulated signal can be made to drive a class *C* amplifier, and the amplitude modulation desired can be obtained by plate modulation. With reasonably flat-frequency response in the plate tank circuit over the frequency excursions used, very little cross-modulation between the two signals is produced, unless regeneration is present.

O'Brien stated that, unfortunately, in reception, separation and demodulation of the two channels are not so easily accomplished. Although there is some possibility of cross-talk produced by the phase shifts caused by multipath propagation, and the amplitude and phase distortion occurring in highly selective resonant circuits, the principal occasions of intermodulation are the demodulation circuits, which must separate a-m from f-m with minimum distortion.

Several demodulator circuits were investigated by O'Brien. He found the *ratio* discriminator, and *dual* type, employing a constant-current impedance in the common center connection of the Foster-Seeley discriminator, to be the most effective single circuits for eliminating a high percentage of a-m from a f-m carrier. The use of a large bypass capacitor across the normal output terminals of the Foster-Seeley discriminator, appeared to reduce greatly the f-m cross talk in the a-m output impedance in the common center connection.

### Use of Frequency Converter

More complete separation of the two channels was achieved by a frequency converter, driven from the i-f stages ahead of the limiters. In this setup, the injection voltage for the mixer is provided by an oscillator, automatic-frequency-controlled by a reactance modulator tube driven by the audio output of the f-m discriminator. The oscillator frequency is made to follow without time delay the signal frequency deviations, with a constant frequency difference. This difference frequency beat is demodulated in an amplitude demodulator, and led to the output for the a-m channel. This output voltage is also applied, without time delay, as automatic gain control bias to the i-f amplifier which drives the limiter stages, and aids in reducing the percentage of amplitude modulation in the f-m channel output.—L. W.

Also at the IRE press luncheon, left to right: J. R. Weiner (*Eckert-Manchly*), former IRE president W. R. G. Baker (*G.E.*), Clinton B. DeSoto (*IRE*), president-elect B. E. Shackelford (*RCA*), George W. Bailey (*IRE*), Virgil M. Graham (*Sylvania*), Stuart L. Bailey, IRE treasurer (*Jansky & Bailey*), Ralph A. Hackbusch (*Canadian RMA*).

# Phasing of Remote TV Signals

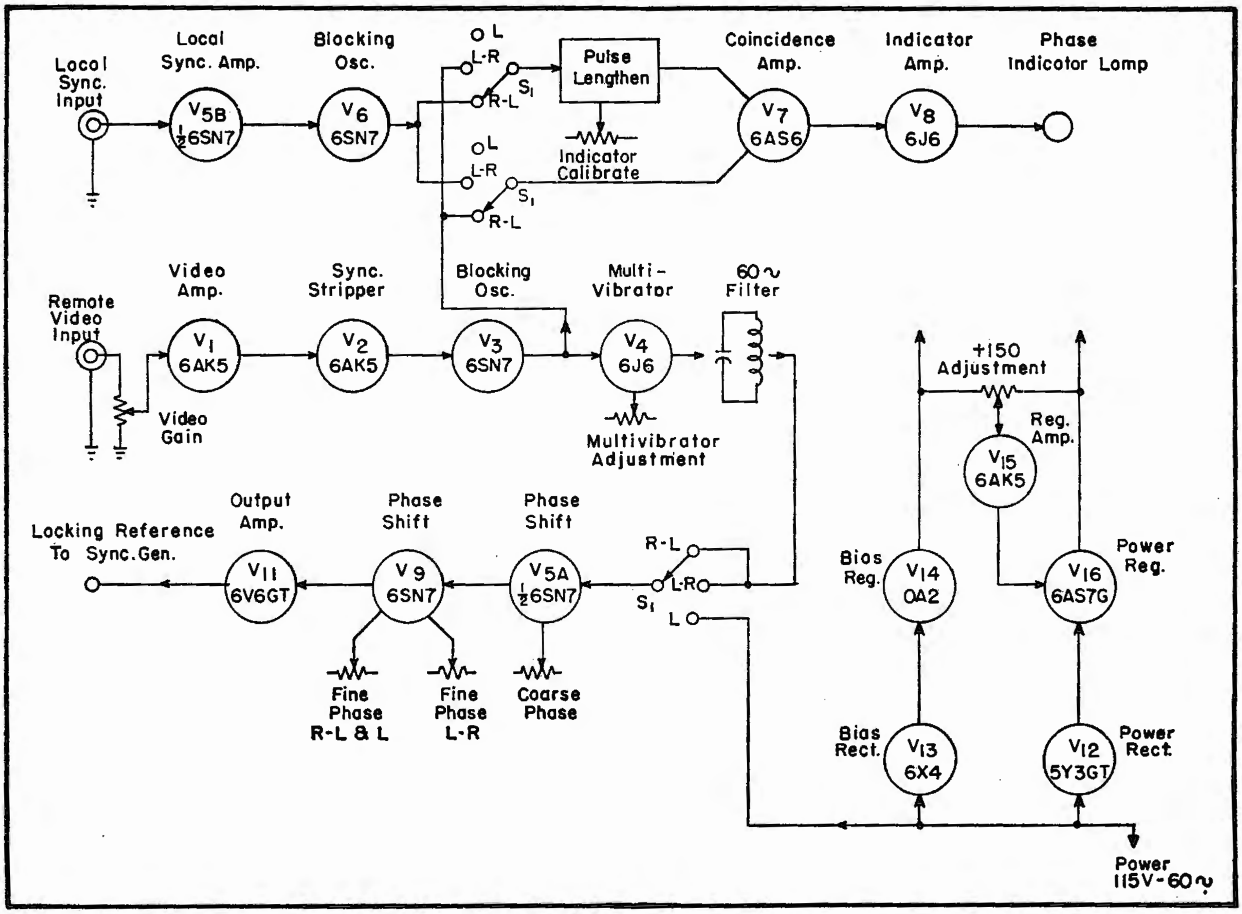



**Figure 1**

Block diagram of the remote sync-phasing unit. $S_1$ is a locking reference switch: L is the local position, L-R, the local-to-remote position, and R-L, remote-to-local position.

Remote pickups have become a very important part of tv programming today. It is customary to originate the remote picture-synchronization signals at the point of pickup and consequently there is the problem[1] of maintaining continuity of vertical sync when the signal is switched between the studio and the remote point. Such switches are demanded by station breaks and sponsored announcements, and during a typical remote, such as a boxing pickup, may occur as often as ten[2] times during the program. The phase problem is also acute in tv-network operation.[a] To secure and maintain phase synchronization between the vertical sync intervals of a remote composite picture signal and studio sync a remote sync-phasing unit[b] was recently developed.

[a]Present operating practice usually allows for fading the picture to black when making a switch so that a *vertical roll* caused by a large phase error between local and remote vertical sync periods will not be visible to the observer. The RMA has proposed[3] limits of 5% leading and 1% lagging for the phase error of succeeding vertical sync intervals, and present tv receivers can easily maintain continuity of vertical sync over this range of phase difference.

[b]DuMont 5056-A.

### Features

In Figure 1 appears a block diagram of the phasing unit.

In this circuit the remote video input signal is amplified by $V_1$, a 6AK5, and applied to a sync stripper, $V_2$, also a 6AK5. The sync stripper is a pentode operated at low screen voltage to in-

## Instrument Designed To Provide Phase Synchronization Between Vertical Sync Intervals of a Remote Composite Picture Signal and Studio Sync. Sine-Wave Output of Approximately 6 Volts RMS in Amplitude Permits Use of Equipment With Current Studio Sync Generators.

**by R. C. PALMER**

**Head, Advanced Development Section**
**Television Transmitter Department**
**Allen B. DuMont Laboratories, Inc.**

sure sharp cutoff, and is self biased by the black positive signal at its grid. The signal input to this stage is of sufficient amplitude so that only the sync portion is included between cutoff and zero bias. Consequently, only negative sync appears at the plate of $V_2$. The vertical sync is separated and applied to a 6SN7, $V_3$, which is a combined trigger-tube and blocking oscillator. The output of $V_3$ is used to trigger a 6J6 multivibrator, $V_4$, whose output circuit includes a 60-cycle resonant filter. $V_4$ thus generates a sine wave at the vertical frequency of the remote sync and with a fixed phase relationship to the vertical sync interval. This sine wave is applied to a phase shifter, $V_{5A}$ (½ of a 6SN7), whose output is applied to two more phase shifter stages in $V_9$, a 6SN5.[c] The output of the phase shifter is applied to a 6V6GT output stage, $V_{11}$, whose plate circuit includes an output transformer which supplies the locking reference to the controlled sync generator.

Negative composite sync from the controlled sync generator is amplified by $V_{5B}$, (½ of a 6SN7). After separation, the vertical sync is used to trigger another 6SN7, $V_6$, a combined trigger-tube and blocking oscillator. Thus a pulse is obtained, occurring at the vertical interval of the controlled sync generator, and of the same shape and relative timing as that generated by $V_3$. These two pulses are applied to a 6AS6 coincidence amplifier, $V_7$. If the two input signals to $V_7$ coincide within the limits proposed by the RMA, a signal applied to $V_8$, a 6J6, lights an indicator.

A self contained power supply furnishes regulated plate power and bias voltage to the unit.

[c]A *coarse* phase-shift control is common to both $V_{5A}$ and $V_{9A}$, while $V_{9B}$ is used as a *fine* phase shifter.

#### Circuit Details

While specifically designed for a composite remote video signal, the video amp. and sync stripper stages, $V_1$ and $V_2$, can handle negative composite sync alone, so that two sync generators may be locked to each other. This facilitates tests on the locking stability of a sync generator. The blocking oscillator, $V_3$, and multivibrator, $V_4$, are biased so as to be inoperative except in the presence of an input signal. This prevents the unit from supplying a spurious signal to the controlled sync generator.

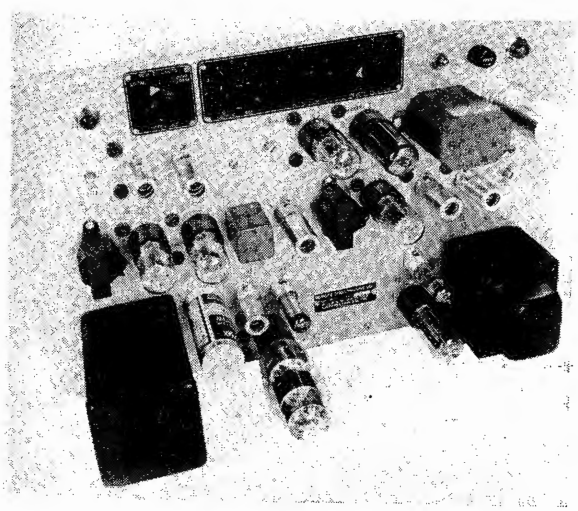
#### Sync Generator Phasing

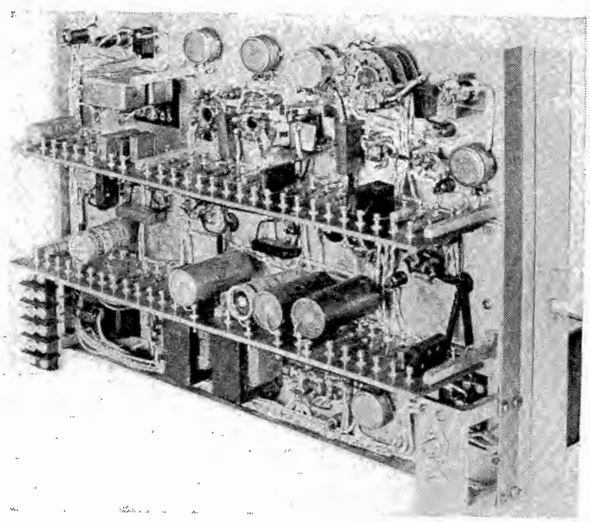
A switch is provided so that the input to the phase shifter may be taken from the local power line. Since the phase shifter has a total range of over 400°, this facilitates phasing the controlled sync generator with respect to studio film pickups.

#### Differentiating Circuit

Precision separation of the vertical sync from a composite sync signal is accomplished by a differentiating circuit having a time constant of approximately one-third of a horizontal line. This differentiation supplies a positive pulse at the end of the first vertical serrated pulse, as shown in Figure 3.

Figure 2.
Front and back views of remote sync-phasing chassis. At upper left is the remote-to-local switch for reference. In the center panel are the coarse phase, local-to-remote and remote-to-local controls.





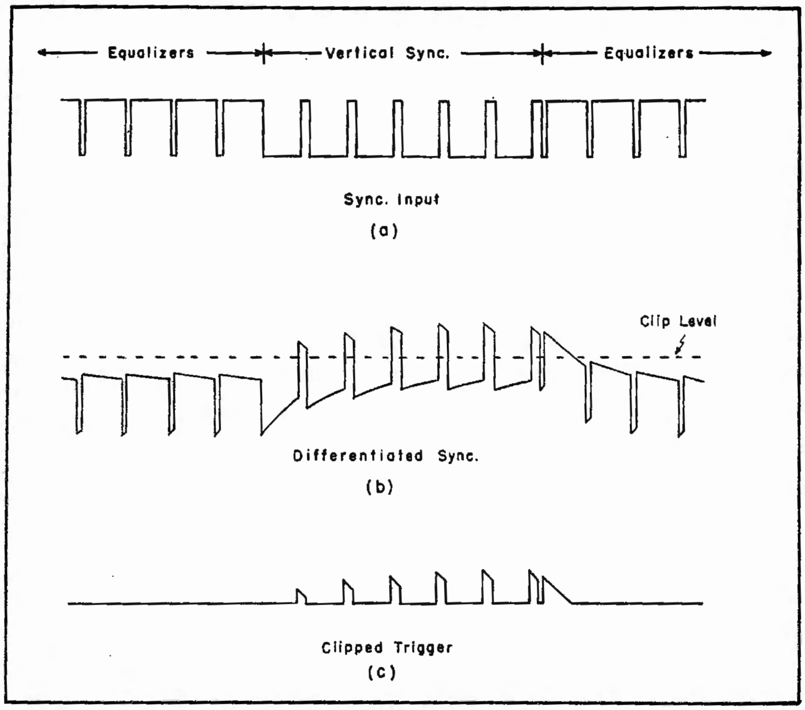



Figure 3.
Sync separation.

This pulse is clipped off and used to fire the blocking oscillator.

RMA proposals specify that at the instant of switching from one sync source to another, the phase of succeeding vertical sync periods should not differ by more than 13.1 horizontal lines leading or 2.6 horizontal lines lagging. To indicate to the operator when this phase relationship is attained a phase coincidence indicator is provided. The remote and local vertical sync pulses from the blocking oscillators are applied to separate grids of a coincidence amplifier; if both pulses occur simultaneously, plate current flows. An integrating circuit removes the 60-cycle component and a direct-coupled amplifier is used to operate a relay controlling the indicator lamp.

#### Sync Pulse Lengthening

To indicate coincidence over the range allowed by the RMA proposals, one of the sync pulses is lengthened as determined by the position of the locking reference switch. For conditions corresponding to local sync on the air and remote sync on preview, the remote vertical-sync period may occur up to 13.1 lines ahead of or up to 2.6 lines after the local vertical sync period. To secure the leading indication, the remote vertical sync pulse is lengthened before application to the coincidence amplifier; the lagging indication is secured by designing the blocking oscillators to deliver pulses about one horizontal line wide. For conditions corresponding to remote sync on the air and local sync on preview, the local vertical sync pulse is lengthened before being applied to the coincidence amplifier. The amount of lengthening is controlled by an indicator adjustment and set so that the indicator lamp is on over a range of phase difference of approximately 13 horizontal lines.

#### Adjustment

Numerous test jacks are provided so that adjustments and checks may be made from the front of the chassis, which is of the rack-mounted style. If the remote picture input exceeds 2.5 volts peak-to-peak in amplitude, it is cut down by means of a *video-gain* control until the sync stripper, $V_2$, delivers clean stripped sync. The multivibrator and tuned filter are adjusted to furnish a good sine wave to the phase shifter. Using a driven-sweep 'scope synchronized from a front-panel jack, the indicator is adjusted to remain on over a range of approximately 13 horizontal lines phase difference between the vertical sync intervals of the two inputs.

#### Operation

Under ordinary operating conditions, the *locking reference* switch will be in the *local* position. The controlled sync generator will then be locked to the local power-line frequency at a phase determined by the settings of *coarse phase* and *fine phase, local* controls. Should it be desired to change the phase of the sync generator relative to the power line, these controls may be varied, and together cover a phase range of over 400°. When it is desired to put a remote signal on the air, the *locking reference* switch is put in the *local-to-remote* position. The local sync generator will then be immediately locked in frequency to the remote sync. The phase may be adjusted by means of the *coarse phase* and *fine phase, local-to-remote* controls until the indicator light comes on. If the video switching is done at the time the indicator is on, the phase difference will be within the limits proposed by the RMA. At any time before the program is switched back to a local signal, the *locking reference* switch must be put in the *remote-to-local* position. Then the *fine phase, remote-to-local* control may be adjusted until the indicator lights. If the switching from the remote to the local picture is done while the indicator lamp is on, the phase difference between succeeding vertical sync periods will be within the limits proposed by the RMA. After these phasing adjustments have been made, then ordinarily the indicator will come on for either position of the *locking reference* switch, and the picture may be switched back and forth between the remote and local signals without further attention, except that the *locking-reference* switch must be in the appropriate position corresponding to the picture on the air at the time. At the conclusion of the remote program, the *locking reference* switch will be in the *remote-to-local* position before the picture is returned to the studio. After the switch has been made to the local program, the *locking reference* switch may be put in the *local* position, locking the controlled sync generator to the local power line.

#### References

[1]W. J. Poch, *Sync Generator Frequency Stability and TV Remote Pickups*, COMMUNICATIONS; July, 1947.

[2]This represents an average of many remotes handled by WABD, New York, during 1947.

[3]Proposed Standards of the RMA Studio Facilities Subcommittee.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- Cue feed to remote lines.
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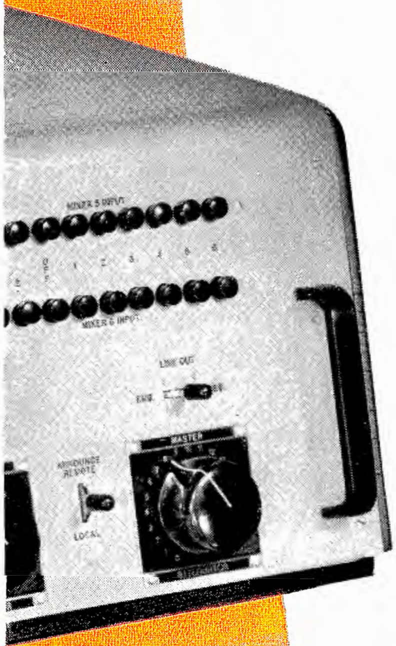


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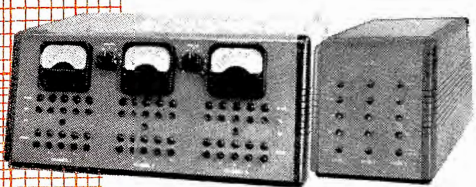

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# Test Instruments In The Broadcast Station

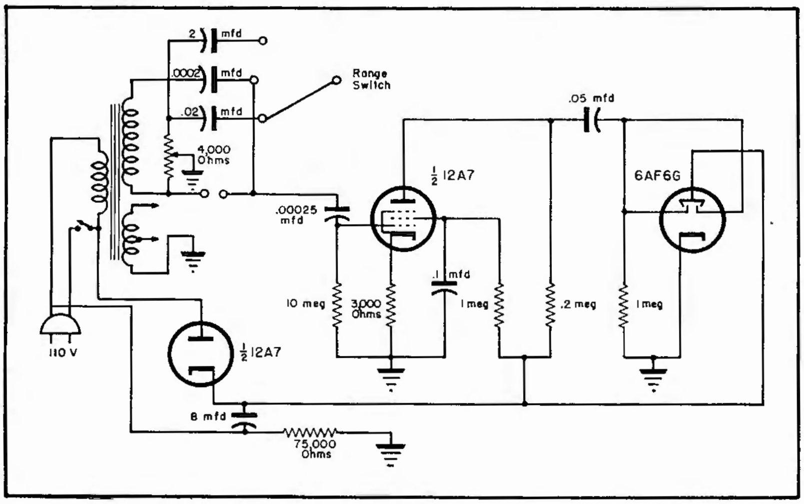



Figure 1. Circuit of the C-D capacitor bridge used at WIS and WISP.

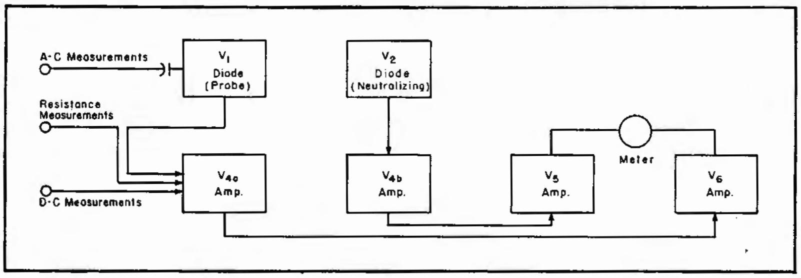
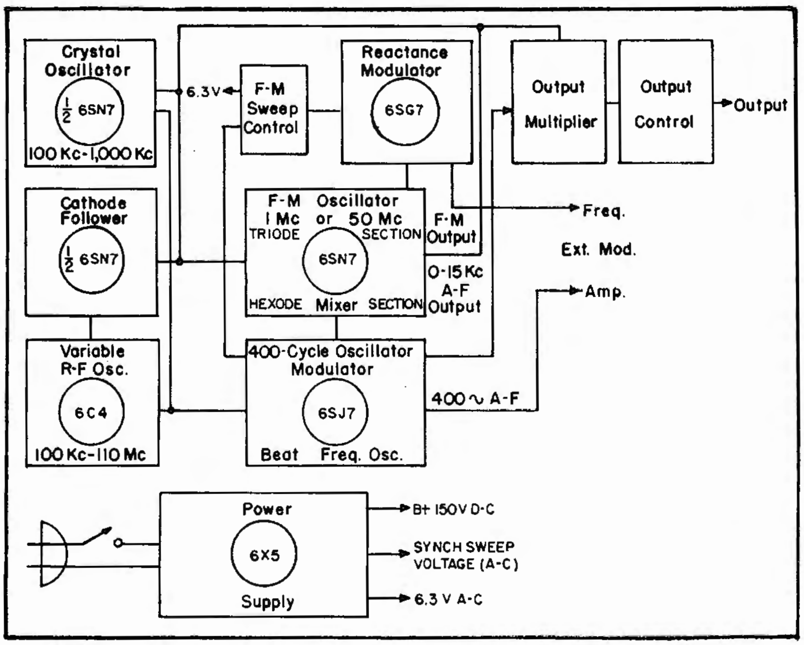



Figure 2. Block diagram of the vtvm discussed by Eidson, *HP 410-A*.

Figure 3. Basic circuit of the crystal-controlled signal generator employed by Eidson for his broadcast-station work; *Hickok 288X*.




IN THE INITIAL installment[1] of this series appeared design and station application data on the volt-ohm-milliammeter, audio oscillator, distortion and noise meter, and 'scope. In this presentation, broadcast-station use of the capacity bridge, vtm and signal generator are discussed.

### The Capacitor Bridge

For many years we have used a 3-range test set[2] for measuring capacitors ranging from .00001 to 50 mfd. It has given good service, and we would now be hard pressed without the instrument.

Besides measuring quite accurately the value of a capacitor, it indicates if a capacitor is shorted, open, or if the power factor is high or low.

A *visual eye* using a 6AF6G indicates bridge balance. When this condition exists, the value of the capacitor is simply read from the dial.

### The Vacuum-Tube Voltmeter

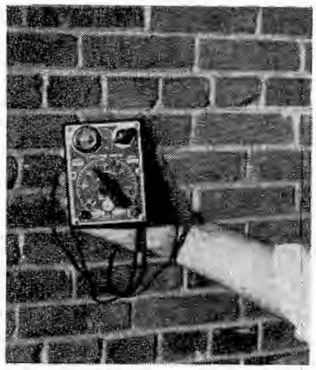
We use a high-frequency vtvm[3] with an a-c range of 1 to 300 volts rms; d-c range of 1 to 1000 volts; resistance of up to 500 megohms; frequency response of ±1 db from 20 cps to 700 mc; and an a-c input impedance of 100 megohms.

The instrument, particularly designed as a universal measuring instrument for use in audio, supersonic, broadcast, f-m and television circuits, has a high input resistance, while the equivalent shunt-input capacitance is sufficiently low. Accordingly even very-high-frequency resonant circuits are only moderately detuned. To further increase the flexibility and usefulness of this instrument, provision has been made for the measurement of both a-c and d-c voltages and resistance.

A-c voltages applied to the input terminals are rectified by a shunt diode circuit located in the instrument probe. This special diode has low anode-cathode capacity, very short

[1] COMMUNICATIONS, March, 1948.
[2] C-D Model BN.
[3] Hewlett Packard 410-A.

**Part II of Discussion, Covering the Broadcast Station Application of the Capacitor Bridge, VTVM and Signal Generator.**



C-D capacitor bridge.


## by HERBERT G. EIDSON, Jr.

**Chief Engineer, WIS and WISP**
**Technical Director, WIST**


electron transit time, and a high resonant frequency.

The output of the diode probe is applied to a d-c amplifier which consists of $V_{4a}$, and $V_6$; Figure 2. Very low voltage is used on the plate of $V_{4a}$ to minimize the magnitude of gas current flowing in its grid circuit. The indicating meter is connected between the plates of $V_5$ and $V_6$ in series with suitable range calibrating resistors.

$V_2$, $V_{4b}$ and $V_5$ operate in the circuit which neutralizes the effect of emission velocity current in $V_1$. This current consists of electrons which are emitted from the cathode with sufficient velocity to break through the diode space charge area and pass to the anode with no voltage on the anode. However, since this current does flow through the diode, the anode is at a potential relative to the cathode even though voltage is applied externally. This potential difference, though small, would cause a reading on the indicating meter which would destroy the accuracy of the lower ranges of the instrument.

$V_2$, with its associated circuit, is used to counteract this effect. This tube, the same type as $V_1$, is matched very carefully with $V_1$. $V_2$ operates merely with heater voltage and load resistor. Since diode $V_2$ is identical to $V_1$, a voltage essentially identical to that present at $V_1$ is also present at $V_2$. This voltage is applied to amplifier $V_{4b}$ and in turn to $V_5$. Thus, the voltage from $V_2$ counteracts that from $V_1$ in the d-c current amplifier $V_5$ and $V_6$, and only voltages applied externally to $V_1$ are amplified independently by the current amplifier.

The d-c voltages to be measured are applied directly to a 100-megohm voltage divider at the input to $V_{4a}$. $V_1$ and $V_2$ are switched out of the circuit.

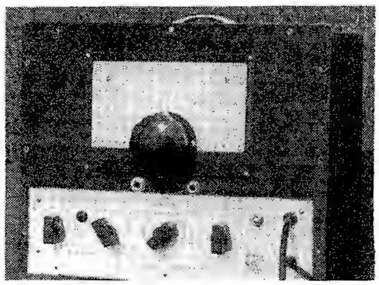
Resistances are measured by means of the voltage generated by two parallel dry cells. This voltage is applied to a network consisting of a known resistance in series with the resistance to be measured. That part of the voltage which is thus impressed across the unknown resistance is applied directly to $V_{4a}$, the first tube of the d-c amplifier.

It must be remembered that the vtvm is a peak reading device but, as in this case we use the meter scale calibrated to read rms volts. This simply means that the meter will read the rms value of a true sine wave. If the wave form of the voltage being measured contains appreciable harmonic voltages or other spurious voltages, errors in measurement will occur, the errors being of a magnitude as indicated by table 1:

The vtvm used by Eidson (*Courtesy Hewlett-Packard*).

| *Percent Harmonic* | *True RMS Value* | *Peak Meter Indication* |
|---|---|---|
| 0 ........... | 100 | 100 |
| 10% (2nd) .... | 100.5 | 90-110 |
| 20% (2nd) .... | 102 | 80-120 |
| 50% (2nd) .... | 112 | 75-150 |
| 10% (3rd) .... | 100.5 | 90-110 |
| 20% (3rd) .... | 102 | 80-120 |
| 50% (3rd) .... | 112 | 108-150 |

Table 1



Composite signal generator built by Eidson.

It is interesting to note that the vtvm used at our station can also be used to measure the positive voltage rise in a pulse provided the reading obtained is multiplied by the factor:

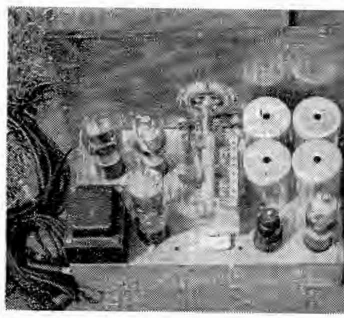
$$1.4\ (1 + t_1/t_2 + K/PRF)$$

Where: $t_1$ is the duration of the positive portion of the voltage;
$t_2$ is the duration of the negative portion of the voltage;
$K$ is a factor which is a function of the source impedance of the pulse generator and of $t_1$ (Must be found from supplied curves);
$PRF$ is the pulse repetition frequency in pulses per second.

Negative pulses can also be meas-

(*Continued on page 33*)

Internal view of the Eidson signal generator.



# TUBE *Engineering News*

## Analysis of Eleven Standard Types of Vacuum Gauges Used to Measure the Degree of Vacuum During the Evacuation of Tubes.

**by K. M. LAING**[1]
**North American Philips Company, Inc.**

THE TRADITIONAL WAY TO measure a vacuum is to compare the lowered pressure inside a vessel with that of the atmosphere. This can be done by connecting the inside and outside of the vessel by a tube with a *U*-shaped portion. Liquid in the *U* assumes a position that is a compromise between the attraction of gravity and the unequal pressures. The position of the liquid is then used as a measure of the vacuum in the vessel. For more than very moderate vacuums, ordinary liquids are too light, and recourse is had to mercury, which is almost fourteen times denser than water. For this reason, measurements of vacuum are most often given in terms of the height of a mercury column.

The standard value for the pressure of the atmosphere has been taken as 760 mm (29.921 inches). This means that the weight of a column of air, from sea level up as high as the atmosphere extends, is the same as the weight of a column of mercury of the same cross section area, but only 760 mm high. Most vacuum measurements are given as the height of a column of mercury in millimeters that the residual gas will support. This will hereafter be abbreviated to mm Hg.

There are a few applications in tube manufacturing where pressure is measured with columns of mercury, or manometers. These are used to measure the pressures in gas-filled tubes, such as grid-controlled rectifiers, voltage-regulators and gas phototubes, in the range up to 20 mm Hg.

#### The Manometer

One type of manometer is shown in Figure 1. This type of gauge can be made more sensitive and easily read over this range by substituting a lighter fluid for the mercury. The pressure to be measured must be balanced against a known vacuum instead of the pressure of the atmosphere. Some organic liquids have a vapor pressure low enough to make them suitable for such use. With their aid, the region from the pressure corresponding to the smallest different in level measurable, up to 20 mm Hg can be spread over 300 mm of scale (12″). In this pressure range, the aneroid type of gauge is available. Varying pressures cause motion of a flexible diaphragm in this gauge. The position of the diaphragm is indicated on a dial or otherwise by a pointer with considerable mechanical amplification.

The pressures in most vacuum tubes are of the order of one hundred-thousandth of an mm Hg. It is impractical to measure heights of columns in this range, and thus other types of measurement are used.

#### McLeod Gauge

Another type of gauge, the McLeod gauge, also makes use of mercury, which shuts off a bulb of known volume from the vessel in which the pressure is to be measured. Then the residual gas in the bulb is compressed by further motion of the liquid metal into a capillary tube. Here either its volume at a known pressure or its pressure at known volume is measured. A conventional mercury manometer measures the pressure; the volume is determined by measuring the length of the gas-filled portion of the capillary, whose cross section area is known.

The method suffers from three principal defects. Pressure cannot be measured continuously, but only at the instant the bulb is isolated from the main vacuum chamber. Automatic readings and recording of results are almost impossible. Since the sample of gas to be measured is compressed to a pressure which might exceed the condensation pressure of certain vapors, principally water, the gauge does not measure such gases or mixtures containing such vapors accurately. If the latter limitation is allowed for, this gauge needs no calibration. It measures pressure in terms of properties of the gauge mechanism that are evaluated in other ways. These properties are volume, cross-section area and length.

Other vacuum gauges depend upon measurement of certain properties of gases which are proportional to pressure.

#### Thermal Conductivity

There are two types of vacuum gauges that make use of the pressure coefficient of thermal conductivity. One uses a filament that is heated by the dissipation of a constant electrical wattage. The temperature of the wire is measured by a fine thermocouple. As the gas pressure varies through the applicable range the thermal con-

[1] *Mr. Laing, who prepared this paper while at North American Philips, is at present with the Pittsburgh Plate Glass Research Laboratory, Creighton, Pa.*

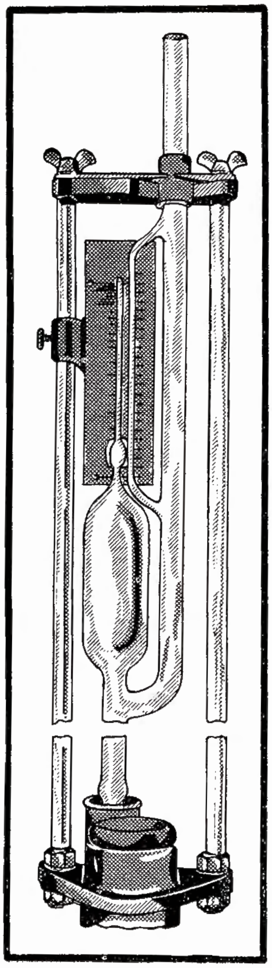


Figure 2
One type of McLeod gauge. In this model the mercury is displaced upward into the glass portion by a plunger. The pressure may be read on the linear or squared scales in the overlapping ranges of 1 mm Hg to $5 \times 10^{-6}$ mm Hg. (*Courtesy Central Scientific Company*)

ed electrically at a constant rate, is made of a suitable metal. The varying resistance of this filament, as the temperature varies with pressure, is measured or recorded in terms of pressures. A similar filament is provided, mounted in a reference vacuum in a tube, otherwise the same as the gauge tube. The two filaments are electrically connected in a bridge arrangement that minimizes error due to changes in ambient temperature.

### Viscosity Type

The viscosity gauge utilizes the pressure variation of gas viscosity to indicate the degree of vacuum. One type has a fused quartz fiber, anchored at one end in the vacuum chamber. The fiber is caused to oscillate by being struck with a magnetically operated armature. The time taken by the oscillations to die down to half their amplitude is a measure of the viscosity of the gas surrounding the fiber, and hence the pressure, provided the latter falls within the applicable range.

Other more complicated gauges use the same principle. One type measures the drag caused by the gas between a rapidly rotated disk and a nearby stationary spring-balanced disk.

### Thermal Energy Models

In the thermal energy gauge the thermal energy of gas molecules is utilized. Gas molecules, striking a hot surface, carry away with them, as they are deflected, some heat energy in the form of increased velocity. If these

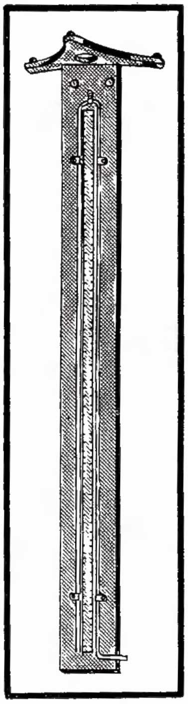


Figure 1
Open-tube manometer. This gauge can be used to measure vacuums where residual gas pressure is as low as a few mm of Hg, provided the pressure of the atmosphere is known at the time. (*Courtesy Central Scientific Company*)

ductivity of the gas also varies. For each pressure in this range, the heated wire assumes a temperature that allows the heat input and the heat output to balance. The temperature is measured by the thermocouple, and resulting voltage indicated or recorded.

Gauges of the second type also make use of the variation of thermal conductivity of gas in a certain pressure range. In this case the filament, heat-

Figure 3
Triode frequently used as an ionization vacuum gage. (*Courtesy National Research Corporation*)

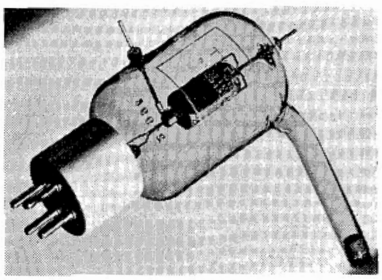
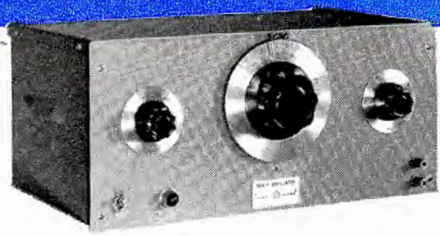


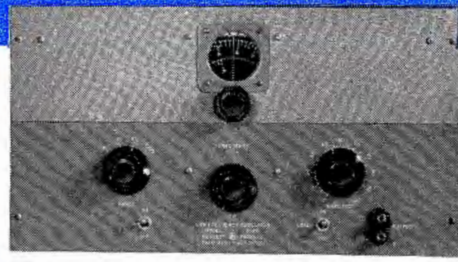
Table I
Properties of various vacuum gauges

| Common Name | Property Measured | Agent Utilized | Means of Indication | Type of Amplification |
|---|---|---|---|---|
| Manometer | Pressure | Low vapor pressure | Liquid level on scale | None |
| Aneroid or Bourdon | Pressure | Flexible diaphragm | Pointer on dial | Mechanical |
| McLeod | Pressure | Mercury | Liquid level on scale | Intrinsic, by volume reduction |
| McLeod | Volume | Mercury | Liquid level on scale | Intrinsic, by volume reduction |
| Thermocouple | Thermal conductivity | Filament | Millivoltmeter or potentiometer | None |
| Pirani | Thermal conductivity | Filament | Ohmmeter, any type | None |
| Langmuir | Viscosity | Quartz fiber | Stopwatch | None |
| Gaede | Viscosity | Rotating disk | Spot of light on scale | Optical |
| Discharge Tube | Ionization | High voltage | Color and form of luminous discharge | None |
| Ionization | Ionization | Hot filament electron emission | Microammeter | None or d-c amplifier |
| Philips | Ionization | High voltage and magnetic fields | Microammeter | None |
| Alphatron | Ionization | Alpha particle from radium | Milliammeter | 2-stage tube amplifier |



## 200 SERIES AUDIO OSCILLATORS

Available in six standard models. *-hp-* 200A and *-hp-* 200B have transformer-coupled output delivering 1 watt into matched load. Primarily designed for audio testing. *-hp-* 200C and *-hp-* 200D have resistance-coupled output and supply constant voltage over wide frequency range. The *-hp-* 202D is a modification of the 200D, extending frequency downward to 2 cps. *-hp-* 200I is a spread-scale oscillator designed for interpolation work and for applications where oscillation frequency must be known with utmost accuracy.



## 202B LOW FREQUENCY OSCILLATOR

Specially designed for work between ½ cps and 1000 cps. Provides excellent wave form, good stability, split-hair measuring accuracy in the very low frequencies. Ideal for vibration or stability checks on mechanical systems, for testing geophysical, electro-cardiograph or electro-encephalograph equipment, checking response of seismographs, or electrical simulation of mechanical phenomena.

# Resistance-Tuned Oscillators ...For Every Measuring Job 1/2 cps to 10 mc!

From A to Z in measuring, there's an *-hp-* resistance-tuned oscillator engineered to fit your exact need. Nine precision oscillators in all...and each bears the famed *-hp-* family characteristics of no zero set, constant output, low distortion, great stability, and decade tuning. Brief data on these *-hp-* oscillators are given here. For complete details, write or wire today!

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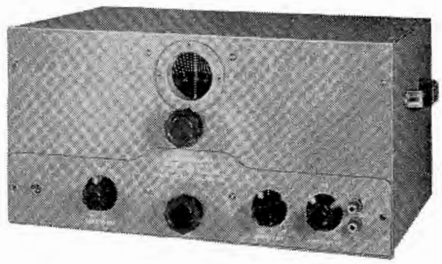


## 201B AUDIO OSCILLATOR

Meets every requirement for speed, accuracy, wave form purity and ease of operation in FM and other fields where high fidelity is most important. Provides 3 watts output into a 600 ohm resistive load. Distortion held to 1% or less, at 3 watts, ½% at 1 watt output. Excels in testing high fidelity amplifiers, speakers, and in comparing frequencies.

## 650A WIDE-BAND OSCILLATOR

Continuous frequency coverage, 10 cps to 10 mc. Highly stable, versatile. Output flat within 1 db throughout frequency range. Available voltages range from .00003 to 3 v. Other advantages include 94" scale length, 6 to 1 micro-controlled tuning drive, 50 db output attenuator variable in 10 db steps, output voltage divider providing 6 ohm internal impedance (reducing output voltage 100 to 1).

### BRIEF SPECIFICATIONS

| Instrument | Freq. Range | Output | Distortion | Freq. Response |
|---|---|---|---|---|
| -hp- 200A | 35 cps to 35 kc | 1 watt/22.5v | Less than 1% | ±1 db to 15 kc |
| -hp- 200B | 20 cps to 20 kc | 1 watt/22.5v | Less than 1% | ±1 db to 15 kc |
| -hp- 200C | 20 cps to 200 kc | 100 mw/10v | Less than 1% to 20 kc | ±1 db to 150 kc |
| -hp- 200D | 7 cps to 70 kc | 100 mw/10v | Less than 1% 10 cps to 20 kc | ±1 db throughout range |
| -hp- 202D | 2 cps to 70 kc | 100 mw/10v | Less than 2% 10 cps to 70 kc | ±1 db, 7 cps to 70 kc |
| -hp- 200 I | 6 cps to 6 kc | 100 mw/10v | Less than 1% above 10 cps | ±1 db, 6 to 6000 cps |
| -hp- 202B | ½ cps to 1000 cps | 100 mw/10v | Less than 1% 1 to 1000 cps | ±1 db, 10 to 1000 cps |
| -hp- 201B | 20 to 20,000 cps | 3 w/42.5v | Less than 1% | ±1 db throughout range |
| -hp- 650A | 10 cps to 10 mc | 15 mw/3v | Less than 1% 100 cps to 100 kc | ±1 db throughout range |

**hp laboratory instruments**
FOR SPEED AND ACCURACY

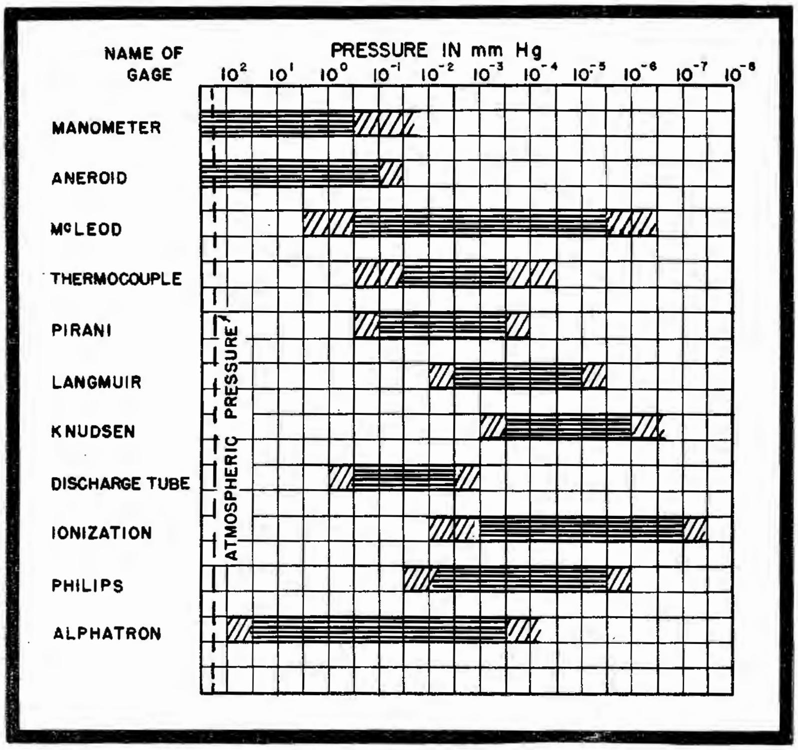



Figure 4
Chart showing pressure ranges covered by eleven types of vacuum gauges.

faster molecules strike a balanced vane, they impart more force to it than the molecules which strike the back of the vane; the latter have not been speeded up by striking a hot surface. The unbalance of forces rotates the vane and twists a suspension wire, restoring the balance. The motion is measured by the deflection of a beam of light reflected from a mirror fastened to the vane. Everything else being constant, the position of the vane is a measure of the number of speeded molecules striking it, and therefore the pressure of the gas. This gauge can be used for all types of gases. When made according to a specified set of dimensions, it needs no calibration to read true pressures.

### Ionization in Gauges

Residual gas molecules can be ionized. In this state they have one or more electrons removed and they are left with a positive charge. This charge enables them to be attracted to an electrode where the deficiency of electrons is supplied from an external metallic circuit. This supply of electrons is proportional, all other conditions being constant, to the number of gaseous ions neutralized, and hence to the pressure of the residual gas.

For rough indications of vacuums, one method of ionization has been employed. In this method, high voltage is applied to the gas, between metallic electrodes for d-c and low frequency a-c, and through the glass walls for r-f voltage. The electric field causes the gas to ionize. A feature of this process of ionization, or the subsequent spontaneous de-ionization, is the emission of light. The shape of the luminous discharge, the color and intensity of the light, and the presence or absence of fluorescence caused by invisible radiation, is judged by workers of long experience as an indication of the nature and pressure of the gas.

Another gauge operating on the inization principle makes use of a triode tube, with the envelope connected to the vacuum system. One of the designs is shown in Figure 3. The filament, usually a pure or thoriated tungsten wire, is heated. Emitted electrons are attracted to a grid by a potential of 100-200 volts. Some of them pass through the interstices of this electrode and proceed toward the plate. However, they are repelled by an inverse field between the plate and the grid of about 20 volts, the plate being more negative. The electrons eventually are collected by the grid structure. The

(*Continued on page* 32)

Figure 5
Combination thermocouple and ionization gauge. Units in the foreground are sealed to the vacuum system and the pressure over a wide range is indicated on the instruments of the control box.
(*Courtesy National Research Corporation*)

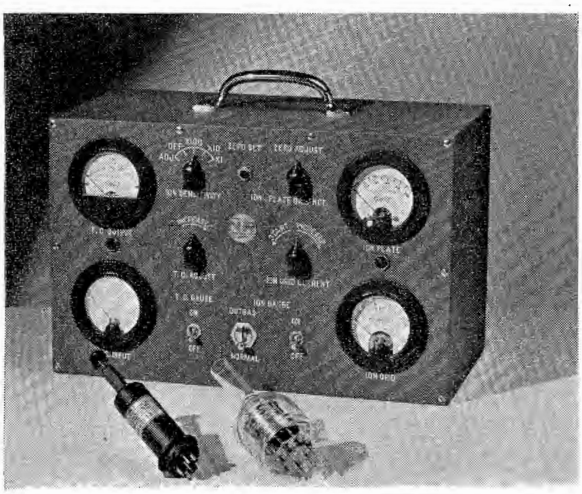
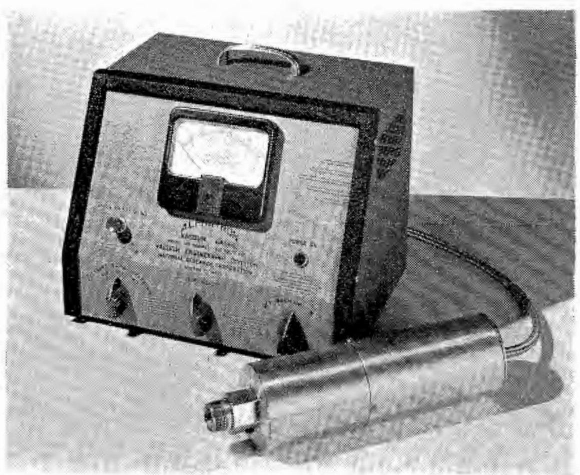
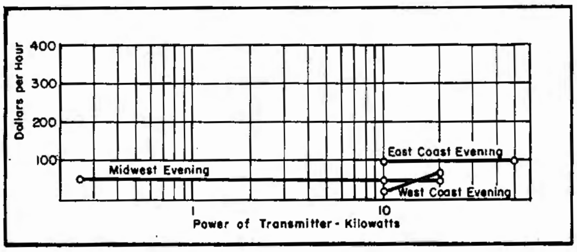
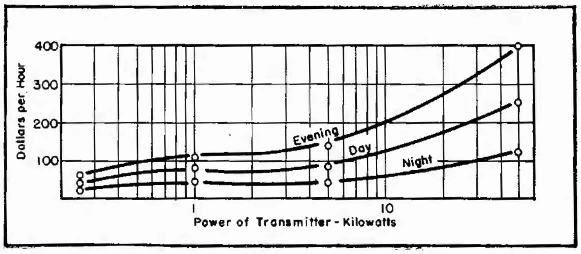


Figure 6
Cylindrical vacuum gauge that utilizes radium to ionize residual gas. Ions are collected and measured by the control equipment.
(*Courtesy National Research Corporation*)



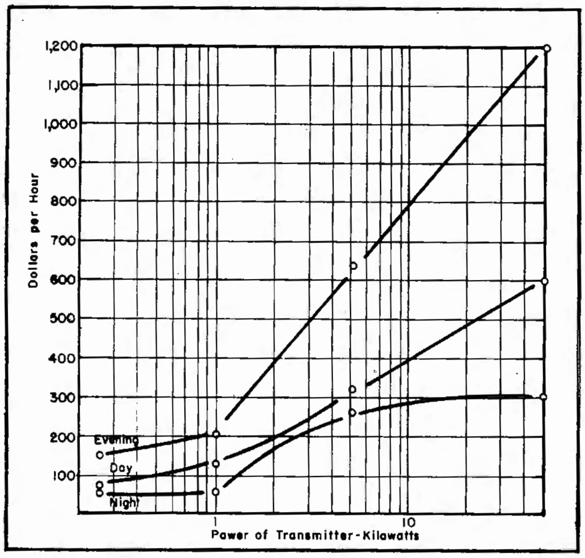
# Engineering Factors Used To Determine



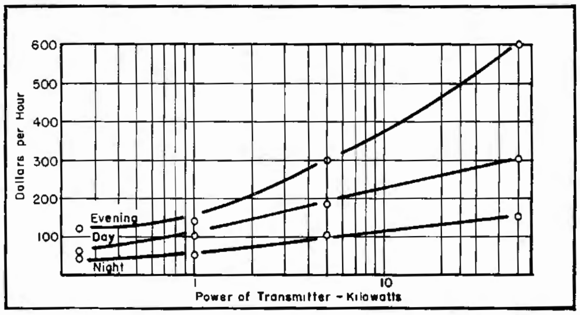

Figures 1 (left) and 2 (right)

Figure 1. Curves of day, evening and night rates of f-m broadcast stations, as a function of power for east coast, midwest and west coast. Figure 2. Curves of day, evening and night rates of a-m broadcasting stations as a function of power for the west coast small communities.




Figures 3 (below) and 4 (left)

In Figure 3 appears curves of day, evening and night rates of a-m broadcasting stations as a function of power in west-coast metropolitan areas. Curves of day, evening and night rates of a-m broadcasting stations, as a function of power in east-coast metropolitan areas, appear in Figure 4.



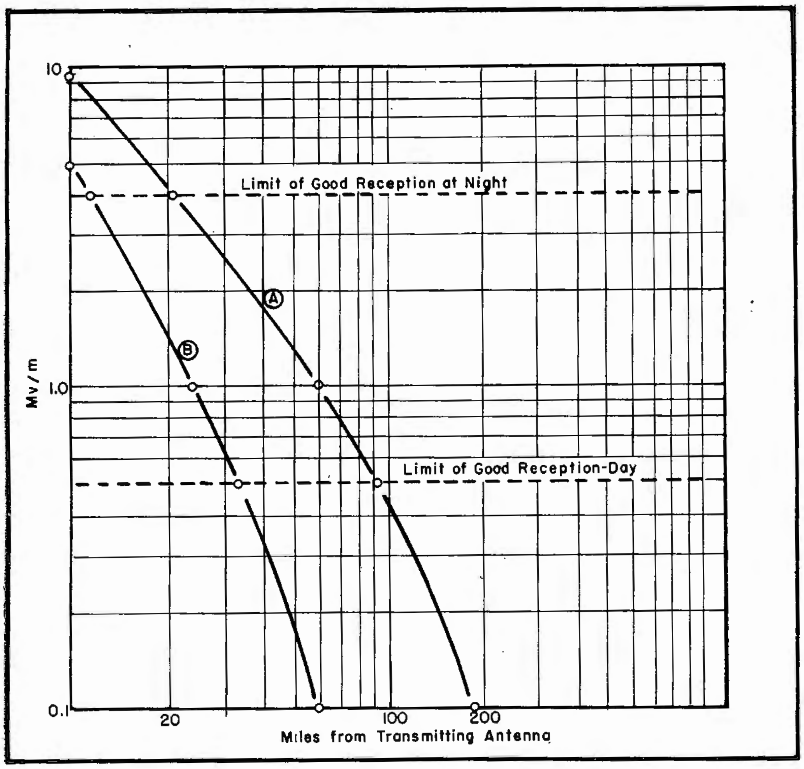




Figure 5

Curves of night and day coverage for the extreme limits of the a-m broadcast band, with an antenna power of approximately 500 watts. In this plot, the midwest ground conductivity was used as a base factor. The curve in *A* is for a frequency of 550 kc and the curve in *B* for a frequency of 1600 kc.

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*Daytime coverage rate for 8:00 A.M. to 6:00 P.M.; evening, 6:00 P.M. to 11:00 P.M., and nighttime, 11:00 P.M. to 8:00 A.M.*

# Broadcast Station Time Rates

Graphical Analysis Reveals How Engineering Factors, Such as Station Location, Frequency and Power Control Advertising Rates. Plots Applicable to F-M and A-M Systems.

by F. J. SHEEHAN

Chief Engineer
WTOL

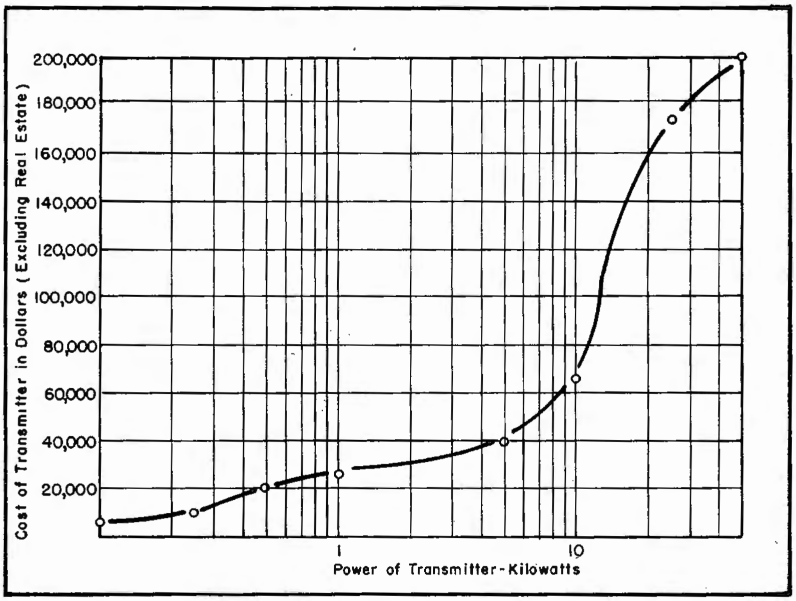
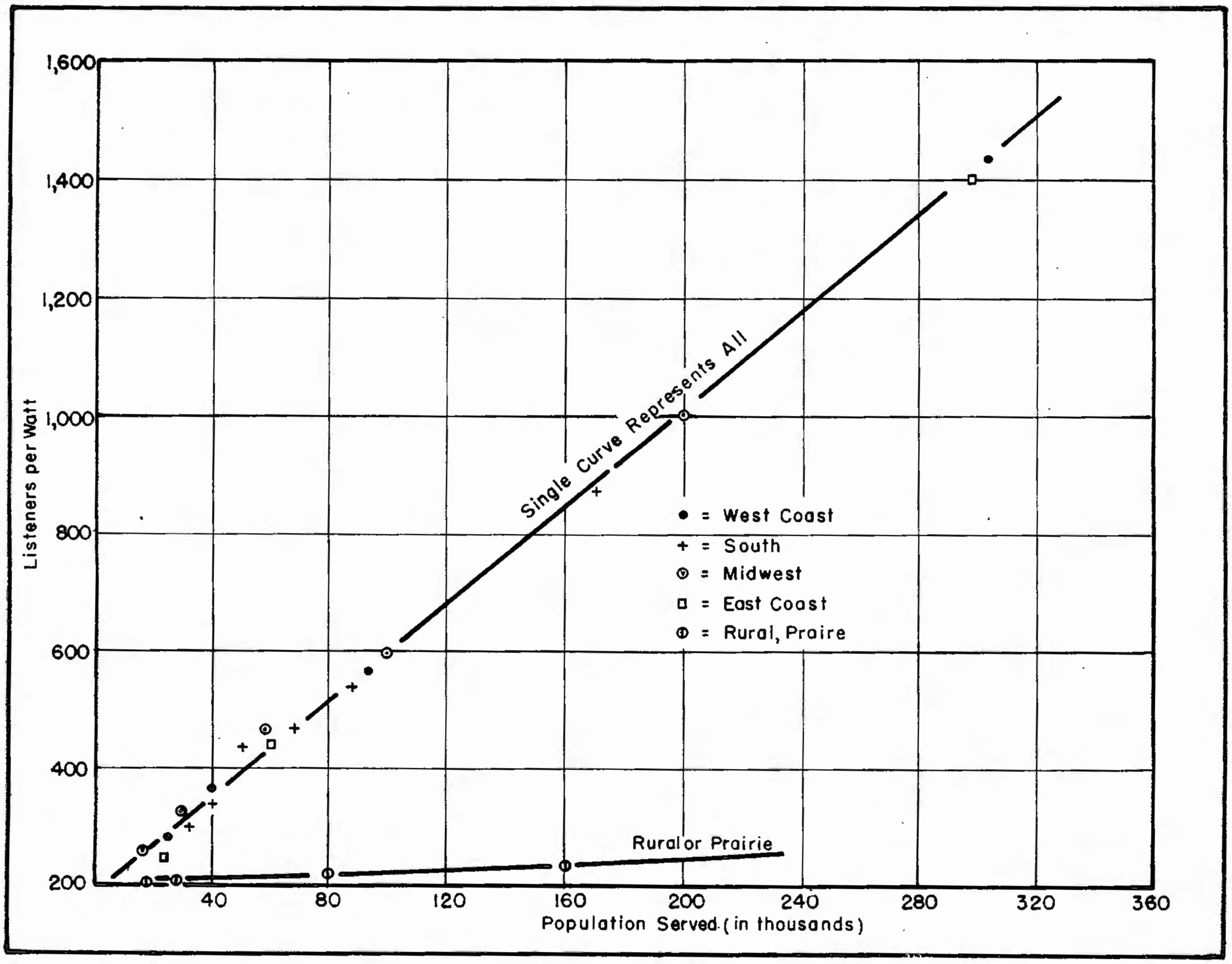



Fig. 6
The cost of a transmitting plant as a function of transmitted power.

Figure 7 (below)
Plot illustrating the listeners-per-watt as a function of population served.



# VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

***Personals***

AT THE RECENT ANNUAL dinner-cruise in New York City, veteran VWOA member G. Porter Houston, who is chief engineer of WCBM in Baltimore, Maryland, disclosed he's quite an old timer, having begun his key pounding days with Marconi and then going on to RCA. GPH has been an active amateur, W3AHA, for years. He has also served on the NAB Engineering Committee as chairman and is a member of the IRE. . . . Life member Jim Rigby, who was formerly personnel director of RCA Communications is now with McElroy as vice president. . . . Vet member Samuel Freedman, who was a commander during World War II as a member of the USNR, is now with DeMornay-Budd in sales engineering. Sam also is quite an old timer having begun his key-clicking days with Marconi in 1919 and following along with RCA up at Cape Cod. Sam has written a very authoritative book on *Two-Way Radio* which is becoming a best seller. . . . H. H. Parker, now with Consolidated Edison Co., also began his radio activities with Marconi and later on shifted to the United Fruit group. . . . Charter member Jim Maresca is now with the Naval Supply Depot in Bayonne, N. J. . . . B. Frank Borsody now checks in at the Micamold Radio Corp. in Brooklyn. . . . Sam Bokovoy now spends his time with August Miller Crystal Research at North Bergen, N. J. . . . Commander E. J. Quinby, USNR, who came all the way up from Key West, Florida, to attend the dinner cruise, spent his early days at WII, New Brunswick, N. J. He also served on Marconi and RCA ships for many years. He was also with RCA Labs and at present, is with the research and development lab in the Bureau of Ordnance. . . . Old timer E. N. Pickerill, who was also at the dinner-cruise, is now at the Central Radio Office of RCA in New York City. . . . Many members of Radiomarine Corp., who are very active in VWOA, were at the dinner cruise. These included George P. Aldridge, L. H. Strong, Lester T. Gates, H. B. Martin, Harvey Butt and George Shecklen. . . . Sam Medford, vet VWOA member, reported at the dinner-cruise that he is with the Isthmian Lines. . . . Harry Cornell another VWOA vet, is with the Standard Oil Co. of N. J. . . . E. J. Wakefield was also at the dinner-cruise. EJW is with United Fruit Co. . . . R. K. Davis of Tropical Radio was also at the affair. . . . Conrad B. Lee of Westinghouse Electric International, was also at the Hotel Astor annual get-together. . . . VWOA life member Commander Arthur Van Dyck disclosed at the banquet that he'd like to be an operator on the rocket line between Earth and Venus. . . . Admiral J. F. Farley unfortunately could not attend the banquet and sent a wire stating that Congressional hearings prevented his appearance at the gala affair. He sent his best to everyone. . . . Robert E. Barber also was unable to attend, being out at sea at the time. In a note to the boys and girls at the banquet he said: "While you fellows are wining, and dining and dancing, eating caviar and filet mignon, think of us fellows who are still out there twisting a bug's tail and glad to get even beans . . Have a good time, smooth sailin' and 73's . . Have completed the first 50,000 words of what promises to be the most informative, humorous work on radio today. Perhaps, a best seller." Hope we'll see you REB at the next meeting. . . . Vet member Rodney Duane Chipp is now assistant manager for the Dumont tv network. RDC was formerly with ABC as a radio facilities engineer. Rod has had a varied experience in radio since 1928. He was on the staff of the RCA Institutes in Boston and later spent a bit of time as lab assistant at MIT. After a period as chief engineer of WKAV, Laconia, N. H., he joined NBC in 1933 as control engineer and was transferred to the tv group in 1938. During the war, he was on active duty with the USN as a staff radio officer. He was later transferred to the radar section of the Bureau of Ships in Washington. He became a Lt. Commander and his work with the Bureau of Ships won him the Commendation Ribbon. Rod is a senior member of the IRE, an active member of SMPE, as associate member of the Naval Institute and a member of the New York State Society of Professional Engineers. His education has been quite complete, having studied at MIT and George Washington University. Good luck, Rod, in your new post.

Gilson V. Willets, co-founder of the VWOA, at the microphone of WRNY of which he was general manager in 1925, the year VWOA was born. GVW is now chairman of the San Francisco chapter of VWOA.

## NAB Meeting

(*Continued from page* 9)

will preside over the afternoon session on Thursday. Six papers will be offered:

*The CBS Grand Central Television Studios*; William B. Lodge, director of general engineering, CBS, and A. B. Chamberlain, chief engineer of CBS.

*Physical and technical facilities of the new WCBS-TV studios including a discussion of the video and audio facilities systems, studio cue-communications facilities, studio lighting and control, etc., will be offered in this paper, which will be presented by Mr. Lodge.*

*Television Field Broadcasts, including Radio Relay*; Robert Clark, tv operation supervisor, NBC.

*Mr. Clark will cover problems encountered in presenting tv field programs, preliminary surveys, equipment setup, microwave relay equipment.*

*Network Facilities for Audio and Studio Broadcasting;* Ernst H. Schreiber, engineer, The Pacific Telephone and Telegraph Company.

*Current methods and equipment used for audio and video-program channels, which include regular cables, coaxial conductors, shielded wire and microwave radio systems.*

*Installation and Maintenance of Television Receivers*; *Edward Edison, field engineer Los Angeles tv operation, RCA Service Company.*

*A review of some related problems between the tv broadcaster and the installation and servicing organization will be offered in this paper.*

*Absolute Speed for Magnetic Tape*; R. H. Ranger, president, Rangertone, Inc.

*A demonstration of tape reproduction at 30" per second, and discussion of professional type magnetic recorders will be offered by Colonel Ranger. Data will be offered on new type hysteresis motors now being used in tape recorders.*

*Magnetic Tape Editing Device;* H. W. Pangborn, assistant chief engineer, KNX-CBS and R. S. O'Brien, general engineering department, CBS.

*A unique tape-editing machine, which enables the precise location of words or portions of words, will be described in this paper to be presented by Mr. Pangborn. The equipment uses a variable speed forward-reverse drive to provide rapid reeling of the tape. A pickup*

(*Continued on page* 30)

## NAB Meeting

(*Continued on page 29*)

*head mounted on a drum is rotated to scan a 2-to-5 word section of the tape repetitively. Aural and 'scope methods for locating an exact cutting point within the scanned section will also be discussed.*

***May 21, A.M. Session***

Paul A deMars, consultant, Raymond M. Wilmotte, Inc., Washington, D. C., and a member of the NAB Engineering Executive Committee, will preside over the Friday morning session during which 5 papers will be offered:

*The Economics of Coverage in F-M Broadcasting*; Everett Dillard, general manager of WASH and KOZY and member-elect, NAB Board of Directors.

*Mr. Dillard will discuss the engineering considerations which contribute toward the best coverage consistent with the economy of investment and operation. Topics will include engineering aspects of combined f-m/a-m operation at a single site; review of the relative importance of transmitter power, antenna height and antenna gain; planning for future f-m expansion; effects of topography on coverage; factors to be avoided in selecting sites; how to avoid multipath distortion problems; the use of f-m for relaying in networking, etc.*

*A Studio-Transmitter-Link Radio System*; W. G. Broughton, assistant sales manager, broadcast equipment division, G.E., and D. J. Nigg, engineer, transmitter division, G.E.

*Measuring Equipment and Techniques for F-M and A-M Broadcast Transmitters*; David Packard, president, Hewlett-Packard Corp.

*Mr. Packard will offer a review of audio frequency, measuring equipment and techniques. He will discuss the application of low distortion oscillators, distortion analyzers and intermodulation measuring equipment. Various problems and techniques involved in making gain measurements, and measurements of noise and residual hum will also be discussed. In addition, Mr. Packard will analyze the application of monitoring equipment to obtain measurements of residual a-m modulation on f-m transmitters, together with the normal measurements of distortion, noise and residual hum.*

*Factors Affecting Performance of Directional Antenna System*; A.

Earl Cullum, consultant, Dallas, Texas.

*A System for Measuring Co-Channel Interference*; Robert A. Fox, general engineering department, WGAR, WJR, and KMPC.

*System for continually recording the ratio of desired-to-undesired signal for stations operating on the same channel will be described by Mr. Fox. The setup employs a receiver having a constant output over a wide range of input voltage followed by a selective amplifier, which isolates the heterodyne voltage when an undesired signal is present. The selective amplifier operates a graphic recorder whose reading is proportional to the ratio of the desired-to-undesired signal.*

At a luncheon session, Dr. Haldon A. Leedy, acting director, Armour Research Foundation, Chicago, Ill., will discuss:

*The Development of Magnetic Recording Leading to Stereophonic Sound.* In this paper, which will feature a demonstration, Dr. Leedy will describe the stereophonic sound system which consists of sound recorded on 3 magnetic tracks simultaneously, on a single paper tape, with reproduction obtained by placing loudspeakers in positions corresponding to those of the original sound source.

**_Afternoon Session, May 21_**

Orrin W. Towner, technical director of WHAS, Louisville, Kentucky and chairman of the NAB Engineering Executive Committee will conduct the afternoon session on Friday, when two papers will be offered and an FCC industry round-table session will be held.

The first paper on the afternoon session will be presented by J. L. Hathaway, assistant manager, engineering developments, NBC, and cover *Developments in Sound and Relay Broadcast Equipment.* A pack-type transmitter and a miniature field pick-up amplifier which can be carried in a standard briefcase will be described by Mr. Hathaway. The second paper will be on *Modern Design Features of the CBS Studio Audio Facilities.* This paper prepared by R. B. Monroe and C. A. Palmquist of the general engineering department, CBS, New York, will be presented by Lester H. Bowman, manager technical operations, western division of CBS. Mr. Bowman will describe a recently completed broadcasting studio audio-control console which although comparable in size to a standard office desk, is said to contain as much equipment as formerly required in three or four standard equipment racks.

Royal V. Howard, director of NAB Department of Engineering, will preside over the FCC industry round-table panel. He will be assisted by Neal McNaughten, who is assistant director of the NAB Department of Engineering.—L. W.

## Tube News

(*Continued from page* 25)

resulting grid current is kept constant. While the electrons are in the space between the grid and the plate, they collide with gas molecules in this region and ionize them. The positively charged gas ions are attracted to the plate, often called the collector in this specialized form of triode. The plate current necessary to neutralize the ionized molecules of gas is proportional to their number, and hence to the pressure.

### Vacuum-Gague Modification

In a modification of this arrangement,[1] the electrons are impelled to follow a long spiral path by combined electric and magnetic fields. As a convenience the electrons are not emitted by a hot filament, but from a cold cathode by a potential of 2,000 volts. The current due to the electrons is small and constant compared to that caused by the ions, which is proportional to the pressure of the gas.

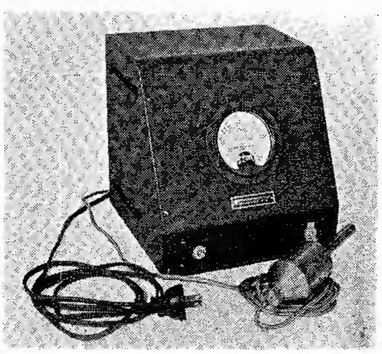
### Medium Type Gauge

Another gauge uses a small amount of radium to produce gaseous ions, which are collected and measured in the usual way. The radium, in a sealed capsule, disintegrates to form, among other things, alpha particles. These are doubly charged helium ions. These particules are emitted with a high velocity. Numerous collisions with the residual gas molecules are produced, and the latter are ionized at a rate proportional to their number. The ions formed are collected and measured as before.

[1]The Philips Gauge.

Figure 7

Foreground, Philips vacuum gauge. Pressure is indicated on the instrument in background. (*Courtesy Distillation Products, Inc.*)



## Test Instruments

(*Continued from page* 21)

ured but not to as small a value as with positive pulses.

Since the resonant frequency of $V_1$ is something above 1000 mc, readings on r-f transmission lines can be obtained with good accuracy up to the 1000-mc point. For readings above 100 mc the manufacturer recommends that the small tip on the end of the diode be removed (this tip contains a built-in .00025-mfd blocking capacitor) and a button type capacitor of approximately 50 mmfd be tightly connected to the point to be measured. For frequencies below approximately 50 cycles, a capacity of .25 mfd should be substituted for the tip.

The vtvm can be used for:

(*1*)—Measuring standing wave ratios on transmission lines.

(*2*)—If exact *swr* is known, power can be measured at f-m frequencies as well as at lower frequencies.

(*3*)—Neutralizing of transmitter r-f stages.

(*4*)—Measuring any voltage within the range of the meter at critical points in circuits where a conventional voltmeter would upset circuit characteristics.

(*5*)—Measuring of resistances from approximately .1 ohm to 500 megohms.

(*6*)—D-c voltage measurements from .01 to 1,000 volts at a load of 100 megohms.

***The Signal Generator***

Two signal generators are used at our stations. One is a composite lab-built generator and the other a commercial model.[4]

While the commercial type can hardly be considered broadcast test equipment, since it was designed primarily for the servicing of receivers, it does come in handy when checking receiver monitors and shortwave pick-up equipment. This generator can also be used in conjunction with an r-f bridge, but it must be borne in mind that its output is too low to override much interference or static when measuring antenna characteristics.

The lab-built unit, which features a cathode-follower output stage, was designed with one main purpose in mind: to provide a steady, strong signal capable of being modulated up to 100 per cent with an output of at least 10 volts so that static and station interference could be overridden when using an r-f bridge to measure characteristics of antennas within the 550 to 1600-kc range. The oscillator has a much greater frequency range than this, and thus it can be used for receiver work also.

The output varies from 10 to 15 volts across the standard broadcast band and drops lower when other bands are switched in. The full frequency range of the unit is 380 kc to 7 mc in four bands. Harmonics can be used if a higher frequency is needed for receiver test work.

The instrument is well shielded with filters in the 110-volt supply lead to prevent radiation of the signal.

The cathode-follower output stage affords a low impedance output for good regulation.

The modulating signal is set at 400 cycles and is generated by a Wein-bridge oscillator driving a modulator, which in turn excites an electron-coupled oscillator operating at a radio

(*Continued on page* 34)

[4]Hickok Model 288-X.

## Test Instruments

(*Continued from page* 33)

frequency. This then drives the cathode-follower output tube.

Previous experience has shown that a null is most difficult to obtain on an r-f bridge under other than ideal conditions when the driving generator is incapable of producing more than .1 to 1.0 volt of r-f, especially when the antenna being measured is of low ohmage.

**[To be continued]**

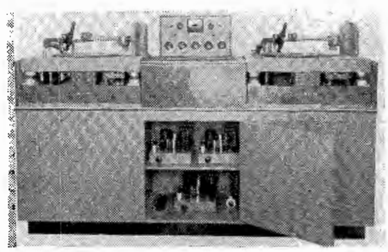
## CAA Range

(*Continued from page* 11)

navigational program, since the basic policy adopted in this country provides for navigation information aboard aircraft to be obtained direct by a means not requiring communication between aircraft and ground, and to allow each aircraft to navigate a desired course independent of all other aircraft without help from ground personnel.

The next step in the long term navigational plan will be the addition of distance measuring equipment (*DME*) to the *VOR* system, which will provide almost unlimited navigational possibilities. For example, using *DME-VOR* equipment with a course computer of relatively simple design, the pilot will be able to pre-set any desired straight line or orbit course. This course need not pass over the *VOR* station and can be made good regardless of changing winds and without the need of dead-reckoning or numerous other methods of orientation. The pilot need only fly the vertical needle of the deviation indicator and may, if his aircraft is equipped with an automatic pilot and automatic flight coupler, merely flip a switch which will fly this course automatically; thus we may think of the *VOR-DME* system as satisfying the exact means of aircraft position control required by the increasing number of aircraft using our domestic airways.

**AUDIO CONTROL EQUIPMENT**

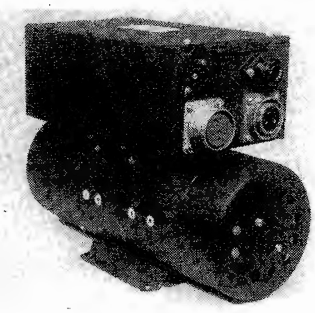


**Professional recorder console and control turret which incorporates two recorders for simultaneous operation, recently installed at WKJG, Ft. Wayne, Indiana. Either one of the two program busses on the cutting units may be monitored during operation.** (*Courtesy RCA*)

# The Industry Offers

### BENDIX DYNAMOTOR

A regulated dynamotor, which is said to permit constant output voltage with as much as a 25% variation in input voltage, has been announced by Bendix Aviation Corporation, Red Bank, N. J. Unit is said to be designed for operation under extremes of temperature, humidity and altitude. Available in a variety of frame sizes and voltage ratings.



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### C-D TV CAPACITORS

A line of tv capacitors, DSTH, has been announced by Cornell-Dubilier. Capacitors, oil impregnated and wax filled, are made with a double seal consisting of one complete wax paper tubular, including a wax dip inserted in a second outer dip. The size range is from ½" diameter x 2⅛" length up to 1 13/16" x 4¾". Voltage d-c, from 3,000 to 6,000.

* * *

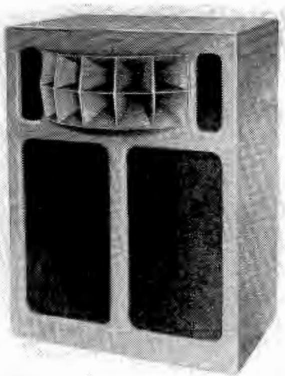
### STEPHENS TWO-WAY SPEAKER

A 2-way speaker system, Tru-Sonic model P-63HF, has been developed by Stephens Manufacturing Corporation, 10416 National Boulevard, Los Angeles 34, California.

Rated at 30 watts. Has a 600-cycle crossover to relieve the two model P-52L, 15" 20-watt low-frequency drivers of high frequencies and consequent intermodulation and cone breakup. Horn loading down to 60 cycles. Chamber behind drivers reinforces bass to 30 cycles. 2 x 5, 10 cell, 100° x 40° h-f dispersing horn. A model P-30, 30-watt h-f driver is said to extend range beyond 15,000 cycles. Equipped with h-f attenuator.

Size, 25" deep x 36" wide x 45" high. Input: 16 ohms.

Bulletin 109 contains additional data.



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### RMC AMPLIFIERS

A series of amplifiers, type 115, for broadcast monitoring, recording studios, public address systems and wired music services, has been announced by Radio Music Corp., Port Chester, New York.

Equipped with aural and gain controls. Aural control on low end said to boost without high end attenuation. Three-stage push-pull.

Bulletin A1-4 upon request.



### G.E. PANEL INSTRUMENTS

A new line of 3½" panel instruments of internal-pivot design has been announced by the meter and instrument divisions of G. E.

The instruments, type DO-71, feature an Alnico magnet which is said to provide high torque for quick response and good damping. High torque is also said to allow the use of larger-radius pivots.

* * *

### STACKPOLE DUAL CONCENTRIC SHAFT CONTROLS

Dual concentric volume and tone controls have been announced by the Stackpole Carbon Company, St. Marys, Pa.

Controls, 57/64" in diameter, available as a dual unit with single control at the panel, as a dual concentric with two separately controlled continuously variable resistance units mounted in tandem, or as dual concentric with one continuously variable unit, and one tone switch in tandem.

### BRACH H-F WHIP ANTENNA

A high-frequency antenna, covering 152 to 162 mc, for auto communications systems, has been announced by the L. S. Brach Manufacturing Company, Newark, N. J.

Antenna features a locking device, a single clamp which by pressure and biting into the metal roof, from above and below provides a mount and ground to coaxial shield. The antenna portion is of beryllium copper, pressure fitted into a locking nut.

* * *

### RAYTHEON TV EQUIPMENT

A line of tv station equipment has been announced by Raytheon Manufacturing Co., Waltham, Mass.

Both 500 watt and 5-kw tv-transmitters will be in the line. Portable camera chain equipment will be produced for both pick-up and studio use.

(*Continued on page 36*)

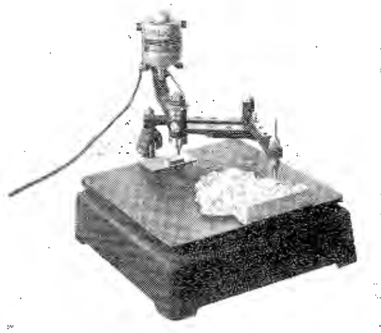
## The Industry Offers

(*Continued on page* 35)

### MICO ENGRAVER

A 2- and 3-dimensional portable pantograph engraving machine, type 252, has been announced by Mico Instrument Company, 80 Trowbridge St., Cambrdige 38, Mass. Can be used to make small dies and molds for plastics, rubber, glass, die castings, templates, etc. Three-dimensional milling is accomplished by tracing the shape of an enlarged master with the stylus.

A spindle is mounted on pre-loaded ball bearings and equipped with a chuck that holds midget milling cutters, burrs or mounted points having ⅛" diameter shanks. A micrometer depth control, graduated in thousandths of an inch of feed, has a range of .250".



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### SORENSEN AUTOMATIC ELECTRONIC VOLTAGE REGULATOR

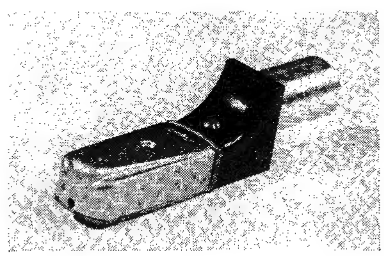
An automatic electronic voltage regulator, the **Controller,** which is said to permit seective stabilization of a-c, d-c or r-f outputs in any one circuit over wide ranges of line and load, has been announced by Sorensen and Co., Inc., Stamford, Conn. The a-c output is said to swing between 85 and 145 v, **automatically** adjusting the output of unit against line and load.

At least one watt of power must be made available to the **Controller** bridge circuit. In a d-c application at least 0.4 ampere must be made available from the rectifier filter circuit.

* * *

### AUDAX TUNED-RIBBON PICKUP

**A tuned-ribbon reproducer,** Audax model 79-G, has been announced by Audak Co., 500 Fifth Ave. 18, N. Y. Linear 50 to 10,000 cycles; point-pressure about 24 grams; jewel-stylus; output about — 30 db.



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### LENKURT 22-CHANNEL CARRIER SYSTEM

A carrier system which is said to provide 11 voice circuits in the 200 cps to 50 kc band has been announced by Lenkurt Electric Co., 1124 County Road, San Carlos, California. Where limited fidelity is acceptable, as many as 22 narrow-band channels can be provided.

Particularly suited for application between communication control centers and associated radio transmitter and receiver stations.

Up to 18 signaling sub-channels can be transmitted over each of the eleven voice channels. Wide-band signaling circuits for semi-automatic keying can be obtained with a maximum dotting rate of 20 per sec. Each voice channel can be divided into six such channels plus six normal signaling channels.

### RCA D-C MICROAMMETER

An electronic microammeter, WV-84A, which is said to be capable of measuring d-c currents down to one-billionth of an ampere, has been announced by the RCA tube department.

The microammeter is a portable, battery-operated, vacuum-tube meter.

May be used with multiplier photo tubes in measuring light intensities and the density of gases.

Current ranging from 0.001 microampere to 1,000 microamperes can be measured.

Can also be used as a high-range ohmmeter when connected to a suitable power supply. For example, when used with a 45-volt battery, the instrument will measure resistance up to 4,500 megohms.

The voltage drop for full-scale deflection of the meter is said to be ½ volt for all ranges.

* * *

### HOFFMAN FREQUENCY METER

A heterodyne frequency meter and crystal calibrator, TS-323 U/R, with a frequency range of 20 to 480 mc, has been announced by Hoffman Radio Corp., Los Angeles, Calif.

The unit operates on two 6-volt A batteries and three 45-volt Bs for portable operation. For fixed use an external connector is provided for operation through regulated power supply.

### TRIPLETT VOLT-OHM-MILLIAMMETER

A combination 20,000 ohms per volt d-c multi-range volt-ohm-milliammeter has been announced by The Triplett Electrical Instrument Co., Bluffton, Ohio.

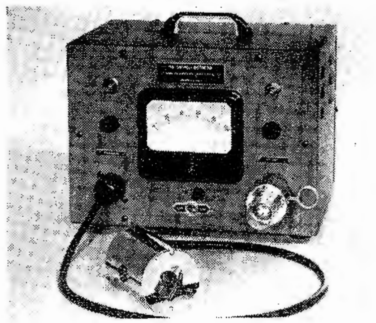
There are 35 ranges: Voltages to 1,000 d-c at 20,000 ohms/volt and a-c at 1,000 ohms/volt; d-c current ranges from 0-50 microamperes to 10 amps; a-c amps to 10; db —10 to +55.

* * *

### ROWE V-H-F/U-H-F MILLI-WATTMETER

A v-h-f/u-h-f milli-wattmeter, type MW55, for measuring power output of h-f transmitters, oscillators, multiplier stages, has been announced by Rowe Engineering Corp., 2422 N. Pulaski Road, Chicago 39, Ill. Two methods of measurement are provided in the instrument, selection of which is made by a front panel switch. One is a thermistor bridge arrangement for indicating powers from 2 to 60 milliwatts, and the other a p-m filament brilliance comparison method for higher powers from 20 to 1,000 milliwatts.

Accessory probes are available providing various methods of circuit coupling for obtaining maximum power measurements most satisfactorily.



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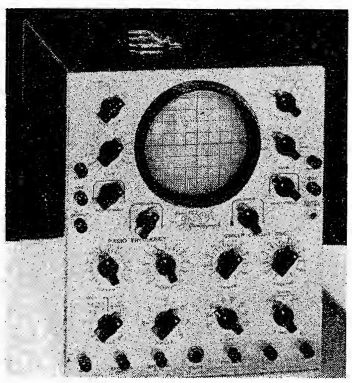
### HICKOK 5" SCOPE

A 5" scope, model 505, which uses the 5 UP-1 has been announced by the Hickok Electrical Instrument Co., 10521 Dupont Avenue, Cleveland, Ohio.

Features include a wide and narrow band f-m oscillator, a wide-band, high-gain vertical amplifier (to 1 mc), a modulation circuit which permits the f-m oscillator to be either internally modulated or from an external source such as phonograph pick up, or microphones, demodulator which permits any modulated r-f signal to be viewed, self-contained mixer circuit, permitting f-m output with any good signal generator, sinusoidal sweep with phasing control, and a 3 range frequency compensated attenuator network in vertical amplifier.



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### CLARKSTAN SWEEP-FREQUENCY GENERATOR

A sweep-frequency generator, model 125, has been announced by The Clarkstan Corp., 11927 West Pico Boulevard, Los Angeles 34, Calif.

Designed to operate in the audio range in conjunction with a 'scope. Complex signal is produced by scanning photoelectrically a synchronously rotating disc, modulated photographically from a precision pattern.

Output, 7 volts, open circuit, 50 milliwatts or 5 volts into 500 ohms; internal impedance, 200 ohms; frequency range, 40 cps to 10 kc with 60 cycle a-c; marker pulses at 1, 3, 5, 7, 9, and 10 kc. Sweep frequency governed by 20 synchronizing pulses per second.

# News Briefs

### *INDUSTRY ACTIVITIES*

**The 14th** annual meeting of the Associated Police Communication Officers, Inc., will be held at the Rice Hotel, Houston, Texas, Sept. 20 to 23, 1948.

Paul Franklin of the Houston Police Department is chairman of information for the meeting.

**The U-Dryvit Auto Rental Co., Inc.,** Cambridge, Mass., will establish fixed station and mobile radiotelephone facilities in 21 cities throughout New England and New York State.

The U-Dryvit Co., which rents automobiles and trucks, plans to rent mobile radio-equipped vehicles. In addition, limited common carrier systems will be set up as a separate service to customers. Installations in privately owned vehicles will also be made.

Ultimate use of 1915 Philco mobile units is planned.

Gordon Huggins is general manager of the radiotelephone division of U-Dryvit.

At present, U-Dryvit operates a 100-unit system in the Boston area.

**WDTV,** Pittsburgh outlet of the DuMont television network, is expected to be on the air with test patterns by the middle of September, and with a full program schedule by December 1.

WDTV is being constructed in the Braslear Reservoir district, with transmitting antenna 1,140' above river level in Pittsburgh.

The transmitter will equal WABD's in signal strength, with an effective radiated power of 14.25 kw for video and 9.45 kw for audio.

**Andrew Corporation,** Chicago, recently received a citation from the Illinois department of the Disabled American Veterans for hiring a greater percentage of veterans than any other concern in Chicago.

**WGHF,** the 20,000-watt f-m station owned by Capt. W. G. H. Finch, New York City, has become affiliated with the Rural Radio Network, Inc., of Ithaca, N. Y.

The network, owned and operated by the ten statewide farm organizations of New York, has under construction six f-m stations on mountain tops across upper New York State.

**A Canadian IRE Convention** will be held in the Roof Garden of the Royal York Hotel, Toronto, on April 30 and May 1.

Papers to be presented include: *Narrow Beam Radar Recording Altimeter,* B. J. McCaffrey, National Research Council; *Frequency Allocations,* L. E. Coffey and C. J. Acton, Department of Transport; *Industrial Electronics,* J. T. Thwaites, Canadian Westinghouse Co., Ltd.; *A Direct Reading Phase Monitor,* D. F. Wright, Canadian Marconi Company; *F-M Field Intensity Measurement,* J. E. Hayes, Canadian Broadcasting Corp.; *Recent Developments in Facsimile,* F. A. Hester, Radio Inventions; *The Reproduction of Sound,* E. O. Swan, CKEY; *New Measuring Equipment in the Radio Industry,* Col. B. DeF. Bayly Engineering, Ltd.; *25 Cycle Operation of Television Receivers,* Orin Dakin, Canadian General Electric Co., Ltd.; and *Theatre Television Systems,* H. Goldin, Gaumont-Kalee, Ltd.

B. E. Shackelford, IRE president, will be the guest speaker at the banquet which will be held on Friday, April 30.

### *PERSONALS*

**Henry G. Randolph** has been appointed district manager at Dallas, Texas.

He succeeds **Walter M. Skillman** who was recently appointed sales manager of standard line radios in the G. E. receiver division.

**R. E. Mathes,** recently chief engineer of Finch Telecommunications, has been named chief engineer of the Gray Research & Development Company, Inc., Elmsford, N. Y.

**Edgar Kobak,** president of Mutual, has been elected president of the Radio Pioneers, a 20-year club, succeeding Mark Woods, president of ABC.

**Otis S. Freeman** has joined the engineering staff of WPIX as assistant for operations.

Freeman was with WABD for four years as chief operating engineer.

**O. S. Freeman**

**Dr. John A. Hutcheson** has been appointed director of the Westinghouse Research Laboratories, succeeding Dr. L. Warrington Chubb.

**David Ferrier** is now assistant to the president of the Servo Corporation of America, Lindenhurst, N. Y.

Ferrier was formerly with Harvey Radio Labs.

**Ray S. Groenier** has been appointed RCA sales engineer in charge of communications sales for the southwest region.

Groenier will headquarter at 1907-11 McKinney Avenue, Dallas, Texas.

Groenier was formerly chief radio engineer for the Madison, Wis., Police Department.

**Anthony Wright,** formerly chief RCA tv receiver engineer, has been appointed chief engineer of The Magnavox Company.

**W. Hamilton Walter** is now coordinator of sales for the Raytheon Manufacturing Co., Waltham, Mass. He will supervise Raytheon's marketing, advertising and public relations programs.

**Ben Adler** has opened a consulting engineering office at 15 Gedney Circle, White Plains, N. Y. He will specialize in broadcast facilities design, construction supervision and tv installation.

**Dr. B. S. Ellefson,** director of Central Research Laboratories, Sylvania Electric Products, Inc., will discuss **Ceramic Developments in the Electronic Field** at the May 19 meeting of the Metropolitan New York Section of the American Ceramic Society. As a part of the same program **A. J. Monack,** consulting engineer, will discuss **The Chemistry of Glass-Metal Seals.** Meeting will be held at Trammer's Restaurant, 1 West 52nd St., and begin at 5 P.M.

**Rear Admiral Walter Albert Buck,** U. S. Navy (Ret.), former Paymaster General and Chief of the Bureau of Supplies and Accounts in the Department of the Navy, has been elected president of Radiomarine Corporation of America.

Admiral Buck

**J. E. Mossman,** Phillips Control Corp., has been named chairman of the National Association of Relay Manufacturers' Committee on Standards and Nomenclature for 1948.

Other members of the committee include E. H. Gillette, Allied Control Corp., Inc., Fred W. Falck, Jr., Advance Electric & Relay Co., R. M. Brumfield, Potter & Brumfield Mfg. Co., Inc., and F. F. Rowel, Sr., Guardian Electric Mfg. Co.

## LITERATURE

**RCA Engineering Products,** Camden, N. J., have released a 16-page brochure describing a 10-kw f-m broadcast transmitter, type BTF-10B.

Topics discussed in booklet include direct f-m, automatic frequency stability, grounded-grid amplifiers, power stage, power supply and control circuits, and general performance specifications.

**The Standard Piezo Co.,** P. O. Box 164, Carlisle, Pa., have published a 4-page bulletin describing 11 types of mounted crystals. Crystal ranges include 1 to 20 mc, 100 to 10,000 kc, 3,000 to 10,000 kc, 12 to 75 mc and 400 to 10,000 kc.

**The Broadcast Operators Handbook** described in the March issue of COMMUNICATIONS is priced at $3.30 and not $3.00.

**The Chemical Publishing Co., Inc.,** 26 Court Street, Brooklyn 2, N. Y., have published a 1948 catalog of technical books.

Catalog includes books on chemistry, physics, science, technology, engineering, metals, technical dictionaries, etc.

**John F. Rider, Publisher,** Inc., 404 Fourth Avenue, New York 16, N. Y., has published a 416-page book on **F-M Transmission And Reception,** by John F. Rider and Seymour D. Uslan.

One section covers narrow-band and wide-band transmitters. Both direct and indirect f-m transmitter theory is explained. Transmitting and receiving antennas are also described.

Receivers are analyzed in another portion of the book. There is also a chapter on alignment of receivers, with both the meter and visual method discussed. Such servicing problems as relocation of antennas, image response, noise and oscillator troubles, cathode lead inductances, etc., are contained in last chapter.

**The RCA Tube Department** has published a revised edition of the reference booklet, **RCA Receiving Tubes for Television, FM, and Standard Broadcast.**

The new edition contains 24 pages and includes data on tv picture tubes.

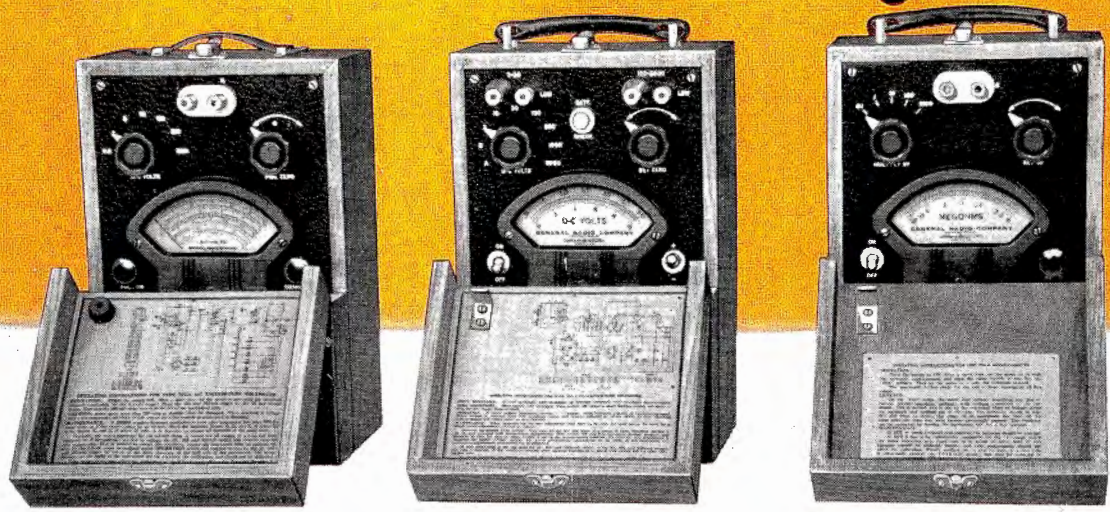
Booklet (form 1275-D) can be obtained from RCA tube distributors, or by sending 10 cents to Commercial Engineering RCA Tube Department, Harrison, N. J.

## ADVERTISERS IN THIS ISSUE

### COMMUNICATIONS INDEX

### APRIL, 1948

# METERS—by GR



### TYPE 727-A
### VACUUM-TUBE VOLTMETER

This general-purpose, battery-operated v-t voltmeter is for use at frequencies up to about 100 megacycles.

**RANGE** — 0.05 volt to 300 volts ac, in seven ranges (0.3, 1, 3, 10, 30, 100, 300 volts, full scale)

**ACCURACY** — With sinusoidal voltages applied, the accuracy is ±3% of full scale on the 0.3-volt range and ±2% of full scale on all other ranges. Periodic checking of the full-scale sensitivity will give corrections to be made to eliminate effects of aging on the higher voltage ranges.

**WAVEFORM ERROR** — On lowest ranges the instrument approximates a true square-law device. It is calibrated to read the r-m-s value of a sinusoidal voltage. On the higher voltage ranges it is essentially a peak-reading instrument calibrated to read 0.707 of the peak values and on distorted waveforms the percentage deviation from r-m-s values may be as large as the percentage of harmonics present.

**FREQUENCY ERROR** — Less than 1% between 20 cycles and 30 Mc. At 65 Mc the error is about +5% and at 100 Mc about +10%.

**INPUT IMPEDANCE** — The input capacitance is about 16 micromicrofarads. Parallel input resistance (at low frequencies) is about 5 megohms on the lower ranges and about 3 megohms on the upper.

**PRICE: $180**

### TYPE 728-A
### D-C VACUUM-TUBE VOLTMETER

This battery-operated v-t voltmeter is designed for measuring d-c voltages in low-power circuits where no appreciable power can be taken by the meter.

**RANGE** — 0.05 to 3000 volts in seven ranges (3, 10, 30, 100, 300, 1000, 3000 volts, full scale)

**ACCURACY**—Within ±3% of full scale on all ranges. If the full-scale sensitivity is checked occasionally the effect of aging, on the higher voltage ranges, can be eliminated

**INPUT RESISTANCE** — 1000 megohms on the ranges above 100 volts; greater than 5000 megohms on the lower

**TERMINALS** — Two sets of input terminals are provided; one for measurements at the 0 to 30 volts end of the range and the other for higher voltages

**POLARITY** — A reversing switch on the panel permits measurements with either the positive or the negative of the source grounded to the panel of the instrument.

**EFFECT OF A-C** — A superimposed a-c voltage of as high as 200 volts has negligible effect on meter indication

**PRICE: $155**

### TYPE 729-A
### MEGOHMMETER

This battery-operated megohmmeter is particularly useful where portability is required. It is well suited to field measurements of leakage resistance of cables and insulation.

**RANGE** — 2000 ohms to 50,000 megohms in five overlapping ranges

**SCALE** — Standard direct-reading ohmmeter calibration is used; center scale values are .1, 1, 10, 100 and 1000 megohms

**ACCURACY** — Within ±5% of the indicated value between 30,000 ohms and 3 megohms when the central decade of the scale is used; otherwise the error is increased because of the compressed scale

**TEMPERATURE AND HUMIDITY** — Effects of these are negligible over normal range of room conditions (65 to 95 deg. F.; 0 to 95% relative humidity)

**VOLTAGE ON UNKNOWN** — Voltage applied to the unknown does not exceed 22½ volts and varies with meter indication

**PRICE: $105**

THESE three accurate, highly stable and portable meters are all battery-operated and completely self-contained. They are housed in identical walnut cabinets 11 inches by 6⅝ inches by 5⅞ inches in size. Their accuracy is sufficient for a wide variety of measurements both in the laboratory and in the field.

Other G-R meters include a portable a-c operated vacuum-tube voltmeter for audio and radio frequency measurements up to several hundred megacycles, a crystal galvanometer direct-reading in voltage between 30 and 1,000 megacycles, an a-c operated megohmmeter with a range of 2,000 ohms to 50,000 megohms, a counting rate meter for measuring random emanations from radio-active materials, three models of output-power meters, and an audio-frequency microvolter with an output voltage range of 0.1 microvolt to 1 volt.

G-R meters are carefully designed, correctly engineered, ruggedly constructed and accurately calibrated to insure many years of useful life.

**A FEW OF EACH IN STOCK FOR PROMPT SHIPMENT**

# GENERAL RADIO COMPANY

**Cambridge 39, Massachusetts**

**90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38**