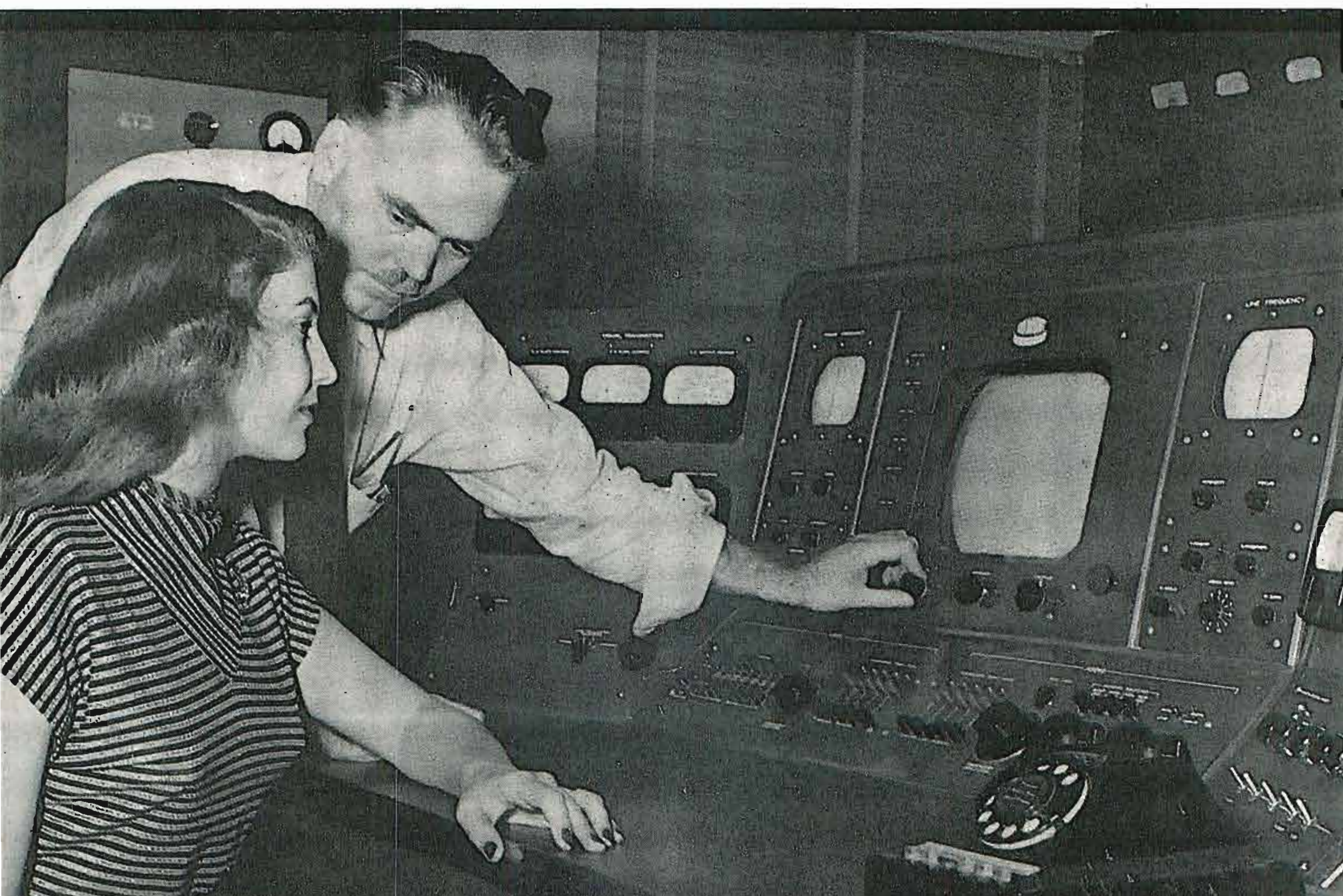
COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"



NOVEMBER

★ SIMPLIFIED REMOTE BROADCAST AMPLIFIER
★ AUDIO MEASUREMENTS IN AM, FM and TV
★ A CHART FOR RESONANT-CIRCUIT CALCULATIONS

1949

NEW Multi-Channel Radio Transmitter with
INDIVIDUAL OVERLOAD PROTECTION

INDIVIDUAL OVERLOAD PROTECTION

Advanced electronic design provides each unit with individual protection against overloading—failure of any one channel because of overload does not affect operation of others.

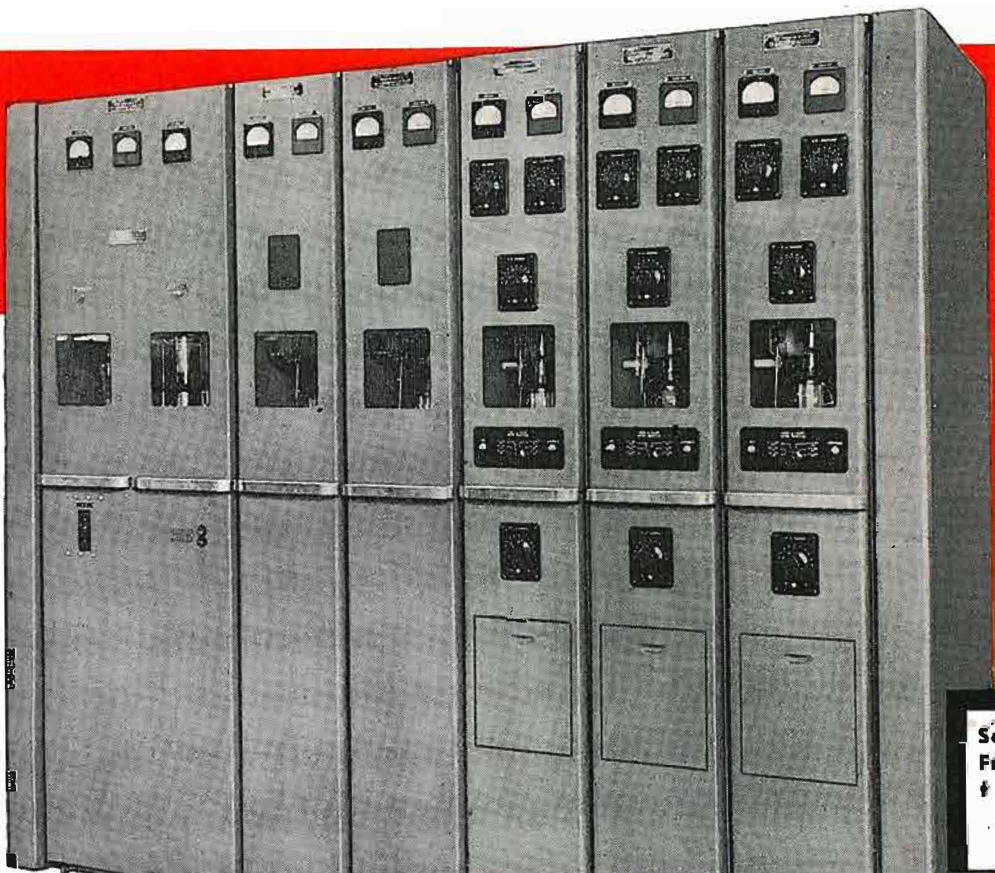
VERSATILE MULTI-CHANNEL OPERATION

Each channel provides up to 3,000 watts for continuous wave or frequency shift transmission—2,500 watts carrier for phone operation. Three basic units—power supply, transmitter, and modulator—permit a variety of combinations through simple channel switching.

TESTED FREQUENCY STABILITY

Meets rigid F.C.C. requirements for ground station operation. Frequency stability within plus or minus .002% at temperatures ranging from 0 to 45 degrees C.

- Channel Switching
- Individual Overload Protection
- Frequency Stability
- Communication Fidelity
- Inverse Feedback
- High Safety Factors
- Primary Circuit Switching
- Forced Air Cooling
- Low Operating Cost, Easy Maintenance



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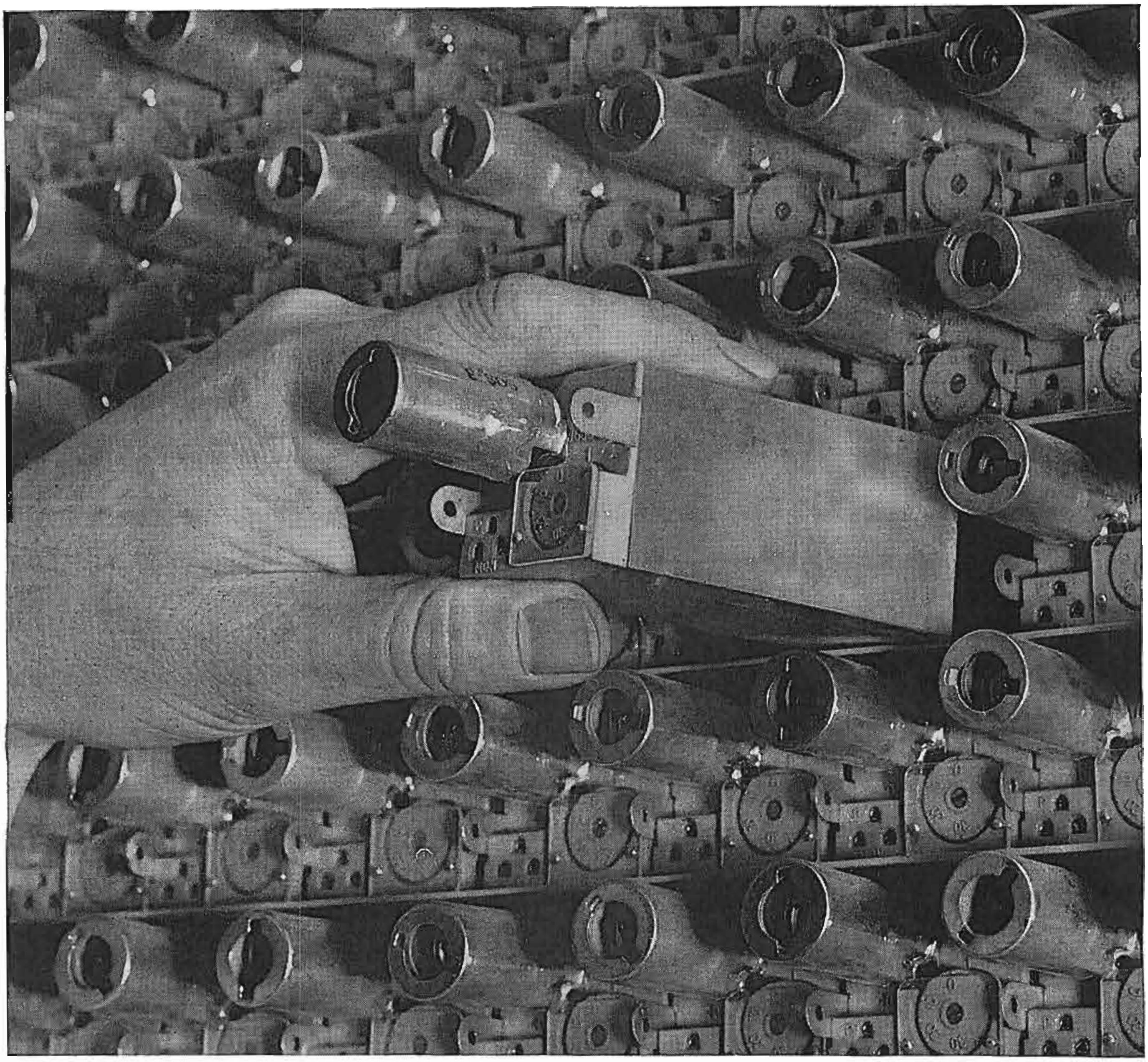
Research, Engineering, Production, and Testing facilities for equipment for: Wire Lines • Submarine Cables • Railroad Communication • Radio Airway Systems • Municipal Signaling • Army and Navy Signaling • Carrier Current • Automatic Telegraph • Facsimile



NOVEMBER, 1949 VOLUME 29 NUMBER 11

COMMUNICATIONS

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Bryan S. Davis, President
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East-Central Representative:
James C. Munn
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Telephone: Erieview 1726

Pacific Coast Representative:
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COVER ILLUSTRATION

Morris Barton, chief engineer of KBTV, Dallas, Texas, detailing the operation of a DuMont TV console to Angela Roberts, TV operator-in-training.

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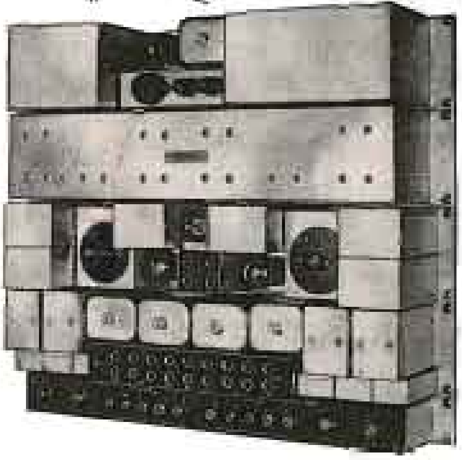
QUICK QUIZ

With a Helpful Answer

FOR COMMUNICATIONS MEN



Problem:

A company has a circuit between offices "A" and "B" consisting of 40 miles of No. 12 BB iron wire. Extending from "B" to "C" is another circuit made up of 25 miles of No. 12 BB iron. Changing traffic conditions call for a direct through circuit from "A" to "C". The use of the existing wire facilities does not provide acceptable transmission since the measured loss is 20 db and requirement is for a 5 db to 6 db circuit. How can this requirement be met?

Possible Solutions:

(a) One possibility would be the replacement of the iron wire with .104 copper wire. This would provide a calculated 4.5 db circuit but present day wire and construction costs would require an expenditure ranging from $12,000.00 to $18,000.00.

(b) Another solution would be the use of a voice frequency telephone repeater at location "B" capable of a minimum usable *gain* of from 14 db to 15 db under all ordinary weather conditions. If such a repeater could be found then this, obviously, would be the correct solution since the cost of a repeater is less than 5% of the cost of wire replacement.

The Logical Solution:

Yes—the logical solution is a voice frequency telephone repeater—*if* it's a Kellogg Repeater. Here's why—

One of the most important factors in obtaining maximum usable gain in a voice frequency repeater is the limitation of the band of frequencies to be amplified. In the Kellogg repeater this is accomplished in the No. 204 filter which has exceedingly sharp cutoff characteristics outside the voice band, i.e. below 300 cps and above 2700 cps.

Another very important consideration in establishing stable balance at the highest gain is the ability to obtain fine adjustments of resistance and capacity in the balancing net with the maximum of ease. This ideal condition is provided in the No. 1 balance network of the Kellogg repeater by the use of continuously variable potentiometers (two in each net) and a series of small capacity steps both readily adjustable by hand or screw driver. **Thus the time-consuming and comparatively inaccurate method of strapping to adjust for balance is completely eliminated.**

Gain adjustments (also screw driver adjusted from the front of the repeater) are accurately calibrated in 1 db steps so that the gain being obtained is always known without the necessity for measurement. Other refinements in Kellogg repeater design include (1) the use of push-pull amplification eliminating harmonic distortion and cross talk or other interference which may be introduced through the power source, (2) the operation of all components at conservative values of current and voltage well below the maximum ratings assuring long, trouble-free life, (3) unit type construction mounting on standard 19" equipment racks thus giving the flexibility necessary for adaption to various circuit requirements, (4) a wide variety of line units for different circuit or signalling functions and (5) provision of test and monitoring jacks for checking tubes and repeater operation.

Kellogg Repeaters are available for operation from either 24 volt or 48 volt battery or from a 105-125 volt 60 cycle AC power source.

SEND FOR OUR REPEATER BOOKLET NOW!

Kellogg Switchboard and Supply Company
6650 So. Cicero Avenue
Chicago 38, Illinois

Please send Repeater Booklet to:

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ADDRESS ____________________

CITY __________ STATE __________

KELLOGG SWITCHBOARD AND SUPPLY COMPANY

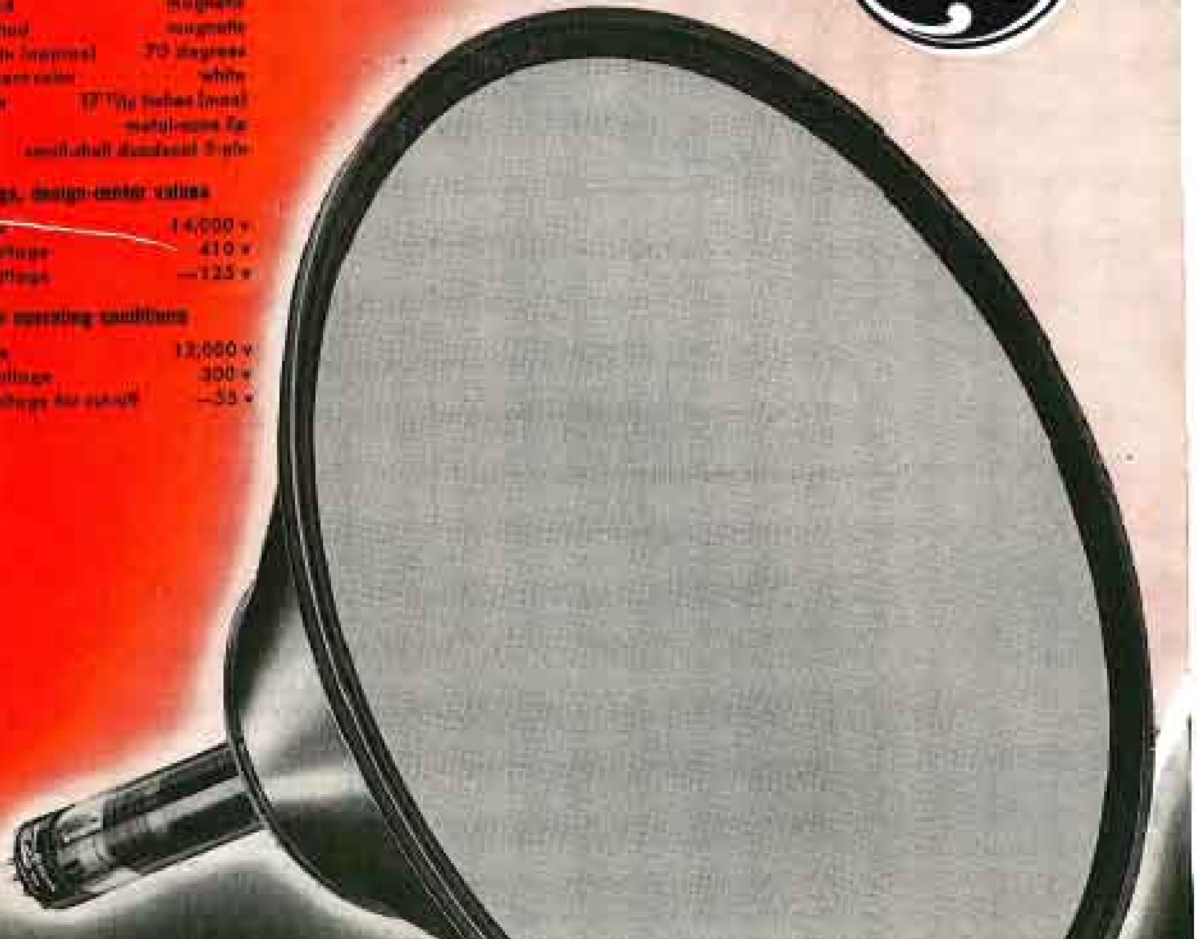
REPEATER

6650 SOUTH CICERO AVENUE • CHICAGO

STAY AHEAD IN
CHOOSE

CHARACTERISTICS
TYPE 16GP4

Max bulb diameter	16 inches
Min useful screen diameter	14⅝ inches
Heater voltage	6.3 v
Heater current	0.6 amp
Focusing method	magnetic
Deflecting method	magnetic
Deflecting angle (approx)	70 degrees
Screen fluorescent color	white
Over-all length	17 11/16 inches (max)
Bulb contact	metal-cone lip
Base	small-shell duodecal 5-pin
Max ratings, design-center values	
Anode voltage	14,000 v
Grid No. 2, voltage	410 v
Grid No. 1, voltage	—125 v
Typical operating conditions	
Anode voltage	12,000 v
Grid No. 2, voltage	300 v
Grid No. 1, voltage for cutoff	—35 v



TYPE 16GP4

16-inch metal picture tube, with wide-angle (70-degree) sweep, and high-contrast-glass face. Designed for modern receivers where size of the cabinet is restricted, yet the picture must be large, clear, and sharp. . . . Tube is less than 18 inches long; its weight is approximately half that of an all-glass type. . . . Generous picture area is 163 sq. inches when the entire tube face is scanned; 132.5 sq. inches when standard raster of 3-by-4 aspect is employed. . . . Special high-contrast-glass face helps produce a clear image with superior definition.

Interstage and Output TRANSMITTER DESIGN

to any combination of *rf* and modulator units up to a total of six.

The plate circuit efficiency of the class *B* power amplifier stage, including output transformer losses, is approximately sixty per cent. The overall transmitter efficiency (that is, useful *rf* power output divided by total power input to the rectifier unit) for the medium frequency transmitter is approximately fifty per cent.

The use of high-frequency iron-core transformers and untuned class *B* circuits have been found to provide many advantages over the conventional tuned class *C* design. The transmitter is only one-third to one-half the physical size of the equivalent class *C* transmitter. The use of class *B* circuits permits voice modulation without a modulator for the power amplifier stage. Since tuning of the transmitter circuits is not required, the operating frequency can be changed with a minimum of moving parts. When class *C* tuned transmitters are operated in parallel for greater power output, it is necessary to compensate for phase changes due to circuit tuning. Since the medium-frequency transmitters use untuned circuits which have a negligible variation in phase shift, they can be operated

Antenna matching transformer employed in the *mf* transmitter. This transformer weighs approximately eleven pounds. The plate voltage of 3500 to 4000 volts for the power amplifier tubes is supplied to the center of the primary winding. The ends of the primary are connected to the tube plates. Spark gaps are provided across each side of the primary to prevent voltage surges from damaging the transformer.

Part II . . . Constructional and Operational Features of Transmitter and Transformers.

by I. F. DEISE and L. W. GREGORY

Westinghouse Electric Corp.

more easily in parallel than the tuned class *C* transmitters.

While the medium frequency *rf* unit described was designed for 2.5-kw output, 5.2 kw power output has been obtained by increasing the drive to the power amplifier stage. This increased grid drive to the power amplifier stage was obtained by increasing the anode potential of the WL-807 second amplifier stage. When thus modified, the medium frequency *rf* unit has a rating of 4.5-kw power output. The medium frequency *rf* unit may be used as a three-frequency transmitter by limiting the types of emission and using an additional crystal oscillator.

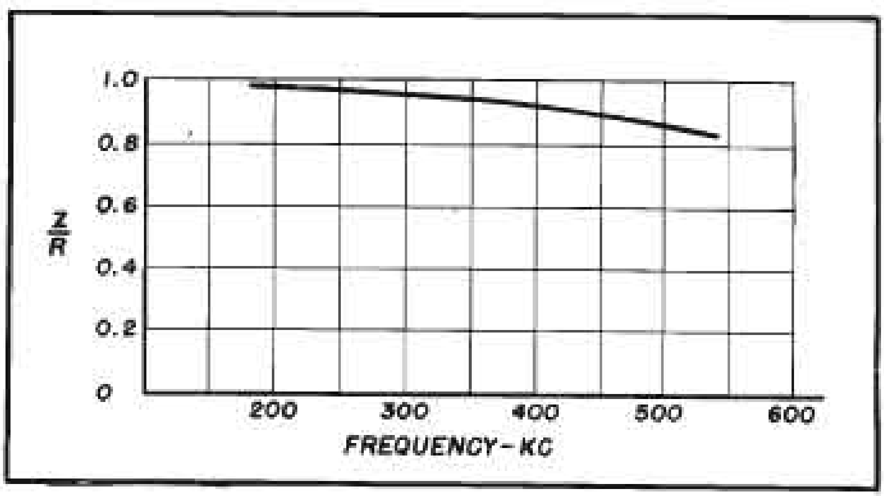
Transformer Design

Iron-core transformers designed to operate at medium *rf* are not materially different in construction or appearance from audio transformers. As in audio transformers, the characteristics of the *rf* transformer are determined by the primary open circuit inductance, the leakage inductance between windings, and the internal distributed capacitance of the transformer. For satisfactory operation the leakage inductance and distributed capacitance of the transformer must be held to low enough values so that the frequency at which the transformer becomes self-resonant is well above the highest operating frequency. These requirements dictate that the size must be as small as possible.

Core loss is an important consideration in *rf* transformers and generally determines the maximum operating flux density.

[To Be Concluded in December.]

Plot of the output transformer variation of impedance with frequency. With this impedance variation the plate current will be approximately 10% higher at 540 kc than at 200 kc for the same output, and thus the efficiency will be slightly lower at the high frequency.



Equivalent Circuit Method For

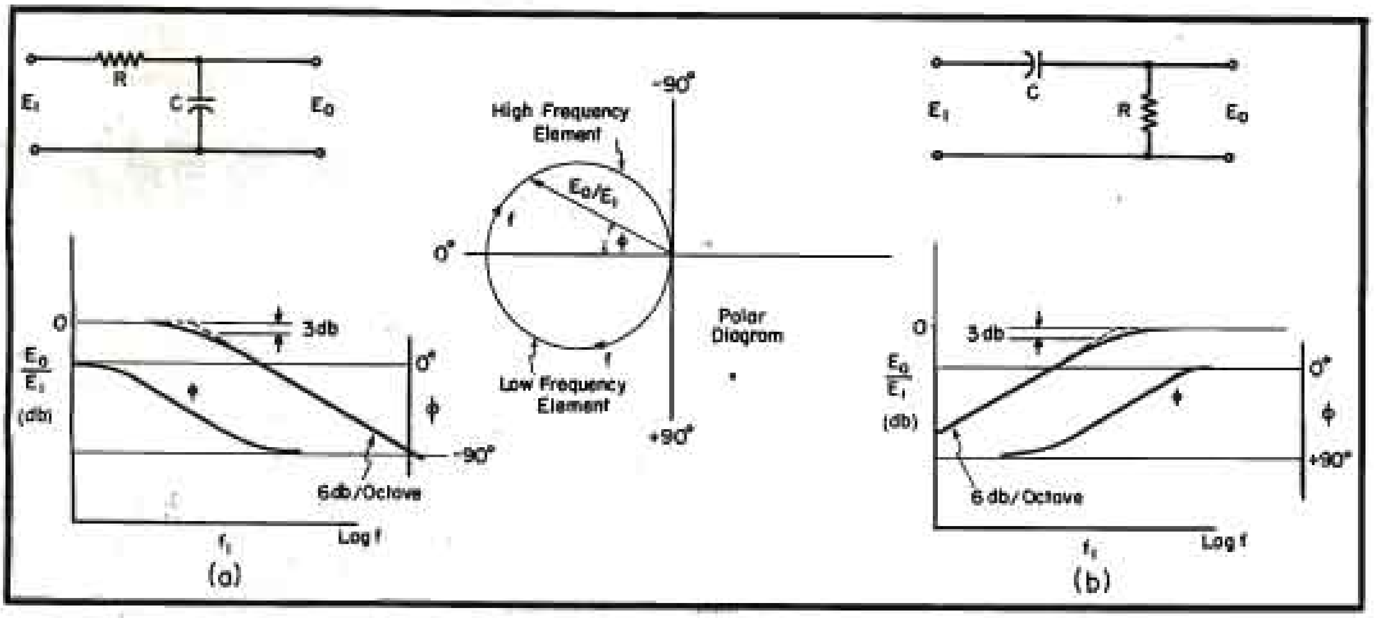


Figure 1
Fundamental elements of the equivalent circuit; (*a*) the high-frequency element and (*b*) the low-frequency element.

Successful design of a feedback amplifier requires careful consideration of the phase shifts of signals over a frequency range considerably larger than the range for which the amplifier will eventually be used; otherwise the amplifier may break into spontaneous oscillation. The circuit may oscillate if any signal, in going through the amplifier and feedback network, suffers a phase shift of 360° or more and has a gain of unity or greater around the loop. The conditions for stability, stated by the Nyquist criterion,[1] are that the locus of the end points of the complex loop gain vector ($A\beta$) must not enclose the point $1 + jO$. In applying Nyquist's criterion it is, therefore, necessary to know both the magnitude and the phase angle of the $A\beta$ vector. Since phase shifts are not easy to measure, the design of amplifiers to which feedback is to be applied also uses Bode's[2] relation which says that for minimum phase shift networks[3] the phase shift depends only on the slope of the attenuation-frequency curve. Using this relation, it is possible to calculate the phase shifts around the $A\beta$ loop, given the attenuation-frequency response of the amplifier and the transmission characteristics of the feedback loop. To apply Nyquist's criterion, these calculated phase shifts can be combined with the measured values of the magnitude of the $A\beta$ vector.

Now, Bode's relation is somewhat difficult to apply in practical cases, but, as the phase shift of a network depends only on the slope of the attenuation-frequency curve, our problem can be simplified if we analytically substitute a simple network, whose attenuation with frequency is the same or similar to that of the original network, and whose phase shift may be determined by inspection or by simple calculation.

To synthesize any attenuation-frequency curve the simplest possible *RC* networks can be used as building blocks, and connected to one another by *isolating circuits* in such a manner that their attenuations in db and phase shifts directly add. The *isolating circuits* may be thought of as an idealized vacuum-tube amplifier having constant gain, infinite input impedance, and zero output impedance. The fundamental circuits are shown in Figure 1. In *a* appears a simple high-frequency attenuating network and its characteristic curves. The attenuation of this circuit is zero for frequencies somewhat below its cut-off (or *break*) frequency, $f_1 = \dfrac{1}{2\pi RC}$, and drops at a constant rate of 6 db per octave at frequencies above this frequency. Its response is given by

$$\left|\frac{E_o}{E_i}\right| = \frac{1}{\sqrt{1+(\omega/\omega_1)^2}}$$

with phase angle

$$\phi = -\tan^{-1}\omega/\omega_1$$

where

$$\omega_1 = \frac{1}{RC}$$

Figure 1*b* shows a simple low-frequency attenuating circuit which is the same as the high-frequency circuit, but with the positions of *R* and *C* interchanged. In this case the gain will drop with decreasing frequency and the phase shift will be positive in sign instead of negative. Its response is given by

$$\left|\frac{E_o}{E_i}\right| = \frac{1}{\sqrt{1+(\omega_1/\omega)^2}}$$

with single angle

$$\phi = \tan^{-1}\omega/\omega_1$$

To set up an equivalent circuit for a feedback amplifier it is assumed that the attenuation-frequency curve of the $A\beta$ loop is approximately known for all frequencies where the magnitude of $A\beta$ is significant with respect to unity. This may be determined either from a knowledge of the input, output, and interstage networks, or from a few simple gain measurements. Now, using

[1]H. Nyquist, *Regeneration Theory*, BSTJ; Jan., 1932.
[2]H. W. Bode, *Relations Between Attenuation and Phase in Feedback Amplifier Design*, BSTJ; Vol. 19, 1940.
[3]For a brief discussion of minimum phase shift networks see, for example, F. E. Terman, *Radio Engineers' Handbook*, p. 218.

FEEDBACK AMPLIFIER ANALYSIS

Method May Be Applied to a Feedback Amplifier, Whose Attenuation - Frequency Characteristic is Known to Determine Its Phase Shift as a Function of Frequency, and Thus by Use of Nyquist's Criterion, to Determine How Much Feedback May be Used or How it Must be Changed so that a Given Amount of Feedback Can Be Applied.

by T. W. WINTERNITZ

Cruft Laboratory
Harvard University

as many simple building blocks as necessary, each separately isolated as described, this attenuation characteristic may be closely approximated by sections of straight line attenuations of 6, 12, 18, 24, etc., db per octave.

Equivalent Circuit Problems

In any particular case it may be more or less difficult to set up a suitable equivalent circuit. For the often-encountered case of a resistance-capacity coupled audio amplifier followed by a transformer-coupled power amplifier, it has been pointed out that to realize large amounts of negative feedback it is desirable to make the amplitude responses of the various stages different from one another; so that the attenuation slope will be more gradual.[4] If this rule is followed, the breaks in the attenuation characteristic will be separated and the various slopes will exhibit themselves directly in the measured data. In any case it should be noted that slopes, which are integrally related to 6 db per octave and therefore may be represented by the equivalent circuit, are the slopes that are normally encountered since they represent changes of amplitude with positive or negative integral powers of frequency.

When the equivalent circuit for the $A\beta$ loop has been constructed, it is a simple matter to calculate the associated phase shift; and, having once found this, one may then investigate the danger points of phase shift, the frequencies at which the phase shift is 180° either way from the mid-frequency value. If it is found that for the desired amount of feedback, Nyquist's criterion is well satisfied, then, the design will be satisfactory. On the other hand, if it is found that the loop gain is still large for frequencies which have phase shifts approximately ±180°, it will be necessary to apply less feedback or to alter the design of the $A\beta$ loop to have a slower rate of increase or decrease of amplification with frequency and to re-investigate the new design with a new equivalent circuit.

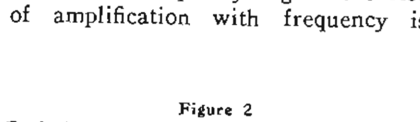
Example

To illustrate the use of this method, let us suppose that we have an amplifier with a constant gain A_m in its mid-frequency region. We find that its amplification drops off in the high-frequency region approximately as follows:

(*a*) At 6 db per octave for one decade above the frequency f', i.e., in the region $f' \leq f \leq f''$.
(*b*) At 12 db per octave for two decades above this, $f'' \leq f \leq f'''$.
(*c*) At 18 db per octave from f''' on.

In the low-frequency region the rise of amplification with frequency is somewhat more gradual than the drop off at high frequencies. It is desired to apply as much resistive voltage feedback to this amplifier as is possible without encountering oscillation. First, we notice that since the attenuation at high frequencies is more abrupt than that at low frequencies, and therefore will be associated with a more rapid phase shift, the high frequencies will control. In other words, it will *sing* at a high frequency if excessive feedback is employed instead of *motor-boating* at some low frequency. Since this is the case, we need only investigate the phase shift at the high frequencies. If the attenuation slope were not more gradual in the low-frequency region than at high frequencies, it would be necessary to investigate the phase shift in the low-frequency region as well.

Figure 2
Equivalent circuit for the $A\beta$ network of the amplifier discussed as example.



A β Loop Equivalent Circuit

The equivalent circuit for the $A\beta$ loop is shown in Figure 2. It will be noticed that we are neglecting all phase inversions in the amplifier. It is understood that for negative resistive feedback there must be one uncancelled phase inversion in the amplifier, if the feedback is applied from output of the amplifier to input. Thus $A_m\beta$ is inherently a real negative number. Let

$$\omega' = \frac{1}{R_1 C_1},\ \omega'' = \frac{1}{R_2 C_2} = 10\,\omega',$$

$$\omega''' = \frac{1}{R_3 C_3} = 1000\,\omega'.$$

Then for the equivalent circuit

$$\left|\frac{E_o}{E_i}\right| = \left|A\beta\right| = \frac{A_m\beta}{\sqrt{1+(\omega/\omega')^2}\,\sqrt{1+(\omega/10\,\omega')^2}\,\sqrt{1+(\omega/1000\,\omega')^2}}$$

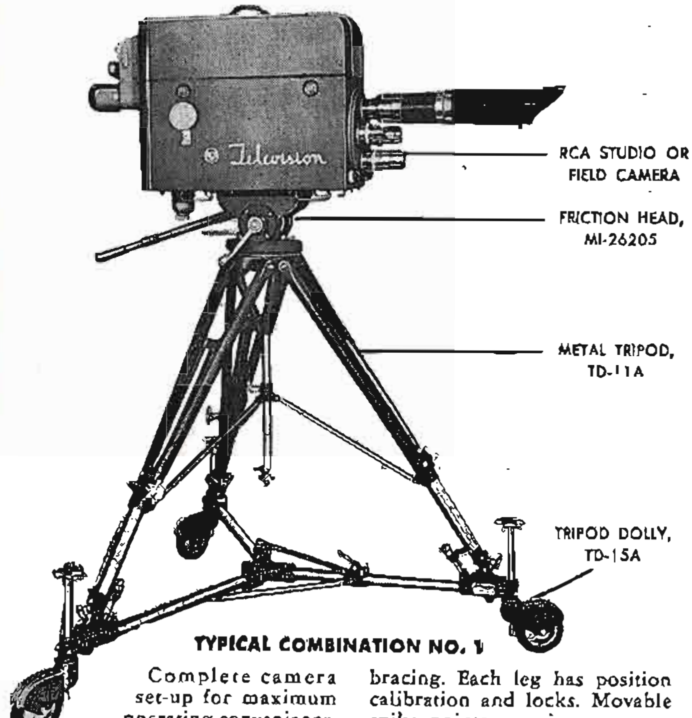
and the phase angle of $A\beta$, ϕ, is given by

$$\phi = -\tan^{-1}\omega/\omega' - \tan^{-1}\omega/10\,\omega' - \tan^{-1}\omega/1000\,\omega'$$

The phase shift is computed in Table 1 (p. 30) and a curve of $A\beta$ and ϕ is given in Figure 3; p. 31. From Figure 3 we see that at the frequency (f_o) the phase has been shifted −180° from its mid-frequency value. Also at this frequency $|A\beta|$ is about 40 db below its value at mid-frequency. This means that the maximum value $A_m\beta$ may have at mid-frequency is 40 db or that the

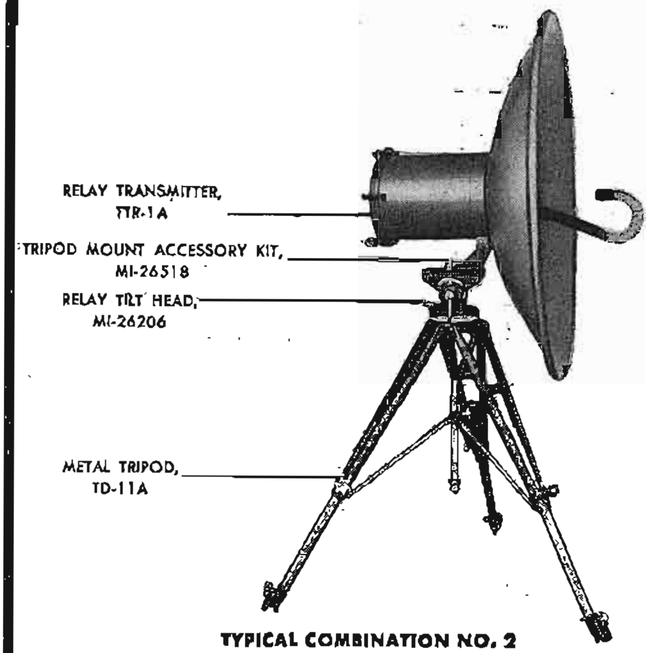
(Continued on page 30)

[4]For example, see F. E. Terman, *Radio Engineers' Handbook*; pp. 397-8.



TYPICAL COMBINATION NO. 1

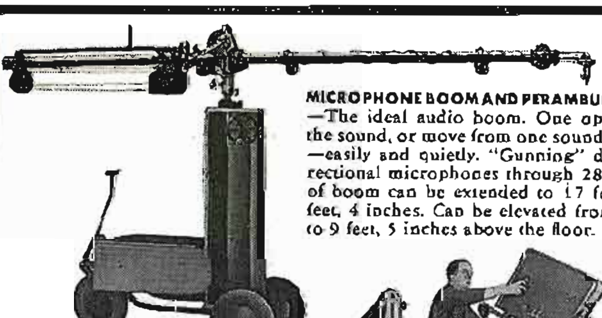
Complete camera set-up for maximum operating convenience. *Friction Head, MI-26205* gives camera 360-degree panning and full tilting action. Has "degree-indicator" scales and locking handles. *All-Metal Tripod, TD-11A* uses individual tie rods and center post for sturdy bracing. Each leg has position calibration and locks. Movable spike points permit set-ups on rough surfaces. Unit folds into compact, self-locking package. *Tripod Dolly, TD-15A* takes up a circular area only 57" diameter. Wheel stops for fixed positions. Folds and carries in a compact package.



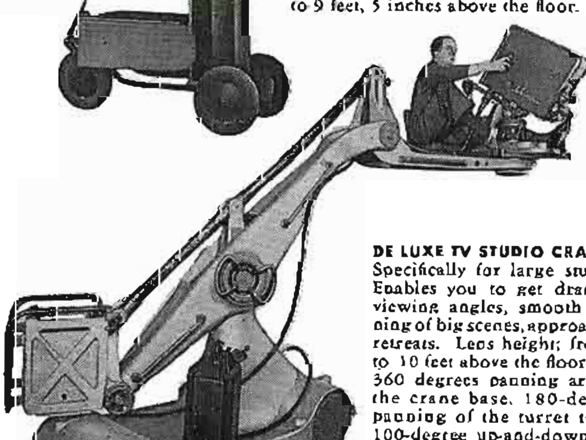
TYPICAL COMBINATION NO. 2

A complete vhf relay transmitter for difficult terrain and long distances, where radio relay is more practical than coaxial cable. *Tripod Mount Accessory Kit, MI-26518* provides means for mounting relay equipment to tripod. Includes mounting plate, saddle, and bolts. *Relay Tilt Head MI-26206* provides wide adjustment angles for vertical tilt and horizontal rotation. Sealed bearings for all-weather service. Accurately calibrated. Individual locking handles. *Metal Tripod TD-11A* same as Combination No. 1.

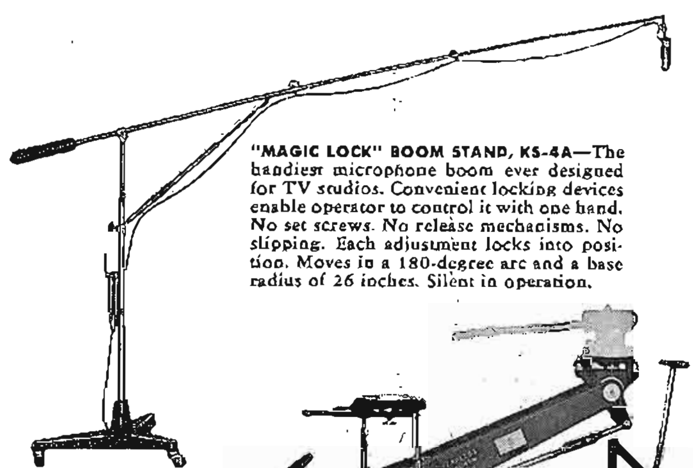
Dollies, booms, stands,



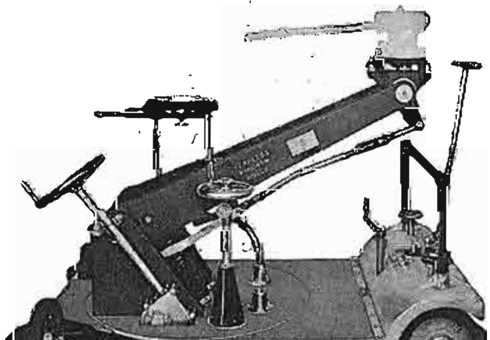
MICROPHONE BOOM AND PERAMBULATOR, MI-26574—The ideal audio boom. One operator can follow the sound, or move from one sound source to another—easily and quietly. "Gunning" device revolves directional microphones through 280 degrees. Radius of boom can be extended to 17 feet; retracted to 7 feet, 4 inches. Can be elevated from 6 feet, 5 inches to 9 feet, 5 inches above the floor.



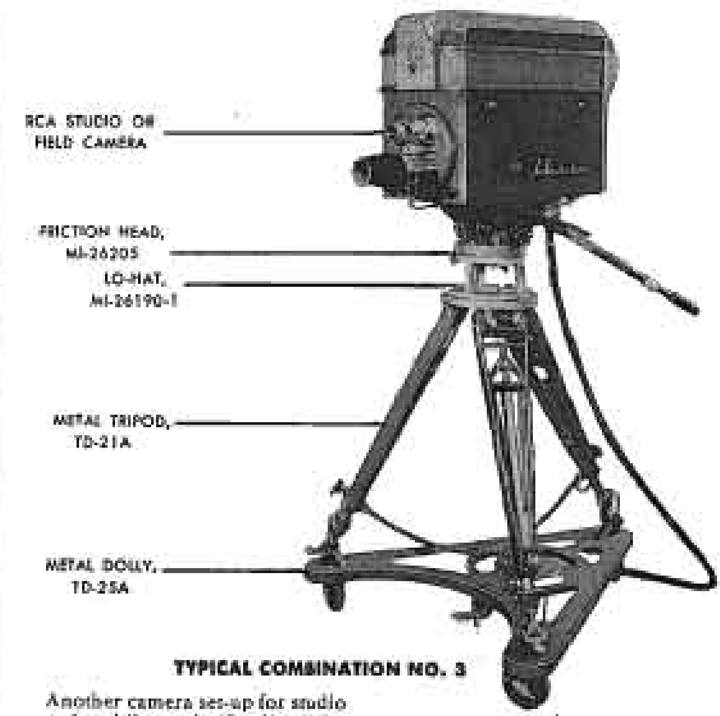
DE LUXE TV STUDIO CRANE—Specifically for large studios. Enables you to get dramatic viewing angles, smooth panning of big scenes, approaches, retreats. Lens height; from 2 to 10 feet above the floor. Full 360 degrees panning around the crane base. 180-degree panning of the turret table. 100-degree up-and-down lift. Turns in a 6-foot radius.



"MAGIC LOCK" BOOM STAND, KS-4A—The handiest microphone boom ever designed for TV studios. Convenient locking devices enable operator to control it with one hand. No set screws. No release mechanisms. No slipping. Each adjustment locks into position. Moves in a 180-degree arc and a base radius of 26 inches. Silent in operation.



STUDIO CAMERA DOLLY, TD-8A—Similar to the dollies used in film studios—but both front and rear wheels turn to the side. Entire unit can be moved sidewise. Stops lock the dolly in a fixed position. Camera crane boom can be elevated from 23 inches to 74 inches above the floor.



TYPICAL COMBINATION NO. 3

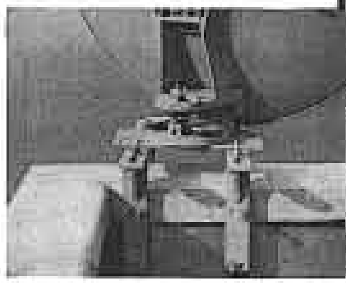
Another camera set-up for studio and mobile work. Handles RCA Studio Camera or Field Camera. *Friction Head, MI-26205* same as used in Combination No. 1. *Lo-Hat, MI-26190-1* provides greater freedom and height for camera action. *Metal Tripod TD-21A* for fixed or portable set-ups. Cast aluminum and stainless steel construction. Legs adjustable up to 21 inches. Dual feet; pointed for field work and flanged for fixed service. *Metal Dolly TD-25A.* Non-swiveling. Foot-controls for parallel wheel alignment. Individual wheel and tripod locks.

TYPICAL COMBINATION NO. 4

A complete relay pick-up receiving system. Relay receiver and parabola fasten to tripod through Reflector and Parapet Mount, MI-26187. *Metal Tripod, TD-21A* is set up for rough surfaces.

* * *

Field Camera and Friction Head, MI-26205, can be mounted on *High Hat MI-26190-2* for wall or parapet use. Complete assembly is attached to *Parapet Clamp Support MI-26189.*



Here, Reflector and Parapet Mount MI-26187 fasten to Clamp Support, MI-26189—which mounts on top of wall. Relay reflector may also be permanently mounted in wall openings by means of "Gimbal" *Antenna Ring Mount, MI-26207* (not illustrated).

mounts, accessories

for every TV set-up

STUDIO CAMERA PEDESTAL, TD-1A—Television's favorite pedestal for studio and other indoor operations. Moves freely, quietly. Crank handle raises and lowers camera to any height between 40 inches and five feet above the floor. Moves in any direction—or about a point. Panning and tilting provided by Friction Head MI-26205.

PICTURED on these pages are typical units and combinations from the most complete line of television accessories in the industry—application-engineered to meet every pick-up situation called for in your TV operations.

This line of mechanical accessories enables you to select just the right combination for your station operation. It includes every device needed for providing universal camera action in the studio and the field. It provides additional flexibility for maneuvering and covering shots from any angle.

RCA TV accessories are stoutly built to withstand the tough wear and tear encountered in field and studio operations. Yet each unit is a model of mechanical simplicity—easy to transport, easy to set up, easy to adjust, and easy to handle.

RCA TV accessories like these are used today in nearly every television station in the country. For complete information on the entire line, call your RCA Broadcast Sales Engineer. Or write Dept. 23K, RCA Engineering Products, Camden, New Jersey.

TELEVISION BROADCAST EQUIPMENT
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ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

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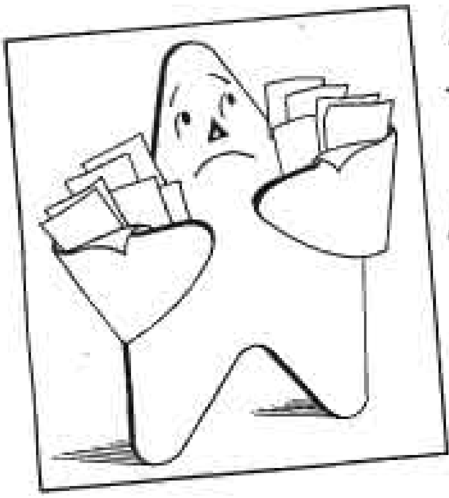


That High-Power INSTALLATION

by RALPH G. PETERS

THROUGH CAREFUL search one might discover a broadcast engineer who has never dreamed, secretly or audibly, of installing a high-powered transmitter, particularly the 50-kw AM or equivalent FM or TV setups. You won't find many. Statistics from such a search would reveal that the intensity of the longing is in inverse proportion to the power of the stations said engineer has operated or installed.

With some of the wounds from such a battle still tender allow me to pour a little sober realism over those dream clouds and if the longing persists, more power to you.

In this day and age the construction of any building, large or small, commercial or dream house, involves headaches common to the building trades and material supplies and will not be discussed at this time. The installation of acres of ground system, erection of towers, building of tuning houses, transmission lines and other details incident to getting the fifty thousand or so radiated into the ether are also another story.

Looking backward, the note book reveals that there were months spent in planning and sketching, trying to anticipate everything that would ease the task of installing the transmitter in the new building. The big roll of blueprints supplied by the transmitter manufacturer had to be studied and studied to become familiar with every item, to know just how everything would fit in place. After much prodding from the *boss*, the building finally reached a state where the transmitter installation could begin, so the transmitter maker was wired to ship at once.

A week or so later a mild sort of shock struck. Seems as if the figures on the blueprint didn't add up to two freight car loads, amounting to some thirty-odd tons of transmitter that were on the siding awaiting our pleasure, with a note to please hurry as the cars and the space were needed. And where was the siding? In the tall weeds a few miles from the transmitter site. This is true because radio stations have to be built in the most inaccessible spots available, and fifty kilowatters appear to go the limit in this respect.

Well, there was nothing to do but make the best deal possible with the machinery mover and get busy, but fast. The precious equipment couldn't be left to the mercies of the weather. The *boss* had warned that he paid for it. Then the fun began, the piling of all the boxes and crates inside, trying to ignore the pointed remarks of the craftsmen who anticipate moving them around as they complete their work on the building. At the same time an effort was made to try and identify the contents of each of the one hundred and fifty-odd boxes and crates so some attempt could be made at opening them in the proper order. The boys found that this process was aided somewhat by so-called packing lists, with their rows of six-digit numbers bearing a tantalyzing relationship to some numbers on the blueprints, but differing enough to pique anyone's sporting blood.

The preliminary data from our equipment friend had assured us that all units would pass through an opening eight feet high, so no extra margin had been allowed in the building design. There was no mention that it would be necessary to remove the crating, a few projecting parts and the supporting beams to be within this limit. Shifting two or three tons of cabinet or transformer on rollers of course is no hardship; dragging it on cement when there is no room for rollers is something else. It offers one an opportunity to exercise your ingenuity and is good training for what is to come.

And then it was found that at least three of the larger units would have to be hoisted two feet or more to set them over the air pipes already in place.

As assembly began, more intriguing problems arose. For instance, as the final amplifier was being arranged, 'twas found that the three hundred-pound gas-filled capacitors had to hang from the top. Why couldn't they sit on a base, we wondered? And we also wondered why the pressure gauges on these capacitors were placed so that only a midget could squeeze in far enough to read them. Some revolutionary design might have remedied these minor inconveniences, but such a move had no doubt been set aside for inclusion in next year's model.

As the modulator unit was being put together we found our ingenuity taxed again by the problem of making neat right-angle bends in stiff two-inch automobile radiator hose which was to carry cooling air to the top of the big tubes. The instructions stated that the pipe was to go to another pipe. Getting it there was our problem. We were installation engineers now, and such details were to be taken in stride.

In both the *rf* exciter and the final amplifier some inductances and capacitors were romantically identified as *frequency determining parts*. Yes, we too thought the frequency was determined by a crystal oscillator, but don't expect an explanation from your rep; he was just as confused as we were. Somewhere, in early stages of design, an engineer wrote *frequency determining parts*, when he meant *parts determined by frequency*. It became a part of *design*, and some higher power will have to be called upon to correct it. The problem at hand was to determine whether our *friends* sent the correct *frequency determining parts* for our frequency (you will find eventually

(*Continued on page 24*)

New Higher Power Electron Tube with All-Ring Seals

Now Available for Full Power Operation Up to 110 mcs/sec.

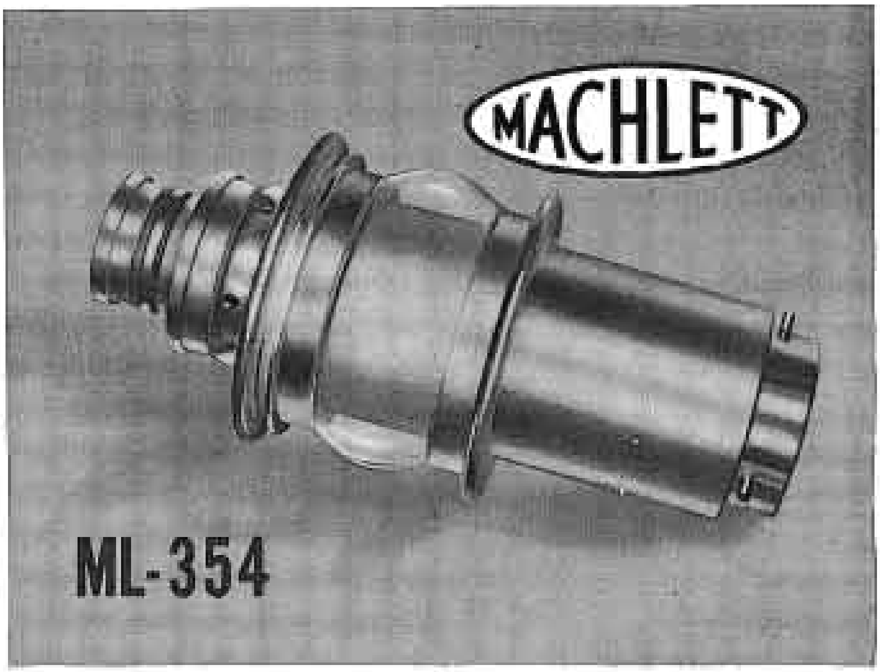
The availability of the Machlett ML-354, a compact, super-power water and forced-air cooled triode for operation up to 110 mcs/sec. in FM, AM, TV and industrial service is a contribution of significant proportion to progress in all fields of electronic development. The tube is provided with coaxial filament, grid, and plate seals, making it ideally suited to cavity-type circuits.

Superior Design Features

Developed to satisfy the need for higher-power electron tubes in broadcast, communications, research, and industrial services, this all-ring-seal triode is of a balanced electrical and mechanical design. Its low plate impedance makes it ideally suitable for broad band applications. All electrodes mount directly from heavy copper cylinders, resulting in a structure which is far superior, electrically and mechanically, to conventional water-cooled electron tube design; all glass-to-metal seals are of Kovar, and the large diameter seals give increased strength and freedom from excessive heating at electrode contacts. The tube incorporates a high-conductivity, heavy-wall copper anode. The integral anode water jacket and quick change water-coupling, contribute to easy and rapid tube replacement. The cathode is a 16 strand self-supporting thoriated-tungsten filament, completely balanced and stress-free throughout life. The rigidly supported grid and cathode are designed to give uniform anode heating. The grid is capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

Wide Application

The foregoing design features and characteristics are incorporated in the ML-354 triode, developed by Machlett Laboratories, Inc., Springdale, Conn. The ML-354, having basic design features usable over a wider range of power and frequencies than has been heretofore available in triodes, finds applications, among others, in high-power AM, FM and TV broadcasting, cyclotron and synchrotron oscillators and in induction and dielectric heating.



DESCRIPTION

The **ML-354** is a compact, general purpose, high power electron tube designed for operation at full power up to 110 mcs/sec. It is an all-ring-seal water and forced-air-cooled triode capable of giving in excess of 50 kilowatts output power at 108 mcs/sec. in grounded grid circuits with 10 kilowatts driving power. Considerably higher power is available at lower frequencies. This tube is ideally suited for cavity operation, and its low plate impedance is advantageous for broad band applications. Features include Kovar glass-to-metal seals, sturdy electrode structures, integral anode water jacket, and quick change water coupling. The cathode is a stress-free self-supporting thoriated-tungsten filament.

GENERAL CHARACTERISTICS

Electrical		Mechanical	
Filament Voltage	12.5 volts	Mounting	Vertical, Anode Down
Filament Current	220 amps	Water-flow on Anode	
Amplification Factor	25	for 75 KW Dissipation	45 gpm
Interelectrode Capacitances		for 50 KW Dissipation	30 gpm
Grid-Plate	65 uuf	Air Flow on Seals	
Grid-Filament	83 uuf	to limit glass to 165°C.	220 cfm
Plate-Filament	2.4 uuf	Net Weight, approximate	40 lbs

MAXIMUM RATINGS: Radio-Frequency CW Oscillator

	Max. Freq. 50 mcs/sec.	*Max. Freq. 110 mcs/sec.*	
DC Plate Voltage	15	9	kVdc
DC Plate Current	13	13	Adc
DC Grid Voltage	−1.6	−1.6	kVdc
DC Grid Current	2.5	2.5	Adc
Plate Input	195	100	kW
Plate Dissipation	75	50	kW

For complete technical data on the ML-354 high power, all-ring-seal triode, write to Engineering Department,

MACHLETT LABORATORIES, INC.
Springdale, Conn.

Distributed by Graybar

MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

Fall Meeting

THE ANNUAL Fall meeting at the Fireplace Inn, New York City, attracted quite an audience, with many old-timers and out-of-towners appearing for the first time in years. Up from New Orleans was Paul Jensen; from St. Louis, George Martin, and from Cleveland, G. P. Shandy. VWOA vice president Haraden Pratt, who had been ill for many months, came down, too.

Others at the get-together included Henry Hayden, VWOA assistant secretary and his guest S. B. Allen; Paul Trautwein, who hasn't been around for a long while; Joe. L. Savick; Roscoe Kent; A. J. Stobbart, who came down from Philadelphia; Stan Wolff, from Brewster, N. Y.; Joe. T. Maresca; Jerry Goldrup, R. H. Pheysey, Tony Brizzalari; Frank Orth; George Duvall; Sam Schneider; Charles R. Shanholtzer, R. K. Davis; H. B. Koch; Pete Podell; Benny Beckerman; Ken Richardson; H. H. Parker; E. N. Pickerill; C. D. Guthrie; Arthur Costigan; Geo. Clark; Bill McGonigle, ye prexy; Bill Simon, ye secretary; H. T. Williams; Joe Maloney; Arthur Rehbein; John Lohman; Gene Cochrane; J. P. Laurant; Robt. L. Fischer, Tony Tamburino; Vic Villandre; Dave Little; G. I. Martin; G. P. Shandy and Marvin Seimes. . . . Lt. Comdr. D. A. Bark advised he couldn't attend since he was in Astoria, Oregon, at the U. S. Naval Station. . . . Jim Marcroft reported that he was busy at Hicksville, L. I., with Press Wireless. . . . Milton King notified the committee that he was leaving for a vacation, and would thus be absent. . . . George Bonadio said he was just too busy. . . . Monte Cohen, E. H. Price, A. Barbalate, Don McNicol and Wylie Paul wrote in for reservations, but were prevented from attending because of QRM. . . . L. H. Marshall was on his way to the Azores aboard the USNT Peconic and thus couldn't come to the affair. . . . Pat O'Keefe was bound for banana land aboard the SS Jamaica that night and so was S. G. Scruggs on the SS Junior. . . . R. S. Henery was busy out at Rocky Point. . . . Due to illness L. C. Nunn could not be present. . . . F. C. W. Lazenby was away on a lecture tour out west. . . . Max F. Ortely could not make it because of duty. . . . Harry Cornell was on vacation. . . . Jack Poppele sent in a reservation, but developed a bad cold. . . . Roger Lum was out of town.

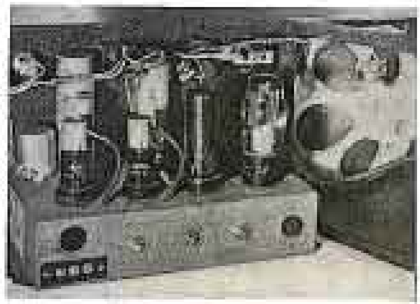
At a recent VWOA dinner meeting in New York City, front to rear: Ray Morehouse, R. J. Iversen and C. D. Guthrie.

Personals

YE PREXY announced at the Fall meeting that the VWOA Dinner-Cruise in February, 1950, celebrating our 25th anniversary, will be an outstanding event. . . . VWOA life member Raymond Guy has been elected president of the IRE for 1950. Congratulations. . . . Geo. Clark has reported that the Monument Committee will soon present plans to the N. Y. City Hall boys concerning the relocation of the Radio Operators Monument. . . . Tom Gardner advised that he was changing his address from Portland, Oregon, to Galveston, Texas, to become Radiomarine service manager in that port. . . . Charles M. Hodge has written in from Dhahran, Saudi Arabia, where he is employed by the Arabian American Oil Co. . . . Al. Koehler wrote in to say that he enjoys hearing via COMMUNICATIONS about some of his old friends. . . . G. G. Benson must be quite busy down in Jackson, Miss., for it's been many months since he's contacted us. . . . Glad to see that dues funds are coming in early this year. Thus far we've heard from H. K. Bergman, who is with WGY, Schenectady; H. B. Black; Monte Cohen, who is treasurer and executive vice president of F. W. Sickles, Chicopee, Mass., and H. L. Cornell, who is with Socony Vacuum, and has been extremely busy during the last few months completing the company's radar installation program. . . . H. D. Kaulback, Commander, USN, is now stationed at First Naval District headquarters, serving as District Reserve Electronic Warfare Program Officer. . . . William S. Marks, commenting on his early days in radio, reveals that he began back in '17 while he was in the Navy. He attended Harvard University Naval Radio School at that time, and in '19 he obtained his First Class Commercial Radio license and started his commercial career aboard the SS Warwick. Also sailed aboard the SS Birmingham City, SS Dannedaike, the old Shipping Board vessels. Later he sailed on the Vacarro out of New Orleans, and Black Diamond and Isthmian out of New York City. He is now chief engineer of the Coles Signal Laboratory, Fort Monmouth, N. J., where he has been located since '30, except for an active duty period in the Signal Corps from '42 to '46 as Lt. Colonel. . . . Old-timer H. D. Taylor was recently honored on his 25th anniversary with WITC in Hartford, Conn. He started there back in '24 as chief operator. For the last eight years he has been plant engineer and chief engineer. . . . Don De Neuf, who for the last two years has been chief engineer of the Rural Radio Network, is now assistant general manager in charge of engineering and station relations. . . . VWOA life member Brigadier General David Sarnoff, chairman of the board of RCA, received the Peter Cooper medal for the Advancement of Science and art at the recent convocation ceremonies in N. Y. City honoring Cooper Union's 90th anniversary. DS was selected by a jury of nine presidents and deans of engineering schools and colleges in the New York area, for outstanding service in the advancement of science *in its practical application to life.*

Left, front view of remote broadcast amplifier. The small unmarked bakelite plate, at the lower left side of the panel, hides the output transformer taps. Removal of this cover allows attachment of suitable loudspeakers, permitting use of the unit as a low power *pa* system. To set the volume, while the amplifier is operating at low gain, a double 3,500-ohm potentiometer front-panel control is used. It was found necessary to use a panel-operated control, in this case, not only to compensate for necessary variations in the studio cue feed, but because of varying requirements at the pickup point.

Internal view. The amplifier is mounted in a cabinet with a hinged lid which may be raised for access to the tubes. The panel, which is removable, mounts the amplifier.



SIMPLIFIED Remote Amplifier

by WILLIAM MARSH

Chief Engineer
WHHM, Memphis, Tenn.

Equipment, Requiring No Special Operator, and Developed for Remotes where Single Mike is Used, Features 6-Watt Amplifier With Provision for Switching Terminations, Gain and Function.

SIMPLIFIED equipment has always been found extremely handy, particularly at the small station with limited manpower. This was demonstrated quite effectively a short while ago at our station, when a simplified remote amplifier was developed.

The amplifier, designed for remote broadcasts of a recurring nature, was found ideal for operatorless pickups from churches, man on the street, night clubs, or any other occasion where a single microphone pickup could be used.

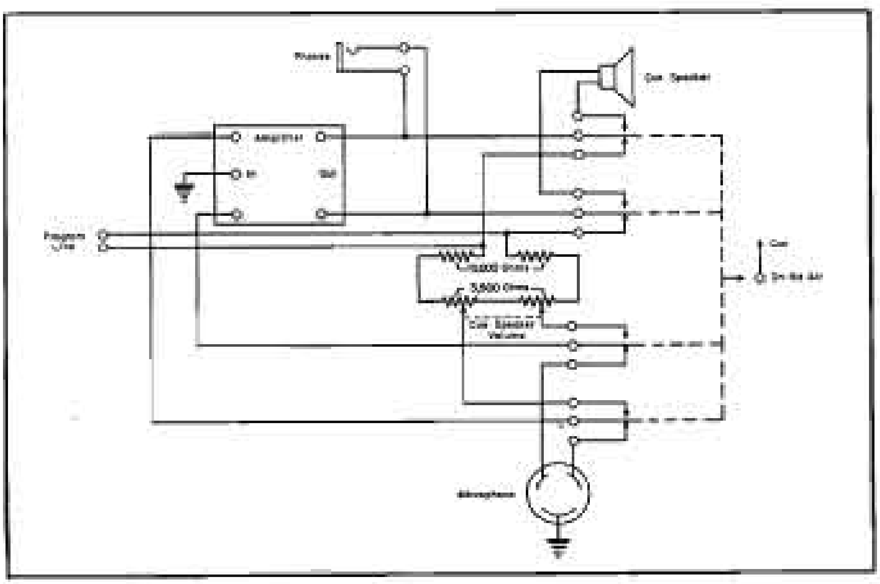
The basic amplifier used was a six-watt unit[1] with low impedance output from one 6L6. The amplifier was mounted in a cabinet,[2] which has a hinged lid which may be raised for access to tubes. A carrying handle is bolted to this lid. A speaker was mounted in one louvered end of the cabinet.

The remote setup is essentially an amplifier with means for switching terminations, gain, and function. When used for receiving a cue, it is a low gain line-bridging amplifier which operates into a loudspeaker, and when used for originating a broadcast, it is a high gain microphone amplifier which feeds a line.

Gain is regulated in the remote amplifier by means of two volume controls. One control, which sets the

(*Continued on page 26*)

[1]RCA MI-12238. [2]Bud C1747.



Circuit of the amplifier which requires no continuous operator for control.

Resonant-Circuit Calculations

(Continued from page 9)

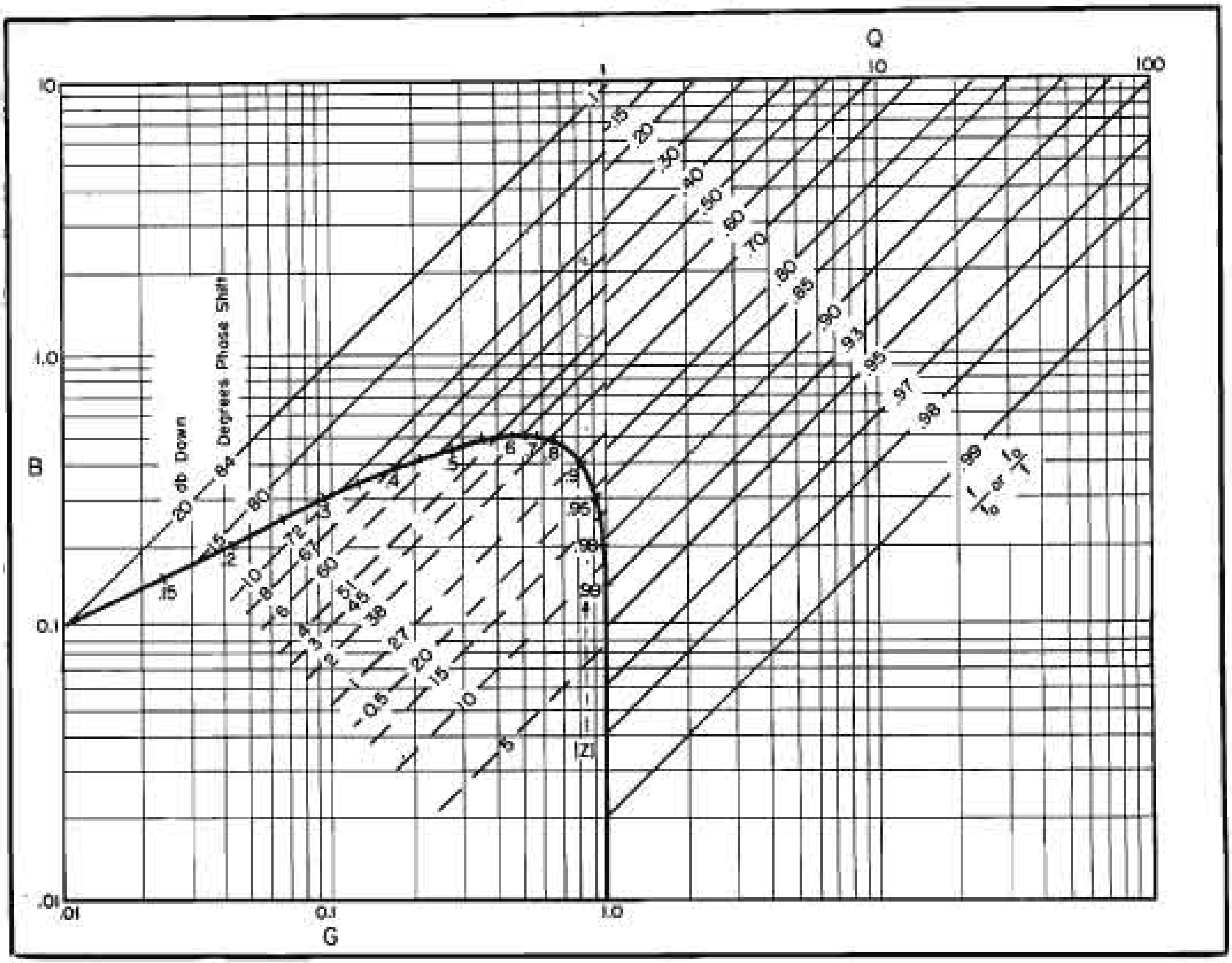


Figure 7
An improved version of the chart of Figure 6 replotted on log-log coordinates.

(ignoring the effect of the tube plate resistance) is proportional to $|Z|$ at each frequency, and the phase shift is equal to θ. Therefore radial lines from the origin to the Y-locus may be *calibrated* in terms of the phase angle and gain in db relative to the gain at resonance.

The chart of Figure 6 incorporates all of the aforementioned features. The radial lines drawn (arbitrarily) from the point $G = 1$, $B = 0$, provide for the variation in Q. Each of these lines represents a fixed value of f/f_o (or f_o/f), whereas the abscissa scale along the top of the graph is marked in terms of Q. If the intersection of given lines for f/f_o and Q is projected horizontally to the B-axis, the corresponding value of B may be read. The intersection of this line with the Y-locus gives the value of Y as $1 + jB$. A line drawn from the Y-point to the origin crosses the circle at the value of Z. For example, suppose a circuit's $Q = 4.75$, and $f/f_o = 0.9$. The intersection of these lines would be point A. Projection of point A to the B-axis gives $B = 1.0$. The admittance of the circuit is found at point C on the Y-locus, and the impedance at point D on the circle. The coordinates of point D result in $R + jX = 0.5 + j\,0.5$ as the complex value of D. The gain is seen to be down 3 db, and the phase shift is 45°.

Unfortunately the form of the chart shown in Figure 6 suffers from a number of deficiencies. The range of Q values that can be used on a graph of reasonable size is limited, and the lines of constant f/f_o are crowded together too much at the small values. The range of the B-scale is also too limited to be useful for calculations on high-Q circuits. The situation can be improved if the chart is replotted on log-log coordinates, as in Figure 7. The radial lines become straight, parallel lines, and their separation is such that the interpolation is easier. Likewise, the accuracy of reading (and interpolating) the Z and Y coordinates is greatly improved. Q ranges other than the 1-100 range given on this chart could be covered by extending the constant-f/f_o lines.

Example

Suppose that a circuit, used as an amplifier load, was to have the gain 10 db down at $f/f_o = 0.9$. Projecting the intersection of the 10-db line with the Y-locus to the right provides a $Q = 14.3$. At this frequency $Y = 1 - j\,3$, and $Z = 0.1 + j\,0.3$. The response thus will be down 3 db at $f/f_o \cong 0.965$.

Acknowledgement

The development of this chart was incidental to a study of correcting networks for resistors at high frequencies prepared under research contract W-36-039-sc-33649 for the U. S. Signal Corps.

High-Power Installation

(*Continued from page 18*)

that they did), and how they fit into place. A good deal of head-scratching, a lot of cigarettes and possibly a few naughty words later we found, by counting turns, consulting tables, and trying various wrong combinations that there was a way to get most of them in position. One or two wouldn't fit, or didn't appear to have any discernible use, but that was a problem for tune-up time, so why worry now?

When wiring between units began more interesting problems developed. Apparently many of the vital and complex control centers had been built for our transmitter supplier by *Private Electric*. Now *P. E.* were no amateurs at this construction business, but someone didn't spend much time coordinating what the transmitter boys wanted, or thought they wanted, with what *P. E.* thought they should have. Claiming a few ideas of their own, *P. E.* found a number of innovations and refinements worthy of inclusion in the design and proceeded to use them. After building a few, more changes were suggested, and these were added in later units. In a few cases the transmitter producer thought enough of the improvements to recognize them and modify their blueprints to suit. In others, they were ignored, overlooked, or forgotten so no one but *P. E.* ever appreciated the changes.

Our set of blueprints showed some late changes which were not incorporated in the unit that came with our transmitter. In a job sent to one of our neighbors his model was too early to have corrections included. These changes caused quite a bit of grief when the current was applied.

A two-hundred-forty-volt relay connected so that the voltage was across only half the winding functioned apparently as it should, for a time. Then someone noticed the smoke and the smell and after hurriedly opening switches the hunt was on. When the hot spot was located a long distance call was initiated for a new coil. While waiting for it to cool enough for handling, three yards of blue-print had to be studied to see how it's operation could be bypassed for the present so tests could continue.

We found a fan for cooling this control center, but nothing resembling a mounting bracket nor any hint as to where it should be mounted. We took a little justifiable pride in our very own solution, only to be told that, in the first place, the fan wasn't really necessary anyway, and in the second place, that a more effective cooling job could be done by providing an extension from the large transmitter-cooling duct under the floor. We immediately saw the wisdom in this advice but wondered why it wasn't pointed out before the cement floor was poured. Putting another pipe through a six-inch cement floor with the aid of chisels and star-drills wasn't our idea of light work.

One of the sales features of our transmitter was the *almost human system of overload protection and indication*. There was a colored lamp or a little red flag to show almost everything that could happen except a wow in the disc-jockey's favorite record. The machinery to operate this electrical brain was necessarily complex, and we were a little tolerant of our supplier's failure to completely understand just what *P. E.* built into it. Our luck was good and we were able to secure the services of a local *P. E.* expert to check the adjustments and repair minor defects. If you're not that lucky your session with the cams, pawls, resets, over-voltage cut-offs, under-volt-

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF COMMUNICATIONS.

Published monthly at New York, N. Y., for October 1, 1949.

State of New York }
County of New York } ss:

Before me, a notary, in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of COMMUNICATIONS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of August 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; Editor, Lewis Winner, New York, N. Y.; Managing Editor, None; Business Manager, B. S. Davis, Ghent, N. Y.; 2. That the owners are: Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; B. S. Davis, Ghent, N. Y.; J. C. Munn, Union City, Pa.; A. R. Goodenough, Port Chester, N. Y.; P. S. Weil, Great Neck, N. Y.; F. Walen, Teaneck, N. J.; G. Weil, Great Neck, N. Y.; L. Winner, New York, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock, and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me, this 14th day of September, 1949.

(Seal) NATHAN JELLING,
Notary Public.

Commission expires March, 1950.

age releases, interlocks and regulators will be educational to say the least.

A part of this protection system usually comes packed under the title of *protective relay*. Our blueprints showed the necessary wiring for it, but was quite non-committal about where it is supposed to mount. We found that our supplier didn't know either. We had to brush up our ingenuity again and find a place to get it out of the way and still run wires to it.

The interesting purpose of this *protective relay* is to turn on a red lamp to show when the carrier is on, and another lamp to show when it is off. We found that there was a slight duplication of functions here, since several meters and lamps had been placed on the transmitter to remind us when the power was on, with the aforementioned system of overload relays taking care of any unorthodox power application. If you've soaked up enough *rf* theory to get your license, and acquired enough broadcast experience to warrant a fifty-kilowatt job you have a fair chance of being able to tell without an indicator lamp whether your carrier is on or off. But it is a refinement, and the colored lamps help impress the *boss*.

Another *modern design* feature in our job was the use of pairs of red and black push buttons instead of tuning knobs or indicating dials. It was decided that broadcast engineers would live longer, and possibly work for lower wages if not required to strain their muscles turning knobs. With the negligible complication of a tuning motor, insulated shaft, universal joints, push-buttons and the associated wiring, this back-breaking task was said to be eliminated. Tuning we were told is now as simple as pushing a button. Since it was not considered essential to provide a front panel indicator, the appropriate meter had to be watched to see what happens. If the reading changes in the manner expected, well and good. If it went the wrong way the other button was to be pushed. It's as simple as that, we were informed. If it doesn't change at all, well either the variable inductance or capacitor was at the end of its travel against the stop, or it was stuck and the motor stalled, or one of the couplings was loose and the shaft had begun to slip or the wrong meter was being looked at. The last possibility, that something was amiss in the circuit, was found to involve *rf* theory. This our friendly supplier took great pains to avoid.

When the moment arrives for turning on the full *fifty-thousand watts* into either a radiating system or a

(*Continued on page 26*)

(*Continued from page 25*)

dummy load, you may experience as we did some let-down in the thrill anticipated. This is partly due to unimaginative mathematics, which shows a current increase to only about fifteen amperes, considering a 230-ohm line.

Mentally comparing this to the almost five amperes used for five kilowatts or the six and a fraction for ten kilowatts and it is suddenly realized that 50,000 watts is not such terrific power after all.

With a bow toward our supplier (and *Private Electric*) we also conceded the ease with which the increased power could be handled. The five or six amperes of plate current were found as *matter-of-fact* as the six hundred mils you may have been used to. The large but unspectacular rectifiers provide their ten or twelve amperes of 10,000-volt *dc* as calmly as 866s.

If you've been conscientious about grounding and shielding you'll find, as we did, there are no shocks from touching metal parts in the building, no lamps burning with the switch off, and no *rf* in the audio circuits. And operation was found to be as stable as with our belated thousand-watter.

But what a time we had before we found out!

Remote Amplifier

(*Continued from page 22*)

amplification while the amplifier is operating at high gain, is a screwdriver control instantly available through an opening in the rear of the unit. The installation engineer sets this control so that the amplifier will furnish an average level, correct with respect to the program source. A jack on the front panel allows headset monitoring during setups.

A four-pole double-throw key switch[1] performs all program switching functions. One pair of poles transfers the amplifier output from the line to the loudspeaker, and another pair transfers the input from the microphone to the line-bridging network and cue volume control.

As telephone lines are frequently used without isolation transformers, it is imperative that no grounded or unbalanced circuit be connected to them. Accordingly in this case it was necessary to remove the ground normally found on one side of the output transformer.

Since appreciable power may be transferred from the amplifier to the speaker, the speaker was carefully matched to the amplifier. The microphone also received this close attention, with its impedance matched into the amplifier. To reduce level without appreciable loading or distortion, an intentional mismatch was included in the bridging connection.

The amplifier-output transformer connection, normally used for the speaker, is connected to the telephone line when the equipment is being used to feed the line. While this is actually a bad mismatch from the amplifier standpoint, it is unimportant because the amplifier has inverse feedback, and is being used well below its rated power output. The line merely sees the amplifier as a generator, with a comfortably low internal impedance and adequate ability to furnish a +8 dbm required, with no apparent distortion. Measured distortion values are on the order of two per cent.

In application at, let us say, a night club for an orchestra pickup scheduled from 11 to 11:30 PM nightly, the line is installed, the orchestra leader shown the remote amplifier by an engineer or production man and a musical setup arranged. Henceforth at about 10:30 PM, each following night, the orchestra leader turns on the amplifier. He then adjusts the cue volume, which amplifies the cue program coming down the program line from the studio, and listens briefly to make sure that

[1]Stromberg.

the cue program is present. Then he turns the gain down and goes on about his business.

At a few minutes to 11 PM the bandman turns up the gain again so that he and the band can hear the cue, and at 11 PM the studio announcer gives the cue, which is heard through the loudspeaker. Then the band leader flips the key switch and he is on the air. At the end of the show, the orchestra leader can push the cue switch down again and hear the studio announcer acknowledging the program if he wishes. The leader then turns the amplifier off, and the remote program is over for one more night.

Incidentally it is rather remarkable how effective a one-mike pickup of a 12-piece orchestra can sound, when the band director realizes that he must make the band fit the microphone.

The unit has provided very dependable service at WHHM, one being used for two nightly broadcasts from a night club for a year and a half, with only four routine service calls required.

•

Audio Measurements

(Continued from page 11)

should be measured in terms of db below 100% modulation. The standards require that the total noise in the 50 to 15,000-cycle band shall be at least 60 db below the audio-frequency level, representing a frequency swing of ±75 kc (±25 kc for TV stations). The noise-measuring equipment should be provided with a standard 75-microsecond deemphasis circuit, the time constant of the meter in the noise measuring circuit being similar to that of a standard vu meter.

Noise Level Measurements (AM): The regulations require that measurements should be made on the amplitude modulated noise at the output of the transmitter. The requirements of the standards are in terms of db below 100% amplitude modulation. Since most modulation monitors for FM stations do not include demodulators for amplitude modulation, this is a difficult measurement to make. Since the *RMS* of the rectified envelope of a 100% amplitude modulated wave is equal to the *RMS* of the carrier itself, it can be assumed that a measurement of the ratio of the amplitude modulated noise to the carrier itself will give the desired figure. The problem then is to measure the *RMS* of the carrier and the *RMS* of the noise wave form. The ratio of these quantities, expressed in decibels, provides the figure required by the standards; according to the standards this value should be greater than 50 db.

The Industry Offers

BLILEY FREQUENCY STANDARD

A frequency standard, employing a 100-kc crystal, has been announced by the Bliley Electric Company, Erie, Pennsylvania.

Features a 24-hour frequency stability of two parts in 10 million, when subjected to line voltage fluctuation of as much as 10%. Under adverse conditions of temperature humidity and semi-portable operation the instrument is said to be capable of maintaining an accuracy of two parts in one million for a 30-day period without resetting.

Frequency source employed is a Bliley GT quartz crystal unit temperature stablized to within 0.1°C in an oven employing a mercury thermostat and external relay.

Long life tubes have been utilized in the crystal oscillator and automatic gain control circuits. Due to operation of the crystals at series resonance, and automatic gain control, the frequency is said to be practically independent of line voltage and circuit component variations; line voltage fluctuation of ±20% causes a frequency change of less than one part per million.

Terminals are provided for sine wave or harmonic output at both high impedance and low impedance.

* * *

GENERAL RADIO SIGNAL GENERATOR

A general-purpose, amplitude-modulated generator suitable for standard IRE and RMA tests on receivers, type 1001-A, has been announced by the General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Carrier oscillator in instrument uses a Hartley circuit and is followed by an untuned modulating amplifier. The output voltage is continuously variable by means of a slide-wire calibrated in microvolts and a decade multiplier.

The frequency range is 5 kc to 50 mc, with logarithmic frequency dial and an auxiliary frequency-increment dial.

Output voltage range is 0.1 microvolt to 200 millivolts at the panel jack; 0.05 microvolt to 100 millivolts at the end of a terminated cable.

Output impedance is 10 ohms at panel jack, 50 ohms at end of unterminated cable, or 25 ohms at end of terminated cable.

Internal modulation at 400 cycles up to 80% is provided. External modulation can be used from 20 cycles to 15 kc.

Incidental frequency modulation is below 38 parts per million at 30% modulation.

Stray fields are said to be substantially less than one microvolt per meter at a distance of 2 feet from the generator.

* * *

GERTSCH FILTER

An applied acoustics one-half octave filter, model SA-2, has been announced by Gertsch Products, Inc., Los Angeles. Set is comprised of separate high and low pass filters having points of 3 db transmission loss ranging from 37.5 to 13,600 cycles ±2 cycles or 2 per cent, whichever is greater, in one-half octave steps.

AUDIOGRAPH TWO SPEED TAPE RECORDER

A console tape recorder, operating at 7½ or 15-inch speeds, by instantaneous switchover, has been announced by Audiograph Co., 1413 El Camino Real, San Carlos, Calif.

Console features a recording amplifier circuit which is said to provide constant—current output from a low impedance source with pre-emphasis equalization; and head interchangeability without response variation.

Three plug-in chassis units, contain recording, playback, and power supplies for the electronic equipment. Amplifier is said to accommodate input levels as low as —10 dbm. Has plug-in tape equalizer. Meter-monitor amplifier provides 0 dbm monitor output and 6 db indication on vu meter at normal recording level. A 60-kc oscillator has a calibrated current control for adjustment to various tapes. Playback amplifier is said to provide a peak output of +20 dbm at less than 1% total harmonic distortion which feeds 150 ohm line.

Tape transport mechanism handles 2,400 feet of tape on NAB standard hub, or RMA reels.

* * *

SYLVANIA HIGH VACUUM RECTIFIER

A high vacuum rectifier has been announced by the radio division of Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y. The tube, lock-in type 7X6, is supplied with a 6.3-volt heater, rated at 1.2 amperes. Has a maximum rated output of 150 milliamperes. Separate cathode leads.

* * *

SPRAGUE HYPASS CAPACITORS

Hypass 3-terminal network feed-through capacitors designed to minimize TV interference from amateur transmitters or attenuate power line-conducted interference from diathermy machines, industrial electronic heating apparatus and other high-frequency signal sources, have been announced by Sprague Products Co., North Adams, Mass.

Units are available in a complete line of capacities and voltages (up to 5,000 volts) for practically any high-frequency filtering requirement.

Bulletin M-432 describing this development in detail will be sent on postcard request.

* * *

EIMAC TRIODE

A triode directly interchangeable with the 592, patterned after the Eimac VT327A radar pulse tube, has been announced by Eitel-McCullough, Inc., 237 San Mateo Ave., San Bruno, Calif.

Tube, a general purpose *vhf* triode, is suitable for both oscillator and power amplifier service. Construction is said to lend itself to power amplifier service at frequencies up to 125 mc.

Plate employs Eimac pyrovac plate material. Non-emitting processed grid material is used.

* * *

DUMONT BENT GUN ION TRAP TV TUBES

TV tubes, in the 12½", 15½", 16" and 19" sizes, featuring a bent-gun ion trap, have been announced by the Allen B. DuMont Laboratories, Inc., 2 Main Ave., Passaic, N. J. In bent-gun design the electron and ion beam is aimed by bending the gun so that the ions will be trapped by the anode barrel structure, and the electron beam is then brought to the axis by the action of a single magnetic field.

The bent-gun design is said to permit the production of short neck length tubes, because of the space saved by eliminating the double beam bending magnet, which permits sealing the gun closer to the bulb without restricting neck length for focus and deflecting components.

Feedback Amplifier Analysis

(*Continued from page 15*)

total amount of feedback that may be applied (defined as $20 \log_{10} (1 - A_m \beta)$) is $20 \log_{10} (1 + 100) = 40.1$ db, since 40 db is a voltage ratio of 100 to 1. If a phase margin of 45° against singing is desired (that is, if it were desired to have the magnitude of the phase shift 45° less than 180° at the frequency where $|A \beta|$ is unity) we find that $\phi = 135°$ at a frequency at which $|A \beta|$ is down about 20 db from $A_m \beta$. Thus, $A_m \beta$ can have a maximum value of only 20 db or the db feedback that may be applied in this case is $20 \log_{10} (1 + 10) = 20.8$ db. The value of the voltage divider β may be determined from the relation $\beta = \dfrac{A_m \beta}{A_m}$ where A_m is now a voltage ratio.

Circuits for Complex Conditions

In constructing an equivalent circuit for networks that may have somewhat more complicated attenuation-frequency curves, it is sometimes desirable to use slightly more complicated building blocks in the equivalent circuit to reduce the total number of terms that must be added to obtain the phase shift frequency characteristic. Such circuits will suggest themselves in any given situation. One such circuit that is useful in cases where a flat step in the attenuating characteristic is added midway in the high-frequency attenuation curve to reduce the phase shift, is shown in Figure 4. By making use of several identical circuits in cascade with isolation it is, of course, possible to obtain a break from flat to a slope of any multiple of 6 db per octave, and by careful choice of equivalent circuit units most attenuation curves may be closely approximated.

Table 1

Tabulation of phase shift against frequency for the example discussed in the text.

ω	$\tan^{-1} \omega/\omega'$	$\tan^{-1} \omega/10\omega'$	$\tan^{-1} \omega/1000\omega'$	ϕ
$0.1\ \omega'$	5°40'	0° 5'	0°	−5°45'
$1\ \omega'$	45°	5°40'	0° 5'	−50°45'
$10\ \omega'$	84°20'	45°	5°40'	−134°
$100\ \omega'$	89°20'	84°20'	45°	−218°40'
$1000\ \omega'$	90°	89°20'	84°20'	−263°40'

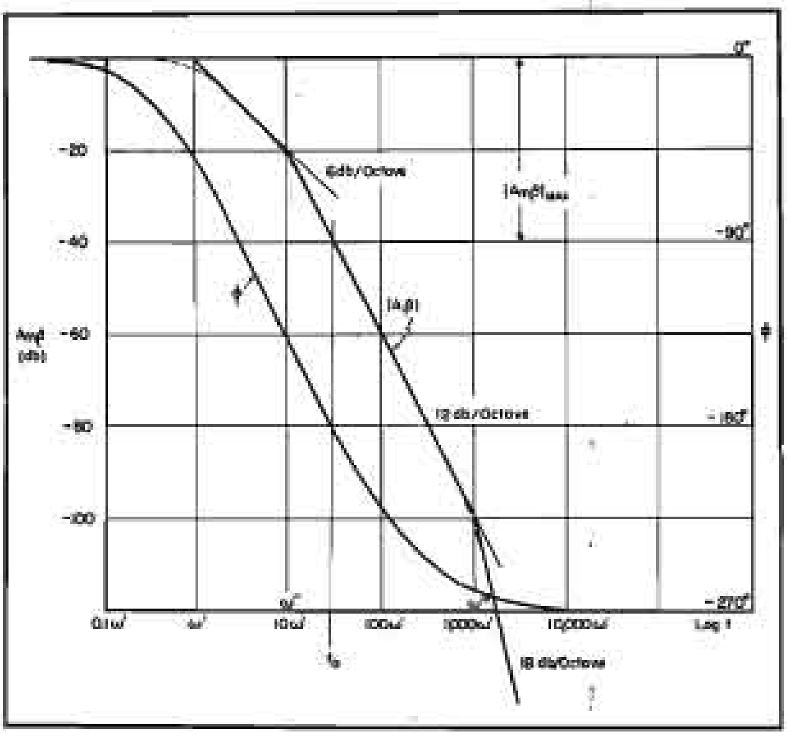


Figure 3
Attenuation and phase shift in the high-frequency region as a function of frequency.

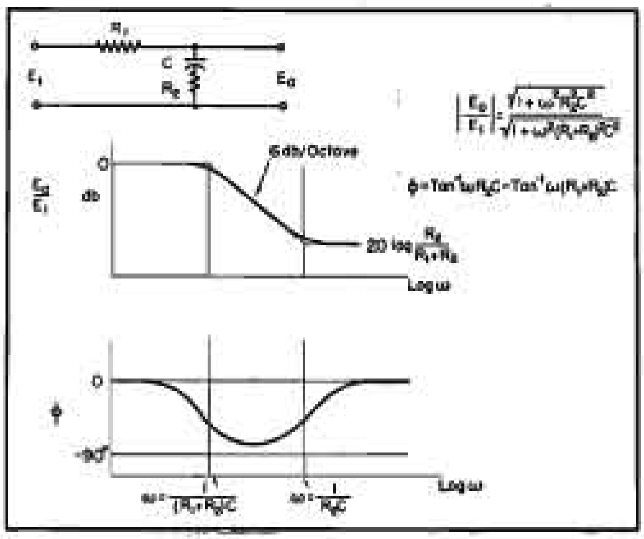


Figure 4
Characteristics of a slightly more complicated equivalent circuit element useful for certain amplifier configurations. For $R_1 = R_2$ slope extends one octave and for $R_1 = R_2$ slope extends one decade.

MOTOROLA CONTROL HEAD

A universal control head, for use with two-way mobile units, has been announced by Motorola Inc., 4545 Augusta Boulevard, Chicago 51, Ill. Unit, features rounded corners and can be mounted in any position on any type of dashboard. Basic unit is said to be adjustable to proper angle, regardless of whether it is mounted on the top, at the center, on the bottom, or any position in between, on dashboard.

Last Minute Reports . . .

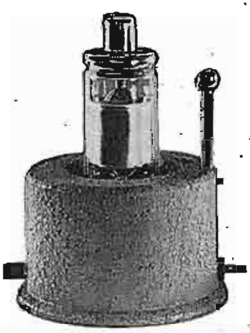
ACTIVITY IN THE HIGH FREQUENCIES has accelerated demand for very thin quartz crystal oscillator plates, having fundamental frequencies up to 100 mc or even higher, and prompted development of unusual grinding methods and machinery. In the course of an investigation of this problem, L. T. Sogn and W. J. Howard of the National Bureau of Standards designed equipment capable of producing .001" thick plates with a high degree of parallelism and flatness. . . . Effective November 1, the letter *U* will supplement the *N* or *W* now being used in the radio propagation broadcasts from WWV, *U* referring to unstable conditions. . . . John D. Kraus has been appointed Professor of Electrical Engineering at Ohio State University. . . . A 150-kw transmitter, developed by RCA, is now in operation in Munich, Germany, carrying the Voice of America programs. . . . WXEL, owned by the Empire Coil Co., will soon begin operation in Cleveland on channel nine. They will use a G. E. 5-kw transmitter and a 6-bay antenna mounted atop a 438' tower. Tom Friedman is chief engineer. . . . Dr. Martin D. Freundlich is now with Airborne Instruments Laboratory, Mineola, New York, in charge of the tube laboratory in the applied physics section which is directed by Rodney F. Simon. . . . Russel O. Hudson is now vice president in charge of sales of the Audio and Video Products Corp., 1650 Broadway, N. Y. C., and W. Oliver Summerlin has been named vice president in charge of engineering. . . . WGKV now has a 3-kw FM transmitter operating at 98.5 mc. . . . WHAS-TV, Louisville, Kentucky, will soon install a 12-bay antenna developed by G. E. Picture and sound signals will radiate from forty-eight batwing-shaped elements spaced in groups of four approximately every six feet along the antenna mast. . . . A. E. Bennett, formerly chief engineer at Hoffman Radio, is now chief engineer and general manager of Audiograph Company, San Carlos, California. . . . Dr. Frank B. Jewett, formerly president of the Bell Telephone Laboratories, will receive the 1950 medal of the National Research Institute, Inc. . . . The Pennsylvania Electric Company have installed a microwave system to provide communications over a ten-mile air line between sub-station points. . . . Dr. Cledo Brunetti, formerly with the Bureau of Standards and now associate director at the Stanford Research Institute, is now on a tour in Europe, visiting the Admiralty Research Laboratory at Teddington and the Royal Aircraft Establishment at Farnsborough, in England. . . . The Graybar Electric Company has announced that it will distribute a complete line of Altec Lansing sound products. Graybar will continue to sell the present inventory of Western Electric sound products, which were recently transferred from Western Electric to Altec Lansing. . . . Frank B. Powers, formerly assistant vice president of the American Car and Foundry Company, has been appointed director of manufacturing operations of Federal Telephone and Radio Corporation. . . . The second issue of the Hewlett-Packard journal has been published with a paper on a new frequency standard and time interval generator. . . . The General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass., have released a four-page folder illustrating the complete line of variacs.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS INDEX

NOVEMBER, 1949

NEW -*hp*- ACCESSORIES INCREASE SCOPE OF YOUR -*hp*- VOLTMETERS



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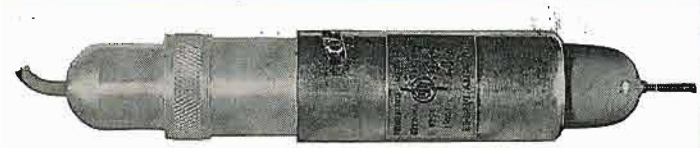
For -*hp*- 400A, 400C and 410A Voltmeters. Safely measure power, supersonic and dielectric heating voltages to 25 kv. Accuracy ± 3%. Frequency range, 25 cps to 20 mc. Division ratio 1,000:1. Input capacity 15 $\mu\mu$f. Price $75.00.

Extend the usefulness of your present -*hp*- voltmeters with these new precision-built -*hp*- accessories. Save time and work. Simplify tedious jobs. Make fast, accurate measurements far beyond the original range of your instruments.



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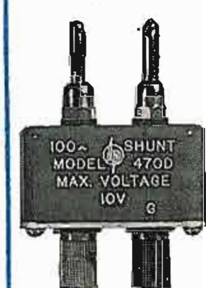
For -*hp*- 410A Voltmeter. Increases range so transmitter voltages can be measured quickly, easily. Accuracy ± 1%. Division ratio, 100:1. Input capacity approx. 2 $\mu\mu$f. Max. voltage 2,000 v. For frequencies 10 kc and above. Price $20.00.



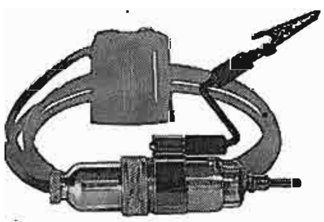
-*hp*- 470A—470F Shunt Resistors

For -*hp*- 400A or 400C Voltmeters, to measure currents as small as 1 μa full scale. Accuracy, ± 1% to 100 kc, ± 5% to 2 mc. Max. power dissipation 1 watt.

Instrument	*Value*	*Price*
-*hp*- 470A	0.1Ω	$7.50
-*hp*- 470B	1.0Ω	6.00
-*hp*- 470C	10.0Ω	6.00
-*hp*- 470D	100Ω	6.00
-*hp*- 470E	600Ω	6.00
-*hp*- 470F	1,000Ω	6.00

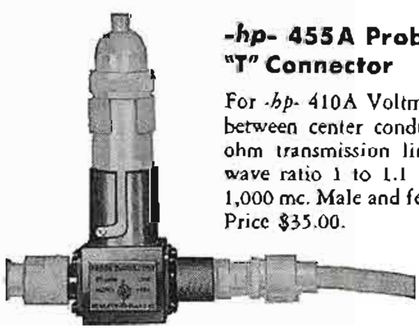
-*hp*- 454A Capacitive Voltage Divider

For -*hp*- 400C Voltmeters. Safely measure power, audio, supersonic and rf voltages. Accuracy ± 3%. Division ratio, 100:1. Input impedance 50 megohms, resistive shunted with 2.75 $\mu\mu$f capacity. Max. voltage, 1,500 v. Price $20.00.



-*hp*- 459A DC Resistive Voltage Multiplier

For -*hp*- 410A Voltmeter. Gives maximum safety and convenience for measuring high voltages as in television receivers, etc. Accuracy ± 5%. Multiplication ratio 100:1. Input impedance 12,000 megohms. Max. voltage 30 kv. Max. current drain 2.5 microamperes. Price $20.00.



-*hp*- 455A Probe Coaxial "T" Connector

For -*hp*- 410A Voltmeter. Measures voltages between center conductor and sheath of 50 ohm transmission line. Maximum standing wave ratio 1 to 1.1 at 500 mc; 1 to 1.2 at 1,000 mc. Male and female Type "N" fittings. Price $35.00.

-*hp*- 458A Probe Coaxial "N" Connector

For -*hp*- 410A Voltmeter. Measures volts at open end of 50 ohm transmission line. (No terminating resistor). Uses female Type "N" fitting. Price $17.50.

All prices and data subject to change
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