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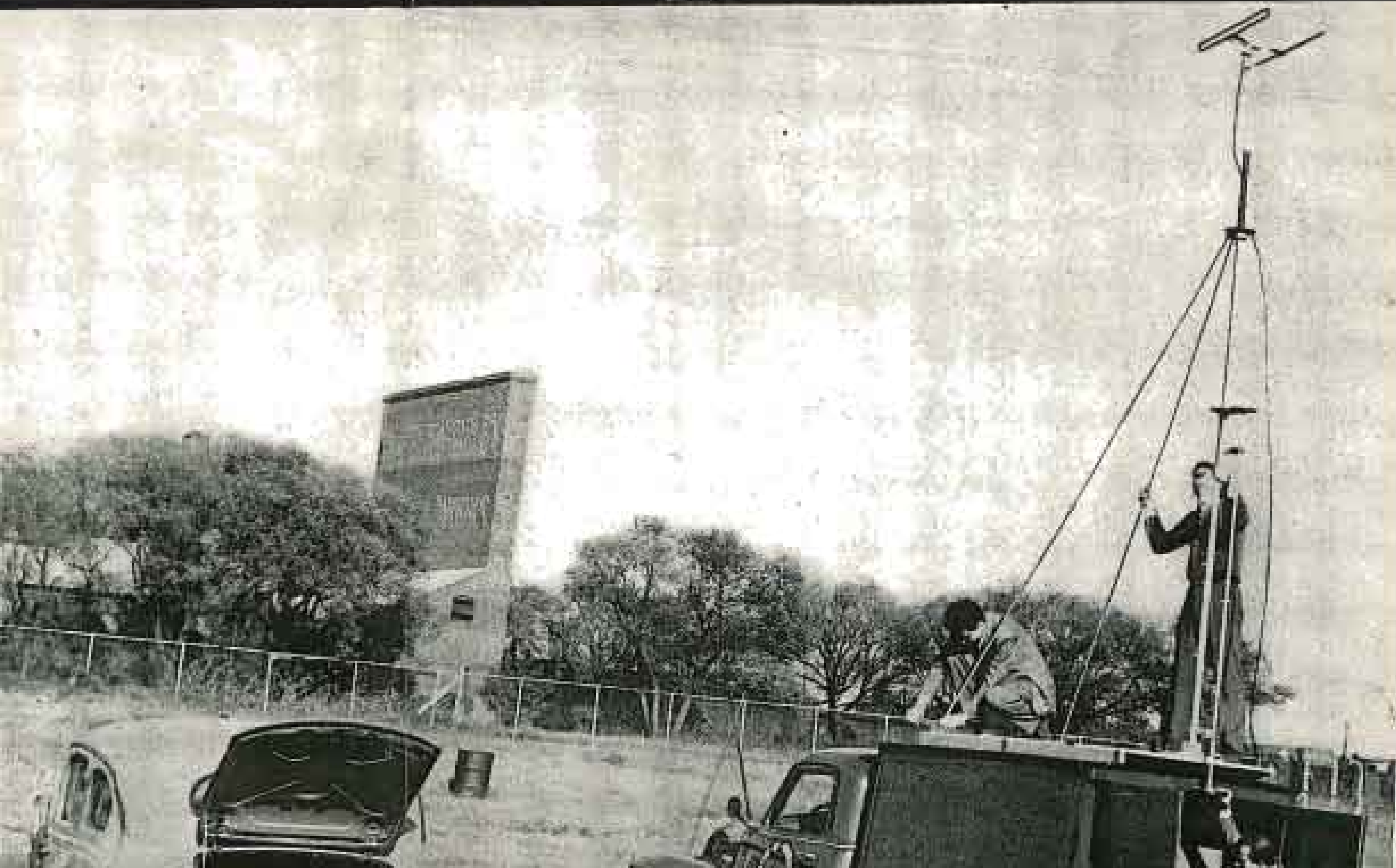

JUNE 1949

* REMOTE EQUIPMENT INSTALLATION PRACTICES
* TV SITE TESTING AND MEASUREMENT TECHNIQUES
* DESIGN PROBLEMS IN TRIODES AND TETRODES FOR HF OPERATION

JUNE, 1949 **VOLUME 29** **NUMBER 6**

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COVER ILLUSTRATION

Orienting a high-frequency antenna during a TV-site testing project, to pick up signals from a barrage balloon equipped with a hard-tube pulse oscillator for transmission.

(Courtesy RCA; see pages 6, 7, 8 and 9, this issue, for complete analysis of tests.)

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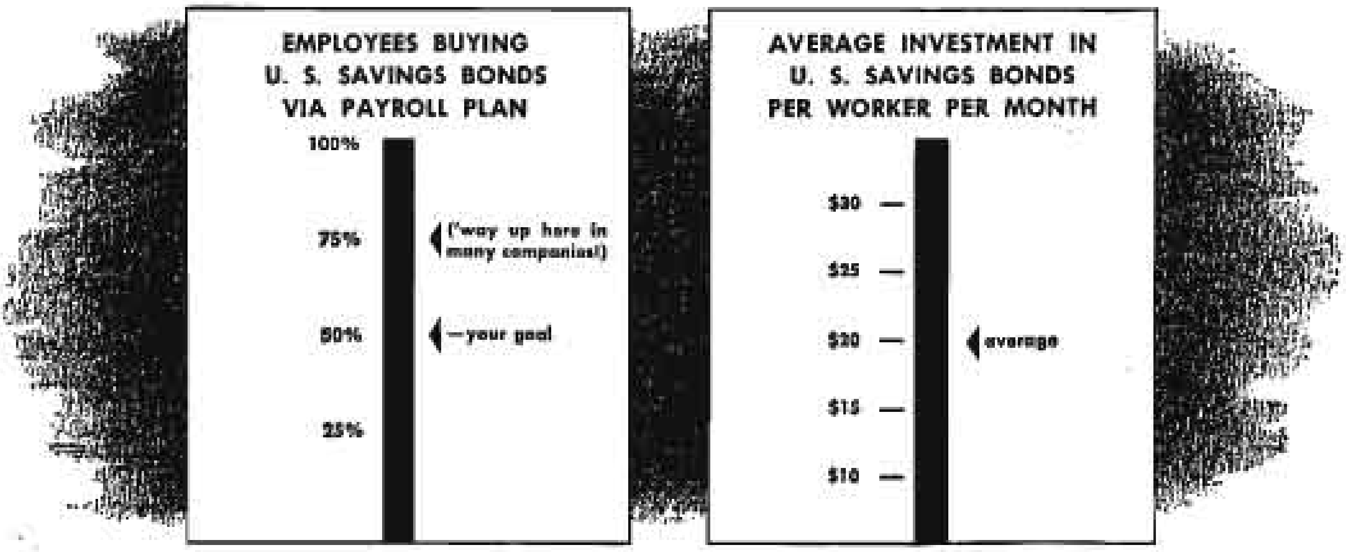

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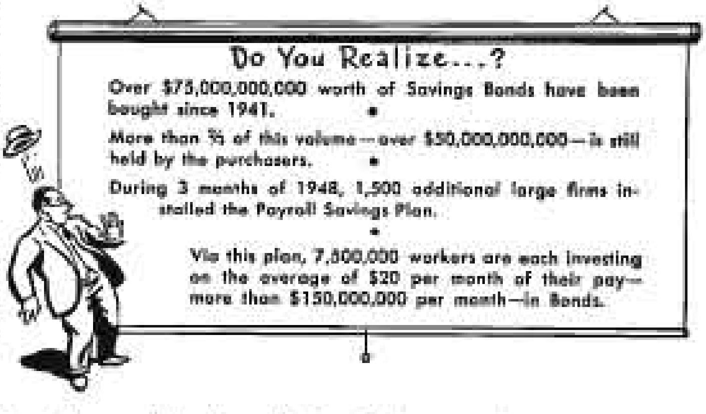

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COMMUNICATIONS

LEWIS WINNER, Editor

JUNE, 1949

On the Development Front

CIRCUITRY and facility research, now being conducted on an unusually wide scale, has accelerated the processing of unusual equipment and materials, featuring many new developments and improvements. An interesting example is the magnetic amplifier, a war-time project employed for the amplification and mixing of powers down to a microwatt.

The current introduction of magnetic materials of high permeability has now made it possible to use less excitation because of core saturation. The particular feature of the magnetic amplifier, which is normally a static device, is its ability to amplify moderately low *dc* powers and provide a simplified mixing of input signals, which may be at different voltage levels. The amplifier also has the advantage of being a particularly rugged piece of equipment, since there are no filaments or moving parts. There is, however, one disadvantage and that is the need for an *ac* supply, operating usually between 400 and 1600 cps. The time delay, because of the input circuit inductance, is another problem.

During the war the Germans used the magnetic amplifier in various servo applications. Today, the amplifiers are employed as line-to-line voltage regulators, *ac* and *dc* voltage regulators, instrument amplifiers, control relays, etc.

In an interesting appraisal of these amplifiers, in a paper presented before the British Institution of Electrical Engineers, A. G. Milnes pointed out that the amplifiers have been found suitable for the mixing and amplification of *dc* powers down to about 10^{-9} watt, with a zero stability of 10^{-11} watt. High-permeability saturable cores must be used to give good transductor performance, with a power gain of 10 to 20 per stage, according to Milnes. With self excitation or other positive feedback, the power amplification can be increased to 2,000 or more. Milnes also reported that much higher gains are possible, but cannot be used in practice if the amplifier must operate over a wide range of supply voltage and frequency.

Describing a 400-cycle 2-stage amplifier, used to operate a sensitive polarized relay for an input power of .004 microwatt, Milnes said that the power required to operate the relay was about 600 microwatts and therefore, the power of amplification required was 1.5×10^5. The *ac* windings were connected in series and self excitation was used in both stages. The amplifier featured reduced self excitation of the first stage, assuring good zero stability, with the maximum output of the stage lower, so that the final stage could not be swamped by an excessive input signal and its output reduced below the level required to operate the relay. During a test, the zero stability was found to be about ± 1 microamp for a voltage and frequency range of $\pm 10\%$.

In another important development, a product of extensive research in *selectivity*, it has been found possible to operate on adjacent channels in mobile service. During one test, messages were receivable even when the vehicle was within .4-mile of the land station transmitting on other channels. Normally intermodulation interference cuts off communications with such cars when they move with a radius of 1½ miles of other stations. As a result of this unique development, cabs will be able to use the recently adjacent-allocated channels without fear of interference.

In tests conducted by RCA at Camden, observers were able to pick up on fixed-type receivers, signals from mobile units transmitting on four adjacent channels: 157.47, 157.53, 157.59 and 157.65 mc.

Another very successful adjacent-channel test was conducted by Motorola in Chicago.

The cavity resonator has played quite an important role in the *selectivity* probe. Commenting on the application of this device, in the mobile communications field, at the recent RMA-IRE spring meeting in Philadelphia, Henry Magnuski, chief engineer of the research department of the Motorola communications and electronics division, said that a cavity inserted between the antenna and the receiver can provide a high selectivity at the *rf* level where we need it the most and reject the unwanted signal before it reaches any tube in the receiver, thus very effectively preventing the receiver from becoming desensitized. This can be achieved with a relatively low loss on the order of 1 or 3 db to the receiver sensitivity.

Discussing intermodulation interference, Magnuski pointed out that this form of interference originates in some non-linear part of the receiver, usually in the first mixer stage where the received signals are strong. It is then amplified by the *rf* stage where non-linearities always exist. If we assume that the receiver is tuned to a frequency, f, and the two interfering transmitters are on frequencies $f + \Delta f$ and $f + 2 \Delta f$ (the uniform channel spacing makes this case a very usual one), the second harmonic of the first transmitter or the frequency $2 f + 2 \Delta f$ is definitely generated in the mixer stage, and often in some other stages of the set. Thus this second harmonic beats with a frequency of the second transmitter, namely the $f + 2 \Delta f$, and by subtraction generates the frequency, f. Magnuski then pointed out that no selectivity after the mixer stage will help, since the frequency, f, is the one to which the receiver is tuned. A rejection of the unwanted frequencies must be achieved ahead of the mixer, either at the antenna circuit or at the *rf* amplifier. Unfortunately, declared Magnuski, neither the antenna circuit nor *rf* amplifier are usually selective enough to reject the unwanted frequencies. However, the cavity resonator does quite a good job of decreasing the intermodulation interference, because it rejects both unwanted frequencies.

The Standards Problem

STANDARDS, which have proved to be a boon to both industry and government in simplifying design and processing, are now being carefully studied for legal adoption in state laws and local ordinances.

This approach has been considered previously, but no substantial steps were taken in view of the fear of the anti-trust laws. Court decisions appear to have dispelled that fear to some extent.

The ASA are fostering the move for legalization and have prepared an unusually interesting report on model laws and ordinances. The committee, who prepared this report, are asking for comments and suggestions on the various methods proposed for legal recognition of national standards. Any help provided will be deeply appreciated.—L. W.

TV Site Testing and

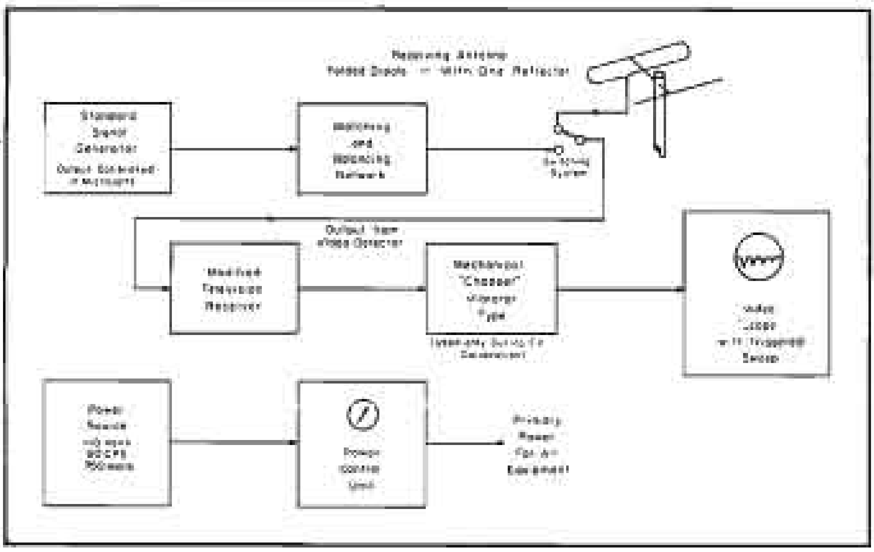


Figure 1
Block diagram of the receiving section of the setup used during the site-testing project.

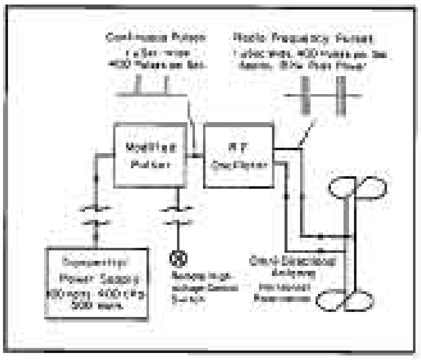


Figure 2
The transmitting section layout of the site equipment. The *rf* oscillator consisted of a pair of push-pull VT127s.

ONE OF THE MAJOR problems confronting prospective television and FM stations is the proper selection of an antenna site. In many instances there is only one really good site available; i.e., the top of the tallest building or nearby hill. It is generally not necessary to invoke the use of site testing methods to affirm this fact. In most cases, however, the solution is not so simple. The community may offer a number of possible locations, all promising, but none outstanding.

What rules apply in making the final selection . . . , assuming that the relative cost would be the same for each site under consideration.

Generally, the *line of sight* rule-of-thumb applies fairly well. Height, of course, is extremely important. But, if some natural prominence suitable for an antenna location lies on the *outer limits* of the desired service area, it should not be necessary to risk non-uniform coverage and possible attenuation by buildings, trees, etc., to obtain height.

Man-made, as well as *natural* reflecting objects, may send out echo signals over a wide zone, thereby degrading the service from what might otherwise be a good location.

In extremely hilly areas, one particular hill-top location might provide better service in the valleys than other equally elevated locations. It may be hard to prove tthis fact *except* by experiment.

On the assumption that the most accurate method of checking a site is to put a station on the air from the site in question, we can proceed to a consideration of the type of test signal desired:

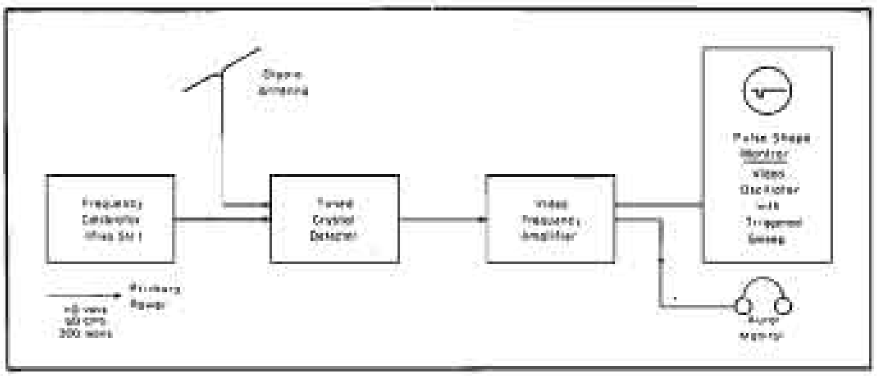
(a) A continuous-wave transmitter could be employed. This would afford information on field intensities, but in general would *not* furnish data regarding echoes, which might be objectionable in television service.

(b) Secondly, an actual television station transmitting a test pattern signal offers possibilities, since it would permit direct observation of picture quality and field intensity. This probably would be the ideal technique. The objections to this idea are practical ones. To provide direct data, the station would have to radiate power equivalent to the proposed TV station, and would, therefore, be very nearly as large and expensive. However, this system is still under consideration. The advantages of *direct* observation of quality are obvious. If any receiver installations already exist in the service area, these sets can be used for typical in-the-home observations and demonstrations.

(c) Third, a swept-frequency *cw* transmitter could be used to indicate the presence of reflections, but the relative delay of the reflections is not easy to obtain.

(d) And finally, a pulse transmitter could be employed. This type of signal will permit observation of field intensity. Using a special pulse receiver with an

Figure 3
The transmitter monitor section of the site-testing arrangement.



Measurement Techniques*

oscilloscope output indicator, by radar technique the time delay between the received pulse and any reasonably long-delayed echo can be observed. Relative strength of the echo can be determined.

The pulse technique seemed to offer the greatest promise, so in our development of a practical system, we selected this approach.

Power outputs in the order of 30 kw (*erp*) are frequently encountered in TB broadcast installations at this time. A small simple pulse transmitter employing radar principles could provide this same order of power. Although it might be possible to compensate for lower test power by added gain in the receiver system, this expedient was not deemed wise. Modern TV receivers approach fairly close to the theoretical optinum noise figure. Therefore, it is doubtful if a receiver could be provided which would allow a justifiable reduction in the test transmitter power. The test should furnish information of coverage in the fringe areas. If the test signal is obscured by noise in these areas, no accurate estimates can be made of what improvements higher power at the transmitter might yield. We, therefore, set an *erp* of 30 kw as the practical goal for our test system, assuming an antenna power gain of two.

The problem of supporting the transmitting antenna of such a site measurement system was quite difficult to solve.

Temporary masts or scaffolding can be used, but if the preliminary tests result in poor coverage, there remains the problem of extending the height of these devices until satisfactory coverage is noted.

Study of Types of Sites and Equipment Which Can Be Used at Test Points, Reveals That Four Types of Transmitters Afford a Means of Checking Before Final Selection Is Made; CW Transmitter, Actual TV Station, Swept Frequency CW Transmitter and Pulse Transmitter. Effective Results Achieved in Typical Setup Using a Hard-Tube Pulse Modulator, Two Coax Loop Transmitting Antennas with a Power Gain of Two, Modified TV Chassis for Pulse Reception and a Barrage Balloon Equipped with Transmitter and Antenna.

E. S. CLAMMER

Commercial Engineer
Engineering Products Department, RCA Victor

Airborne Supports

An airborne support, if practical, would overcome the above objections. This support might have to operate at heights over five hundred feet above the ground. It would be impractical to have an airborne antenna fed by a transmitter on the ground because of excessive line losses. It is, therefore, necessary that this airborne support provide sufficient lift for both transmitter and antenna. The transmitter primary power supply could be self-contained or power could be fed from the ground.

One of the most desirable characteristics such an airborne support must possess is the ability to hover almost motionlessly for several hours at a time. The only apparatus which has been able to fulfill these requirements has been a well-piloted helicopter. Tests have demonstrated their ability to hover, and they appear to be capable of much better stability than any other airborne test platform. The lifting capacity seems to be adequate in the case of the larger machines. One helicopter operator who uses a Sikorsky S-51, estimates operating costs in the order of $85.00 per flying hour. The main disadvantage of this type helicopter is lack of general availability.

It is possible that in the future more of these machines will be available, which would eliminate the major objection and perhaps lower the cost figure.

The transmitting antenna should, ideally, be equivalent in performance to the antenna which will eventually be employed. This obviously is not practical where small size and light weight are of paramount importance.

An approximation of the ideal case is realized when the antenna used in the tests has enough vertical directivity to eliminate straight up-and-down radiation. Some errors may be involved through using a wider vertical angle of radiation than the final antenna's, but tests have shown fairly good correlation. In general, the lower gain antenna will produce poorer results than the larger stacked arrays, thereby yielding conservatively weighted test data.

On the higher bands, two stacked loops seemed to give the desired pattern with the simplest antenna layout. On the lower bands, the loops were hard to construct, so stacked turnstiles were employed. Other configurations might well be used to achieve the same results.

The receiving setup should, of course, be mobile, to facilitate rapid surveying of a large area. It should be possible to make measurements while in motion. Communications between the transmitter control point and the mobile units would be a desirable, but not a necessary feature. To

**From a paper presented at the Third Annual NAB Broadcast Engineering Conference.*

Figure 4
A test pattern taken from WCAU showing the distortions caused by echoes.

facilitate a rapid survey, if costs per unit time are considerable, multiple mobile units may permit a cost saving. For this reason, low cost and generally available standard equipment should be employed wherever possible.

The receiving antenna could be a fairly elaborate affair with extreme directivity to permit analysis of direction of arrival of echoes, or, to expedite observations while in motion, it could be relatively non-directional. Opinions differ on the best approach to this problem. The antenna height should be such that mobile operation can be used, but it should also be possible to extend the antenna to a standard 30-foot elevation to make direct measurements at this height.

Unfortunately, few of the commercially available field intensity meters are suited for measurements on a pulsed signal. However, the requirements are such that an improvised setup can be made using standard components. A wide-band receiver with a pulse detector and pulse observation 'scope can be used as the receiving and indicating system, and a standard signal generator can be used to standardize the receiver sensitivity. Calibration of the entire system, including the vehicle and antenna may be made in the usual fashion in a standard field of known intensity.

The techniques of pulse observation are fairly well known. A standard *synchroscope* can be used to observe the nature of the principal pulse and subsequent echoes. Delay lines permit observation of the full pulse length. Sweep rates can be chosen to display echoes to advantage.

Recording System Problem

Due to the complexity of the information to be recorded, signal intensity, number and importance of echoes, geographical location, etc., the recording system poses a serious problem which has not been completely solved. Photographic records with marginal notations seem to offer the best solution. It is not too difficult to arrange a system to record peak signal voltage on the usual chart recorder, but this often does not provide adequate information.

We have, up to this point, determined the *nature* of the elements which will comprise our measuring system. We have rejected some obviously unsuitable arrangements. We have made some arbitrary selections of the remaining choices. We have planned a system which, we believed, required no radically new or untried techniques, and which would be assembled from components presently available. Now let us probe the manner in which we applied the principles and the amount of success achieved during field tests.

Test Transmitter

The test transmitter, designed to produce a 1-microsecond pulse at a recurrence rate of 400 *pps*, and a peak *rf* output of 15 kw was built around a hard-tube pulse modulator.[1]

The *rf* section of the transmitter consisted of two triodes (VT-127) connected in a push-pull, tuned-plate tuned-grid, grounded-cathode oscillator circuit. Preliminary tests showed the feasibility of this circuit on channels 2 to 13. Our tests were made on channel 13; somewhat better performance could be expected on the lower channels.

The transmitter was operated from a 400-cycle single phase 110-volt power source and consumed approximately 500 watts.

The pulse-rate was controlled by the main power line frequency, approximately 400 *pps*.

The oscillator was designed to feed into a balanced two-wire *rf* transmission line of 300-ohms characteristic impedance.

Figure 6
Miles Brown, who headed the field expeditions during the site project, at the controls of the test and measurement equipment in the truck.

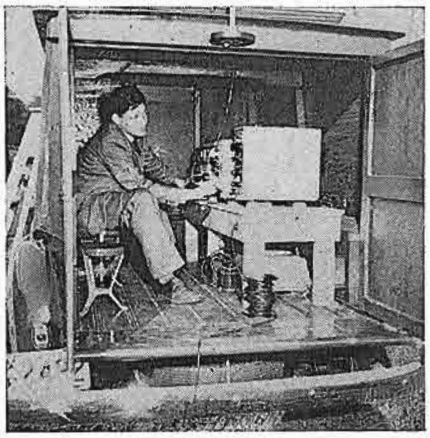


Figure 5
An undistorted WCAU test pattern.

The unit was housed in a light cylindrical protective container, and had a total weight of about 58 pounds. Its design permitted hanging from a rope support or resting on a flat surface.

The 400 *cps* main power supply was derived from a rotating machine which required 220 volts 3 phase to drive its motor unit. A rectifier power supply supplied the required *dc* for the generator field.

Transmitting Antennas

The antenna used in our tests, designed for channel 13, consisted of two coaxial loops, each one wavelength in circumference spaced approximately one wavelength. Its calculated power gain was two.

The antenna which weighed approximately 2 pounds, could be suspended from a rope harness or clamped to a horizontal boom for rigid support.

Neither the transmitter nor the antenna were designed for all-weather operation, although after exposure to the elements for a reasonably long period of time successful operation was achieved, provided the units were allowed to dry before applying full power.

Receiving Antennas

The receiving antenna was quite simple, consisting of a folded dipole and one reflector spaced ¼ wavelength.

Means were provided for supporting the antenna 12′ above the ground for continuous mobile operation, although the mast could be extended to a height of 30′ if desired. Rotation from the truck at either elevation was also provided.

Antenna termination box provided means for feeding two receivers from one feed line, an attenuation of about 5 to 1

[1]MIT type 3, available in limited quantities from war surplus.

in voltage resulting when this branching circuit was used.

The pulse receiver was a modified television chassis, using only the picture channel up to the video amplifier.

A variac and voltmeter provided means for maintaining the line voltage at a constant value.

The video circuits were compensated to match the input circuit of the pulse 'scope.

A *chopper* relay was provided to supply a zero-output base line to facilitate gain measurements using a *cw* input signal and an 'scope output indicator.

The picture receiver was a standard model.

The pulse observation 'scope was operated in the *triggered sweep* position, a delay-line built into the 'scope permitting observation of the entire pulse. Minor modifications were made in the intensifier circuit to produce a brighter trace.

A standard signal generator was included to facilitate calibration of the receiver sensitivities. A terminating resistor and an *elevator* transformer was used to transform from the unbalanced low impedance of the generator to the 300-ohm balanced inputs of the two receivers or the branching network.

A telephone circuit was provided between the operator's position and the driver's seat in the truck cab.

The Tests

Our test consisted of mounting the transmitter and antenna from a barrage balloon[2] inflated with 3,000 cubic feet of helium and allowing it to rise 250 feet. The transmitter power was supplied by a ground power supply connected to the balloon with a pair of light insulated wires. Several days were spent in checking the transmissions by means of the mobile receiving unit. It was found that the balloon, in the presence of a light breeze, would not remain in one position for any predictable length of time. This shifting in position and altitude of our transmitting antenna resulted in wide variations in received signal level. The balloon was accordingly discarded as a suitable antenna support.

During these tests, however, we had become familiar with the operation of the equipment and satisfied that it showed a reasonable amount of promise. Our next step was to correlate our measurements against a known TV signal.

Accordingly, arrangements were made to use the facilities of WCAU-TV in Philadelphia. Our test transmitter and antenna were mounted on the WCAU-TV tower in the center of Philadelphia at a point 725′ above the street level and approximately 60′ below the center of the WCAU-TV antenna. In general, the field strength from our test setup on channel 13 was found to be roughly 70% of that from WCAU on channel 10.

Three Test Runs

Three test runs were made on as many radials. The first run was from WCAU to the Philadelphia Airport.

At the airport, both WCAU and our transmitter produced about 60,000 micro-

[2]War surplus type M-1.

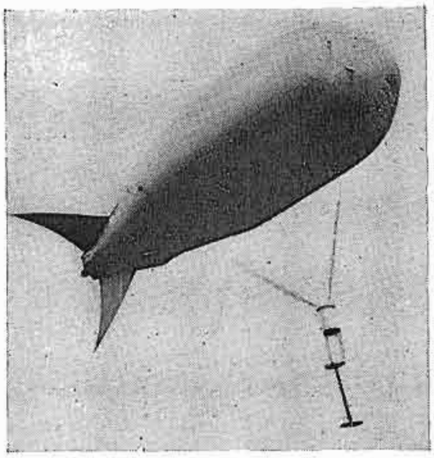


Figure 7
A view of the pulse transmitter suspended from the blimp during a typical test in Camden.

volts on the antenna feed line with the antenna 12′ above the ground. This signal was sufficient to overload the television receiver when the feed line was connected directly to it. The airline distance was about 6 miles, and excellent pictures were observed at this particular location. No echoes were noticed even while rotating the antenna, a clear steady picture being maintained even while driving the truck at high speed along the highway. In some obviously poor receiving locations echoes were noted and excellent correlation was observed between the picture and pulse presentations.

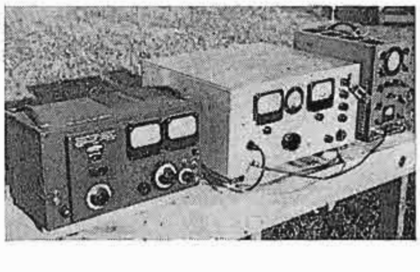
Two observers were used, one checking the picture and the other the pulse. In almost every case, simultaneous shouts of *echoes* were heard when a poor location was encountered. No serious transmission faults were noted on this run.

The other radials chosen extended from Philadelphia northwest to Norristown, Pennsylvania, and from Camden to Princeton, New Jersey. Good correlation between both signals were the general rule, and no serious differences were noted.

A trip was made to the region near Wyncote, Pennsylvania, from which several complaints about echoes had been received.

The particular address which was first investigated showed that the complaints were justified. The section is shielded from the line-of-sight path to WCAU by a relatively high hill, and across the valley a higher ridge of hills receives the signal more-or-less directly. Signals reflected from prominent objects on the higher hill arrive at the Wyncote section with an intensity comparable to the main signal.

Figure 8
Closeup views of the equipment used during the tests: pulse receiver, slightly modified TV receiver and the 'scope.



Echo Problems

Several pronounced echoes were apparent. Although the intensity of the echoes relative to the main wave varied widely with the position of the receiving antenna, it would have been difficult to pick a location where an acceptable signal could be received. With our antenna extended to 30′, the situation improved somewhat, but even under the optimum conditions picture quality was somewhat degraded.

The pulse measurement showed very close correlation with the picture observations. The direction and distance to the major reflections could be estimated with a fair degree of accuracy.

To check this determination, a run was made toward the echo source, following the antenna bearing indication.

As the mobile receiver approached the hills on the opposite side of the valley, the separation of the echoes and main pulse became less, and we finally arrived at a group of three large water tanks, each of which was responsible for a major echo. Other objects were also producing echoes, but the three tanks were the principal offenders.

In the region around the tanks, echoes were still serious enough to cause relatively poor pictures in spite of the increased strength of the main pulse.

Pulse Test System Results

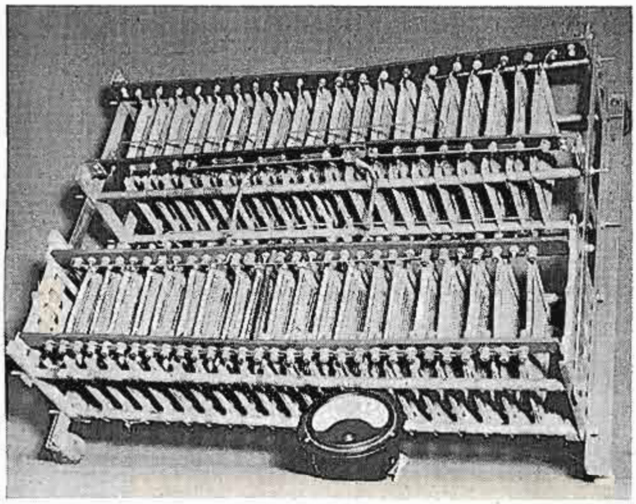
The tests conducted to date seem to demonstrate the essential practicability of our proposed pulse-test system. Our experimental model has not been developed to the extent where it could be considered a commercial product. It was not our objective to develop such a product, but rather to prove that the equipment could be constructed and employed to provide propagation data under actual field conditions.

Our experimental setup gave reasonably good qualitative data. A trained observer could, by using this equipment, determine correctly in almost every case whether good, mediocre or unsatisfactory service would be rendered. It may well be true that the general lack of precision encountered in *uhf* propagation measurements will introduce so many important errors that further refinement of the measuring equipment is not justified.

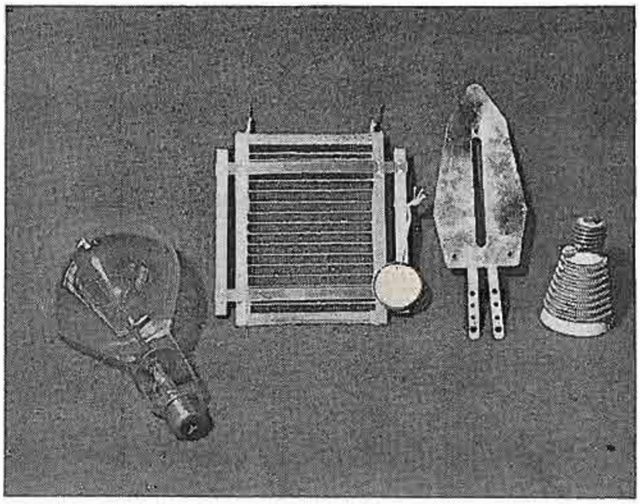
Use of Test Data

It must be remembered that the data furnished by a preliminary check are not intended to supplant data taken during a final field strength survey, made on the completed installation. They are merely used to indicate approximately what results should be expected.

The 11,400 watt *rf* dummy load.



Four types of dummy loads (left to right): 300-watt incandescent lamp; ohmspun unit; 660-watt flat-iron element; 660 watt spiral-heater element.



RF DUMMY LOADS

Survey of Several Types of Air-Cooled Resistors, Normally Used as Broadcast Transmitter Dummy Loads, Reveals That One Type, of Low Inductive Design with a Wattage Rating of 11,400, Is Very Effective.

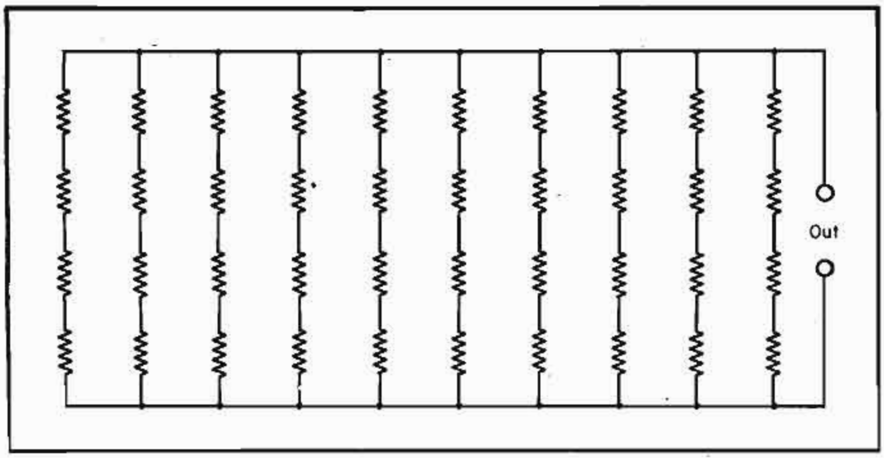
by **HERBERT G. EIDSON, Jr.**

Chief Engineer, WIS and WIS-FM
Technical Director, WIST

THE DUMMY LOAD is a particularly important piece of equipment at the broadcast site, affording an opportunity to study the radiation characteristics of the transmitter, either prior to the installation of an antenna system, or with the antenna cut out, during off-the-air periods.

The dummy load is actually a resistor of usually known characteristics that is used to dissipate the power from an *rf* generator (the transmitter), so that the power from the generator can be measured accurately or long tests can be run while the generator's output is placed into the load and not into an antenna where it would radiate.

Simplified schematic of the WIS AM dummy load. Each resistor is a 44-ohm (approximate) unit and the wattage is 285; the total resistance is 18.2 ohms, X_L is 6.7 ohms at 600 kc and the total wattage is 11,400.



The simplest load that can be used as a dummy is a regular incandescent lamp bulb. For transmitters with over 1,000-watt rating, however, this method becomes rather cumbersome. If 100-watt bulbs are used, then ten are required to dissipate the wattage without overloading; 500-watt bulbs can be used but are rather expensive and usually require special bases. The resistance of a bulb is also very difficult to measure, for it is not the same at different degrees of light intensity or wattage dissipation. At frequencies up to about 30 mc and at low power the bulbs can be used as a simple dummy load. This type of load provides an accuracy of about 6% if the following method is used: Let us assume we have a 100-watt broadcast transmitter in which we want to determine final stage efficiency. Two identical 100-watt 120-volt bulbs are first obtained. One of these is coupled to the output of the transmitter and the other connected to the output of an auto-transformer plugged into a 120-volt *ac* line. A reliable *ac* voltmeter should be placed across the lamp terminals, an *ac* ammeter being connected in series with the lamp. The voltage should be adjusted until exactly 100 watts are being dissipated by the bulb as indicated by the readings of the two meters, the *watts* = *E I* formula being used for calculations. With the use of a light meter, a reading well up on the scale of the meter dial should be obtained, the distance of the light

A typical mike setup for a remote with a band. The applause meter is at the left on the table and is connected to a microphone (not shown) which hangs from the ceiling of the auditorium. In this instance a separate mike was used for the vocalist and the announcer, and a special *pa* amplifier employed since re-inforcement was not required for the band.

Closeup of the miniature transformer mounted in the corner of a *pa* amplifier next to the *phono* input terminal strip.

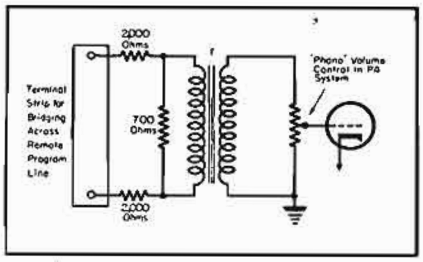
it is not susceptible to breathing noises.

With vocalists *experienced* in broadcasting, you will have little trouble with the ribbon mike, if you wish to use it. Frequently vocalists prefer the ribbon as the accentuated bass characteristic of the mike augments their style.

Sooner or later you will have to make a quick remote setup with an unfamiliar dance band. If the leader has participated in several broadcasts, it is best to ask him what special mike setup he uses for his band, since his group will probably have its own distinctive style, brought out best by a certain mike placement. His observations of previous mike setups are also quite valuable, since he can call on his experiences with engineers on previous remotes and, while his advice may not apply perfectly to your particular location, the information can serve as an excellent guide.

Generally, the microphone for the sax section picks up the brasses. The brasses are usually seated directly behind the sax players. The strings are difficult to pick up as they are not as loud as the other parts of the orchestra and the special mike for the string section must be thoughtfully placed to avoid too much brass section pickup. Another non-directional or cardiod mike should be provided to pick up the string bass, guitar, and drums. The mike should not be placed too close to the drum, as it is loud and may mask the other rhythm instruments. The piano may be picked up by the vocal mike. On occasions, this is impossible, and accordingly a separate mike will have to be provided. The foregoing is a guide, and in this work, the rules are made to be changed.

PA amplifier circuit modified for broadcast station use. The transformer (*T*) is positioned for minimum hum pickup.



A *pa* microphone is frequently placed adjacent to the vocal microphone, since the vocalist is the only member of the band that needs sound reinforcement.

Let us now consider a very important part of the remote picture that is too often overlooked, *showmanship*. While actual conduct of the show is the announcer's responsibility, the engineer must cooperate by providing the additional facilities required by the show.

Whenever possible the remote man should make as professional a setup as conditions will permit, particularly when the equipment is visible to the audience. We all know that to the eyes of the public, the man operating the equipment is an *engineer*. Why not preserve this favorable impression by avoiding haywire installations? Engineers should not appear at a remote loaded like a pack mule with equipment. Perhaps two trips may be required, but it is worth the effort in providing that more favorable impression.

Equipment should be clean. Call letter plates should be on every mike. Every labeled mike appearing in public is a plug for the station and call letter plates last indefinitely. A sign painter should letter the station call and affiliation on the remote amplifiers, the *pa* amplifier and the speakers. A simple letter design is attractive, easily read, and can be quickly touched up in the event it becomes damaged.

An effective way to add *zip* to any remote amateur show is to use an applause meter. Contrary to accepted belief, it is *not* necessary to have an elaborate electronic gadget to evaluate applause peaks. All that is necessary is an extra remote amplifier with a *vu* meter and a mike placed far enough from the audience so that whistles from any given group will have no effect on its operation. A high front position of the mike is suggested, and the amplifier should be positioned so it can be read by both the master of ceremonies and those in the audience at close range, though it is not absolutely necessary to have the audience see the meter. The size of the meter on the amplifier may make reading the peaks extremely difficult. Before the show, the gain of the applause meter can be adjusted for suitable reading when *warming up*.

A *pa* system should be used on a remote whenever possible. The *pa* is an immense aid in attracting a crowd or

(*Continued on page* 30)

An interview at a remote point using a portable dynamic mike and a home made handle as described in the text.

Design Problems In Triodes

Tubes Required to Generate *RF* in the 100 to 1000-mc Bands, Particularly for Broad Bandwidths of 6 mc or More for TV, Pose Many Complex Problems, the Key Question Being How to Obtain High Electron Current Density in Any Type of Tube, Including the Klystron and Magnetron, Except the Traveling Wave Tube Where Beam Density Limits Power. Analysis Covers HF Tubes Developed for Class *B* or *C* Application, Operating with Circuits External to the Tube.

by HOWARD D. DOOLITTLE

Development Engineer
Machlett Laboratories, Inc.

THERE ARE MANY ways to generate or amplify *rf* energy in the 100 to 1,000-mc band. To date the greatest effort has been spent in exploring the use of triodes and tetrodes for this work. This approach has been followed in view of the extensive experience available on tubes of these types at low frequencies, plus the fact that the electronic and mechanical design are relatively simple compared with transit-time devices.

In Figure 1 appears a graphical analysis of the progress made during the last nine years in raising the power level and frequency of triodes. The term *x* on the graph represents the power obtainable in a narrow band tetrode with internal circuits operated as a resnatron.

Basic Design Principles

The principal considerations in the design of high-frequency tubes are:

(*a*) Active electrode length in the direction of wave travel must be less than ⅛ of a wavelength.

(*b*) The time of flight of electrons from cathode to anode must be small compared with the period of the oscillation.

(*c*) Inductance in leads to electrodes must be kept as low as possible.

(*d*) Interelectrode capacitances must be held as low as possible.

(*e*) All surfaces carrying *rf* current must be of low resistance and insulators must be of a low loss type.

(*f*) For broadband television applications the tube must operate at relatively low plate voltage and high plate current.

(*g*) Good thermal design is required to maintain working parts at a sufficiently low temperature and to reduce frequency drifts.

(*h*) Good mechanical design is required to maintain good alignment of electrodes to prevent frequency variations as a result of mechanical variations.

This list presents the more important aspects of tube design and by means of engineering these factors into good tube design the progress shown in Figure 1 was achieved.

The power problem is basically one of size. As the frequency is increased a simple cavity operating in its fundamental mode will decrease in size. This means that a tube working in conjunction with such a cavity and as a part of it must also decrease in size. Certain types of cavities can be made which are many wavelengths long in one dimension and therefore have a large volume. An annular cavity is of such a type and offers possibilities of accommodating a large and a higher power tube.

Figure 2 illustrates many points listed in the design requirements, and shows the progressive design of a 50-kw triode at 2, 25 and 110 mc. A conventional tube used at the low AM frequencies appears at (*a*). Mechanically this tube uses a press seal on the cathode and a copper *housekeeper* anode seal. Long glass was used largely due to ease in handling; glass sealing could be handled at large distances from metal seals without danger of seal breakage from heat while sealing in the tube. The tube in (*b*) illustrates how electrode lead inductance has been reduced, by simply shortening the glassware and using two parallel connections to the grid. Further progress made in reducing lead inductances is shown in (*c*). All leads including both cathodes are made on large diameter cylinders. This latter tube also has substantially reduced interelectrode spacings to lower tube impedance and reduce transit time. It has not been necessary at this power load and frequency to shorten the length of the active cathode structure. For any higher frequency than 110 mc this would be the next step with a consequent reduction in power unless the diameter were simultaneously increased.

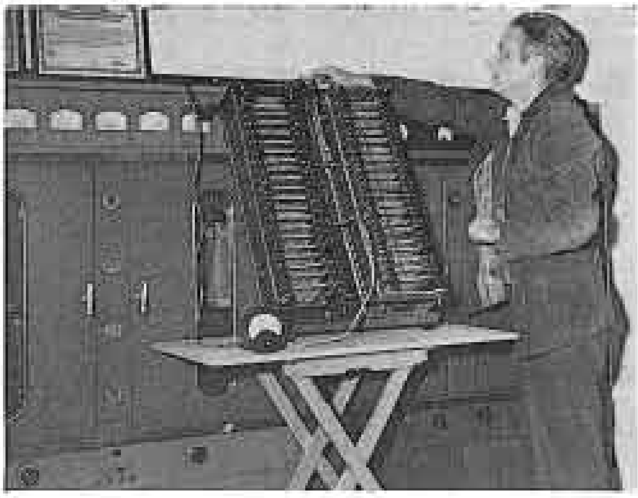
Figure 3 shows a 50-kw tube developed for 110 mc and beside it a 15-watt triode, the 2C39, for 2,500 mc. These two tubes are at the extremes of the power versus frequency curve of Figure 1.

Figure 4 illustrates the progressive design achieved with increasing frequency in tetrodes. For economic reasons tetrodes are not in general use at high powers even at low frequencies, to date most tetrodes being rated below 1 kw. The necessity for using triodes in grounded grid circuits above 50 to 100 mc, with inherently low power gain, has renewed interest in the possibility of obtaining substantially higher gains in tetrodes. Considerable advantage is realized up to from 100 to 400 mc, depending on the power level. Capacitive feedback from plate to control grid and lead inductance from screen to cathode limits gain above the frequencies given. In (*a*) of Figure 4 we have the low frequency design. Here the glass envelope is a vacuum

*From a paper presented at the Third Annual NAB Broadcast Engineering Conference.

Herb Eidson measuring resistance and inductance of the ohmspun unit with an *rf* bridge. The *rf* generator and receiver is at right.

WIS operator Ray Parke adjusting the dummy load for a 5-kw AM transmitter.



meter from the bulb being measured carefully.

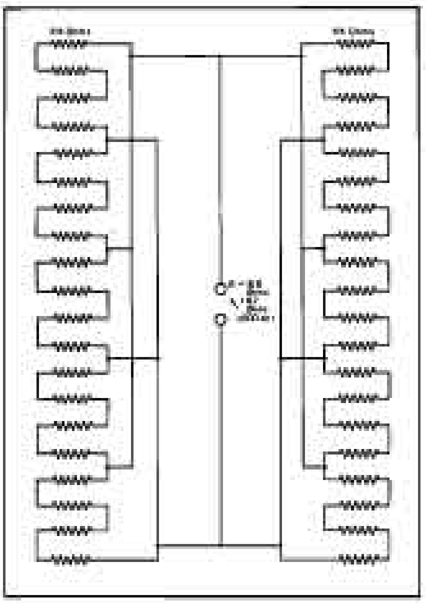
The next step involves *firing* up of the transmitter and adjusting of the excitation and load conditions until the lamp being used as a dummy load becomes as bright as the first lamp which was measured on the light meter and at the same distance. At this moment the transmitter will be now producing 100 watts. The efficiency can then be determined by dividing the 100 watts output by the *dc* input to the transmitter. If a sacrifice of accuracy must be taken, due to lack of extra materials mentioned such as a lightmeter, etc., then the two lamps can be used alone. In this case the lamps are placed side by side and the transmitter is adjusted until the two lamps appear to have the same brightness, using the eye as an indicator. If the lamps are rated at 120 volts, then the criteria should be adjusted to 120 volts as read on the voltmeter across the lamp terminals.

The main disadvantage of using lamps as dummy loads is that one is never sure that the transmitter's final tube plates are operating into their correctly reflected load. (The proper load for a transmitter is a resistor of known characteristics.)

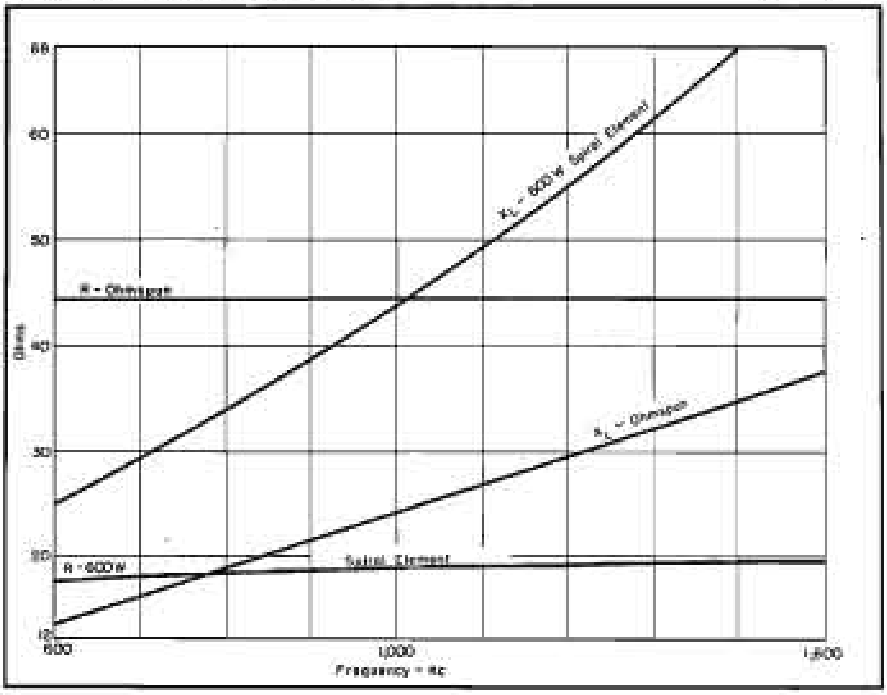
A nickel-base alloy flat-wire element with a rating of about 660 watts (iron element that is used to restore life to burned-out flatirons), has been found excellent as a load. It is simple and very stable. There is very little reactance at broadcast frequencies in this resistor and the resistance changes very little for small amounts of wattage. Three of these have been connected in parallel to fully load a 1,000-watt FM transmitter operating at 104.7 mc. Calculation of efficiency was impossible due to high reactance in the leads at this high frequency, but the load served its purpose in allowing the transmitter to be run at about full power for about a week, while it was being adjusted properly. The resistors had to be carefully watched during this period however, for hot

(*Continued on page 28*)

The physical connections of the *rf* dummy load at WIS.



Plot showing the characteristics of spiral and the ohmspun elements in terms of R_L and X_L.



REMOTE EQUIPMENT And Setups

How to Choose and Use the Correct Mike, Amplifier and *PA* System for the Remote Job. . . . How to Adapt Standard *PA* Amplifiers for Broadcast *PA* Work. . . . Attractive, Professional-Type Equipment Layouts Which Afford Best Results.

by ADELBERT KELLEY

Chief Engineer
WINR, Binghamton, New York

The remote assignment is one of the most interesting on the broadcast technician's schedule. Almost every show presents an unusual situation and it is certainly true that, if variety is the spice of life, the remote engineer's existence is well seasoned. Every location offers its peculiar limitations. Since there is frequently little time to make the setup before air time, experimentation with mike placement, rehearsals, etc., are impossible. It is here that previous experience proves to be a most valuable qualification, for techniques, arrived at by experience, can be used as a guide in arriving at a satisfactory solution to the various problems.

The easiest remote to set up and operate is the interview, where a single mike is used and the announcer either carries the mike or operates from a floor stand. Handles are not generally available for mikes, but a very satisfactory grip can be fabricated by threading a 5" length of ½" pipe, forcing a bicycle handle-bar grip over it, and screwing it onto the microphone. For this remote, the dynamic mike has been found to be best as it is smaller, more rugged, and in addition adapts itself well to close talking. There is no problem of mike placement or balance here, and room acoustics do not enter into the picture since the signal-to-noise ratio is high. The public-address system may give trouble, since there is practically an infinite variety of mike positions and locations. The best way to insure no feedback is to operate the *pa* conservatively.

The majority of musical pickups originate from night clubs and here the problems are many. Crashing dishes, audience noise, inadequate space and crowding are only a few. In these instances it has been found best to place the microphone as close to the musical instruments, as is compatible with fidelity, to combat the high ambient noise-level of the location. A thorough knowledge of the characteristics of dynamic, ribbon, and cardiod mikes is most helpful in arranging satisfactory setups in these locations. If at all possible, the simplest setup should be used. As a general rule, the use of one microphone, intelligently placed, is best, but it is often impossible to arrange all personnel around one mike due to cramped quarters. It is then necessary to increase the number of microphones, always keeping in mind that the more mikes used the harder it will be to keep the background noise down and cope with interference problems.

The state of confusion often on display at remotes, which not only does little to recommend the capabilities of the engineering division but embarrasses management and piques the sponsor.

The musical combination now being used at most night spots is the piano and Hammond organ, which lend themselves admirably to the single-mike setup. Where it is possible, the instruments should be arranged so the players face each other, the organ speaker being spotted so both players can hear it. It is a relatively simple matter to place a non-directional or bi-directional mike in the zone between the speaker and the piano so that both instruments will be in balance. The same mike can also be used by the announcer.

It must be remembered that in arranging mike setups the musicians must be considered, too. Often the boys are quite temperamental and extreme tact is quite a requirement. For every engineer who knows mike placement, there is a musician who knows twice as much. A fine balance must be drawn between observing their opinions regarding seating and mike placement, or ignoring them completely for your own, and doubtless more satisfactory, way. Musicians are artists and must be kept comfortable or they will play badly. Their wishes regarding placement should be respected as much as possible, as it *does* effect their air work.

Most night club vocalists have become so accustomed to the use of the *pa* system, that mike placement for broadcasting is often difficult. To get the most volume out of the *pa* system, the performers get as close to the microphone as physically possible. This, of course, is bad from the broadcasting point of view, particularly if a ribbon microphone is used. There is little one can do to combat the long standing habit of *mugging the mike*, short of building a guard rail around it. We have found that the best thing to do is avoid the use of ribbon mikes entirely for night club vocal work, and use a dynamic instead. This unit does not get bassy, when worked too close, and

*and Tetrodes for HF**

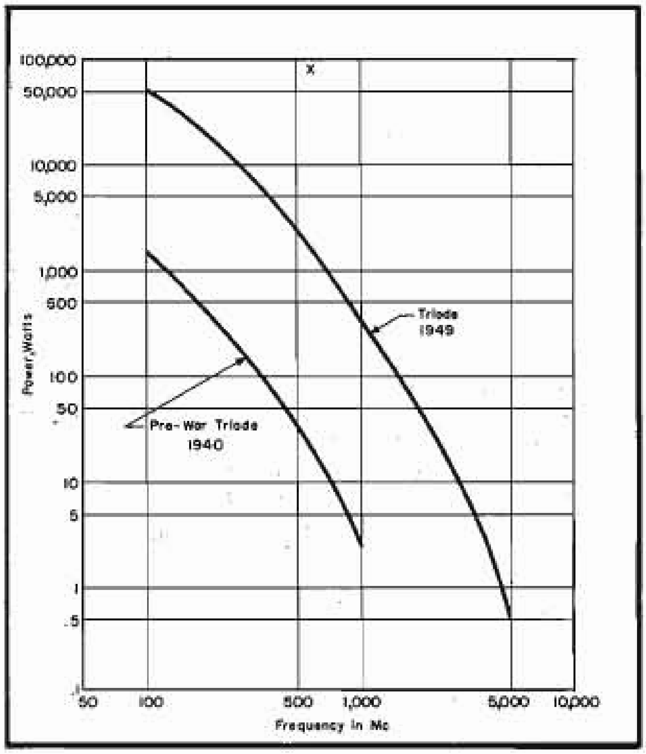


Figure 1
Plot of progress made during the last nine years in raising the power level and frequency of triodes. Graph illustrates the frequency versus power output of triodes using external circuits. The symbol X represents a resnatron with an internal circuit.

container and no attention has been given to lead inductance. In (*b*) provision has been made for an external shield to assist in the isolation of the input and output circuits. The tube in (*c*) illustrates how the screen electrode is brought out on a low inductance ring seal and multiple pins for the control grid are provided to reduce lead inductances. In (*d*) appears a proposed design permitting close bypassing of screen to cathode to raise the frequency ceiling further.

High Frequency Design Requirements

(a) Electrode Length: In order that the cathode emit to grid and plate uniformly it is necessary that it act as a *lumped constant* in the direction of wave travel. That is, it must be not more than 1/16 of a wavelength. At 100 mc the cathode must be less than 18 cm long and at 1,000 mc it must be less than 1.8 cm long.

(b) Lead Inductances and Interelectrode Capacitances: Since these two items are part of the LC circuit, they obviously must be small enough to be compatible with the equation

$$f = \frac{1}{2\pi\sqrt{LC}}$$

C is primarily determined by power requirements, cathode emission, and transit time. In tubes above 100 mc leads must be of the ring or disc type. Only copper or silver plated metals are suitable to carry the high *rf* currents without excessive loss.

(c) Limitations Due to Cathode Emission Density: The greatest single problem in obtaining high-frequency power is cathode emission density; i.e. the number of amperes per cm². Any attempt to increase the yield from commercially feasible emitters is always a

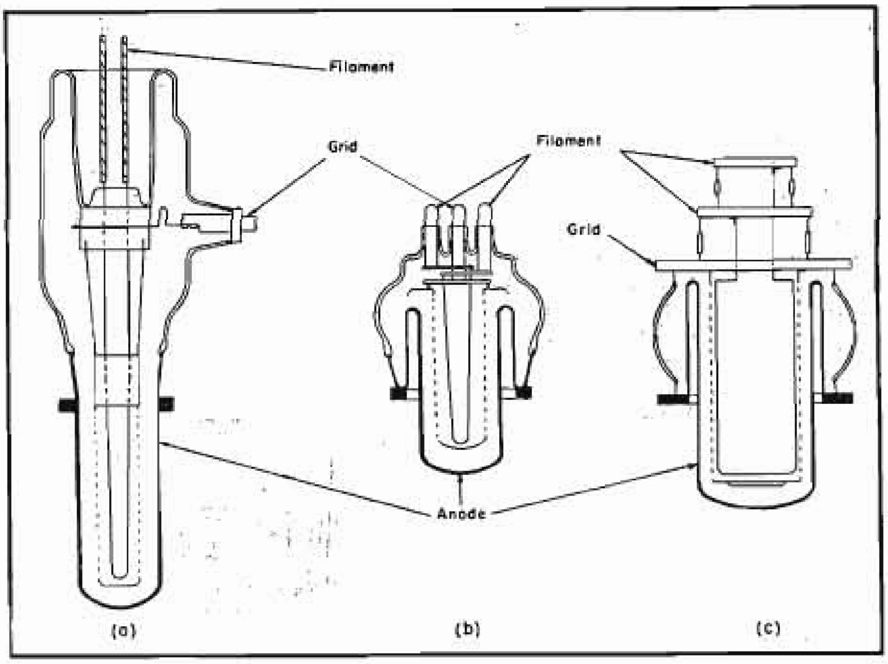


Figure 2
The progressive reduction in lead inductance of a 50 kw triode. At (*a*) appears an AM frequency type tube for 2-mc operation. The design at (*b*) for a 25-mc tube illustrates another step in electrode lead inductance reduction. At (*c*) is 110-mc type tube which further illustrates the progress made in the lead inductance reduction.

compromise on tube life. The latter cannot be cut too short for economic reasons. Thus the emission problem becomes more severe as bandwidth requirements increase.

At present power output can be increased only by increasing cathode area with the resulting higher inter-electrode capacitance and consequent reduction of the ratio of inductance to capacitance in the tuned circuit. How far it is practical to carry this procedure is not clear at present.

(d) Limitations Due to Transit Time: The next most serious problem is transit time. In Figure 5 is shown a plot of efficiency versus frequency for a 100-watt triode. In class C amplifiers the plate current flows in bunches. As transit time takes effect these bunches are smeared out so that some electrons arrive at the plate too late, causing increased anode heating as well as failing to contribute to the fundamental component of plate current. Transit time, or the time it takes an electron to move a distance, d, between parallel plate electrodes with a difference of potential, V, can be equated as follows:

$$T = .05 \frac{d}{\sqrt{V}} \text{ microseconds}$$

The three-halves power law for current flow between plane electrodes is:

$$J = 2.34 \times 10^{-6} \frac{V^{3/2}}{d^2} \text{ amps/cm}^2$$

Combining these equations by eliminating V, results in

$$T = 6.6 \times 10^{-4} \left(\frac{d}{J}\right)^{1/3} \text{ microseconds}$$

This equation shows that for space charge limited emission transit time can be reduced only by reducing spacing or by increasing emission density. The resnatron-connected tetrode with high screen voltage will reduce transit time variations in the grid-plate spacing and hence efficiency will not fall off as fast, as shown in Figure 5 for triodes.

(e) Increased Emission Requirements Due to Displacement Currents: When a capacitor is charged, a displacement current equal to the external circuit current flows in the vacuum space. The cathode must be capable of emitting this current as well as the conduction current. Otherwise plate current would not be related to grid voltage; i.e. the cathode emission will saturate. At the higher frequencies being considered, the displacement current may be larger than the conduction current. This fact imposes a further requirement for higher emission cathodes.

Figure 3

Comparison of *uhf* and *shf* type tubes. At left is a 50-kw 110-mc tube and at right a 15-watt 2500-mc type, both using ring seal construction.

(f) Limitations Due to Wide Bandwidth: The bandwidth of an amplifier can be solved by the equation:

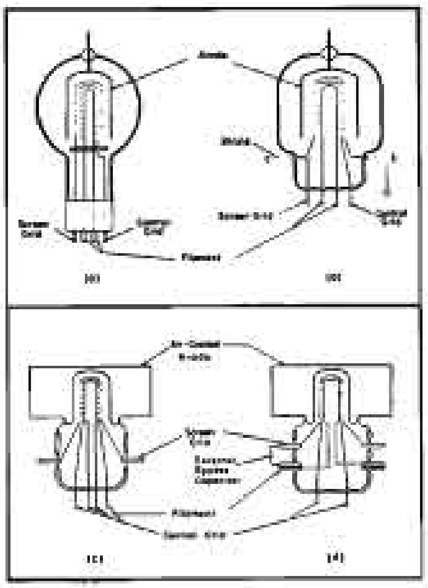
$$\Delta f = \frac{1}{2\pi RC}$$

Where: Δf = bandwidth in mc.
R = shunt impedance of anode-grid cavity.
C = effective grid-anode capacitance.

In a complete transmitter there are other circuit elements that store energy beside the grid-plate tube capacitance and hence the tube's *bandwidth* must always be from 25% to 50% greater than that of the complete transmitter.

Figure 4

Progressive design of tetrodes to minimize lead inductance and to isolate input and output circuits. At (*a*) is an *lf* design. At (*b*) an external shield has been provided to assist in isolating the input and output circuit. In (*c*) the screen electrode has been brought out on a low inductance ring seal and multiple pins for the control grid have been provided to reduce lead inductances. At (*d*) is a proposed design of a tube which permits close bypassing of the screen to cathode to raise the frequency ceiling.



The problem of obtaining wide bandwidth is not unique to high frequency tubes, but the problem of obtaining both wide bandwidth and high power simultaneously is a more difficult problem the higher the frequency. At low frequencies, say 100 mc, and narrow band such as FM speech broadcasting, the RC product can be relatively large since Δf is 0.15 mc. As the desired bandwidth is increased the RC product must be decreased. For television the RC product must be about 1/50 of that useable in FM broadcast. Obviously, the same tube cannot necessarily be used at the same power level in both cases. In practice FM tubes are not designed for minimum bandwidth due to the high voltages that would be required. Most FM tubes are useable at 6-mc television service.

The shunt impedance is determined by $R = \frac{E_b}{2I_b}$, where E_b is the *dc* anode supply voltage and I_b is the average *dc* anode current. Any attempt to lower R by increasing I_b is exactly offset by an equal increase in capacitance, unless higher cathode emission density can somehow be obtained. For a given plate voltage, cathode area can be increased; i.e. for 1,000 mc a 2-cm long cathode can be made on ever increasing diameters, with no adverse effects on bandwidth. Such a change does raise the total capacitance and reduces the LC ratio. Since larger diameters will have lower L, this procedure can be carried to the point where the circuit impedance becomes so low that it is difficult to work with. It is also possible that modes of vibration around the cathode may tend to form since this distance becomes large compared to a wavelength.

Since, due to cathode emission limitations, the plate voltage must be kept low for broadband amplifiers, it is also essential that the positive-grid drive, required to pull the full cathode current, be kept low so that the largest possible plate voltage swing can be used. Figure 6 shows the grid drive requirements of triodes as a function of grid-cathode spacing. Since for full utilization of emission, the peak current capabilities of the cathode must be drawn, curves of constant current density, J, in amps/cm^2 are given. For pure tungsten J = 0.5 amp/cm^2; for oxide cathodes J = 1 to 2 amps/cm^2; for thoriated tungsten cathodes J = 1 amp/cm^2 and for thoria cathodes a J of 2 to 3 amps/cm^2 is feasible. From this graph it can be seen that the closest possible grid-cathode spacing is desirable. Close spacing is also required to minimize transit time as discussed previously.

Fabrication of High Frequency Tubes

From the foregoing discussion it is evident that electrode spacings must decrease as frequency increases for two reasons: (*1*) to prevent loss of efficiency due to transit time and (*2*) to keep the ratio of voltage to current low to obtain large bandwidth. The fact that closer spacings increase interelectrode capacitances is unfortunate, both from considerations of the *rf* circuit constants and also the modulation requirements. The only way to improve the situation appears to be in obtaining higher emission cathodes.

For the present, design is limited to cathode emission of 1 or 2 amps/cm². For a given cathode area there will be a maximum plate voltage which will permit the necessary bandwidth. The product of current by voltage then determines the power level; or, in other words, the maximum amount of cathode area that can be designed into a suitable cavity determines the power level at the frequency for which the cavity was designed. Also since cathode emission is limited, transit time can be reduced only by reducing grid-cathode spacing. For this reason tubes for 1,000 mc require grid-cathode spacing of the order of 5 to 15 thousandths of an inch. This requirement in turn means that grid wire diameter must be small compared with this spacing; i.e. wires of 1 to 3 thousandths of an inch. Such dimensions would make cooling of grid wires extremely difficult if it were not for the fact that the grid must not be over 1/10 of a wavelength long. The grid wires may be imbedded in a thick copper cylinder and brought out to the external electrode surface through a short low inductance ring or disc seal.

The anode can be of thick-walled copper and similarly be brought out to the external contacting surface through a low inductance ring seal. The length of insulation between grid and cathode will be determined by the plate voltage and mechanical limitations of good vacuum seal design. The anode may be air cooled or water cooled.

The cathode for 1,000 mc cannot be over 1.8 cm long, but it can be several centimeters or even inches in diameter. It, too, must be brought out on a ring seal for low inductance. Since the emitter surface must run at from 800° *C* for oxide cathodes to 1,650° *C* for thoriated cathodes, the low inductance lead must have high thermal impedance to prevent excessive loss of heat. Otherwise poor cathode efficiency results and the external cathode lead requires excessive air flow for cooling.

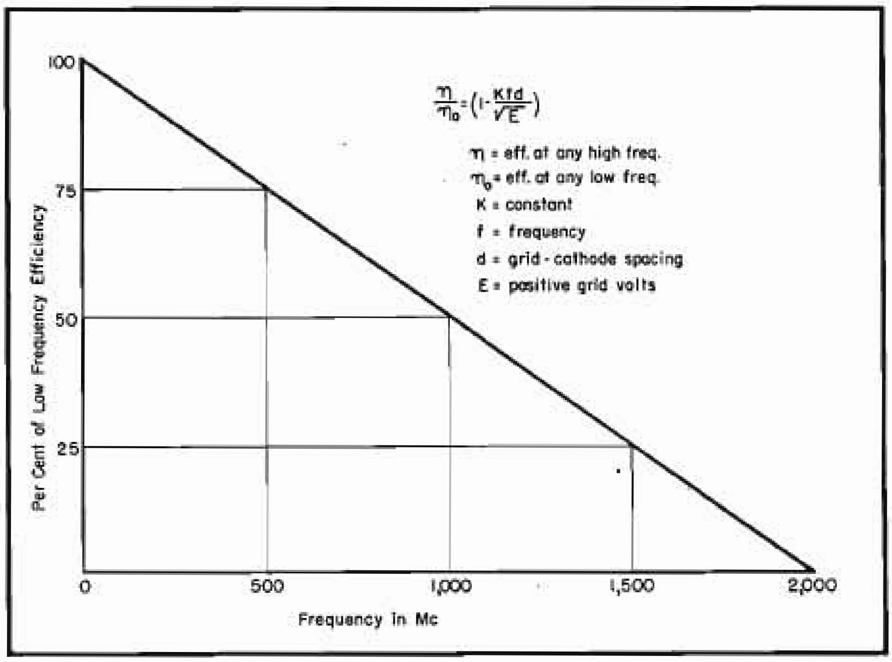


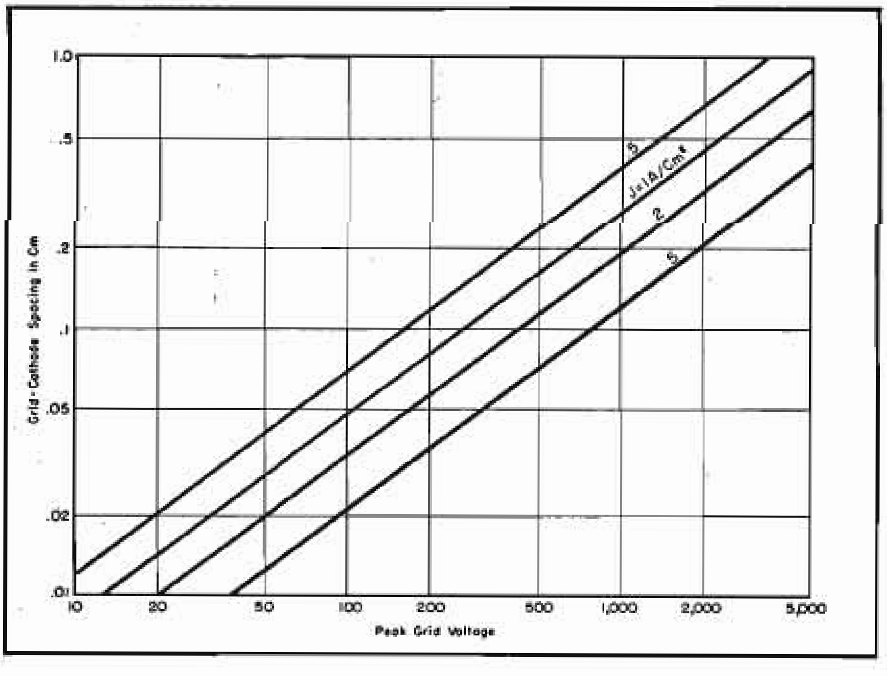
Figure 5
A plot of efficiency versus frequency for *uhf* triodes; 100 watt output.

The complete assembly presents many mechanical and thermal problems which are inherent to the high-frequency design. First, the electrode spacings represent a large share of the capacitance of the tuned circuit and must be closely held from tube to tube and must not be subject to excessive motion due either to vibration or normal heating. It is not practical to use insulators in the vacuum for maintaining spacings since considerable capacitance would be added. The ring type seals when properly constructed can be made to support electrodes adequately.

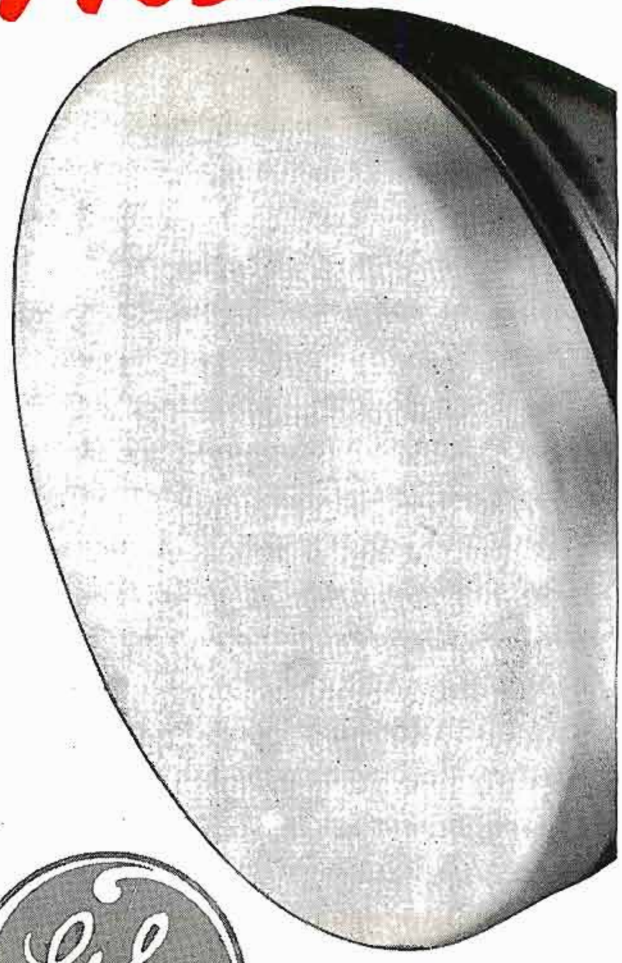
The most radical departure from former tube manufacturing techniques is due to the ring seals themselves and the requirement on minimum overall size. Due to the high temperatures required in outgassing tube parts, only high temperature solders can be used

(*Continued on page 32*)

Figure 6
Graph illustrating the peak-grid voltage versus grid-cathode spacing for various cathode current densities, *J*.



2 GREAT NEW TUBES FOR



WITH television racing ahead to new records in popularity—to ever higher figures in dollar volume—choice of picture tubes takes priority with designers and builders of receivers. The picture tube is the heart of the TV set. Cost, picture size, brightness—these must be carefully weighed in the light of the particular market at which a new receiver is aimed.

Good news to designers is G.E.'s introduction of the two tubes shown here. One—the 8½-inch type (8AP4)—dovetails with requirements of the low-priced receiver market where costs must be scrutinized down to the last penny. The 12½-inch aluminized tube (12KP4) matches the needs of that field of sale—also large—where picture size and quality come first.

Both tubes are G-E-designed to embody tomorrow's advanced engineering concepts. Both tubes are G-E-built to highest precision standards of quality!

CHARACTERISTICS

	8AP4	12KP4
Max bulb diameter	8 11/16 inches	12 9/16 inches
Min useful screen diameter	7¾ inches	11 inches
Heater voltage	6.3 v	6.3 v
Heater current	0.6 amp	0.6 amp
Focusing method	magnetic	magnetic
Deflecting method	magnetic	magnetic
Deflecting angle (approx)	54 degrees	54 degrees
Screen fluorescent color	white	white
Over-all length	14½ inches (max)	18 inches (max)
Bulb contact	metal-cone lip	J1-21
Base	B7-51	B7-51

MAX RATINGS, DESIGN-CENTER VALUES

	8AP4	12KP4
Anode voltage	10,000 v	12,000 v
Grid No. 2, voltage	none	410 v
Grid No. 1, voltage	—125 v	—125 v

TYPICAL OPERATING CONDITIONS

	8AP4	12KP4
Anode voltage	9,000 v	11,000 v
Grid No. 2, voltage	none	250 v
Grid No. 1, voltage for cut-off	—45 v	—45 v
Focusing coil current, d-c (approx)	120 ma	135 ma

NOTE: on Type 8AP4, the electron gun is designed for use with an external ion-trap magnet.

MASS TELEVISION MARKETS

TYPE 12KP4—A 12½-inch cathode-ray tube, all-glass construction. Aluminized screen. Offers *the brightest picture*—93 percent brighter (average) than a standard tube at 11,000 volts! Offers *a big picture*—95 square inches when the entire tube face is scanned; 75 sq. in. when standard raster of 3-by-4 aspect is employed. These areas are nearly half again as large as with the popular 10-inch type.... Here's the tube for TV-set manufacturers who put quality first, who wish to build consumer acceptance based on superior performance, on a larger, brighter, sharper picture. . . . *Here's the tube that's setting the pace in 1949 television!*

TYPE 8AP4—An 8½-inch cathode-ray tube with metal-cone envelope. Has plenty of picture area—47 square inches when the entire tube face is scanned; 36¾ sq. in. when standard raster of 3-by-4 aspect is used.... *Half the weight* of an all-glass tube, so ideal for small TV receivers that are lifted and moved about.... *Shortness of tube* (14½ inches) saves valuable space for the cabinet designer . . . *Requires a simpler, less costly circuit,* because the 8AP4's triode construction does away with need for a Grid-No.-2 voltage supply. . . . *Low in price,* up-to-the-minute in design—a combination that's putting this tube in first place with builders of small TV sets.

Size; responsibility; wide facilities for research, for manufacture—these identify a top source of supply for any manufactured article. Your source for picture tubes need be no exception. General Electric is actively engaged in every phase of television—has pioneered many important TV developments—brings to each tube type the knowledge gained from designing and building numerous other products in this field in which G-E leadership is acknowledged.

G-E tube engineers are ready at all times to consult with you on technical problems relating to the application of picture tubes to the receiver you may be designing. Your phone-call, wire, or letter will bring immediate, helpful response. General Electric's distributor-dealer facilities for replacing picture tubes in owners' sets are nationwide; your sales outlets and customers can count on tube service that is fast and reliable. Specify G-E picture tubes for value, quality, owner satisfaction! *Buy the best for this best new market—television—that is generously rewarding the set builders who serve it well! Electronics Department, General Electric Company, Schenectady 5, New York.*

You can put your confidence in—

GENERAL ELECTRIC

181-HI

FM OVERALL

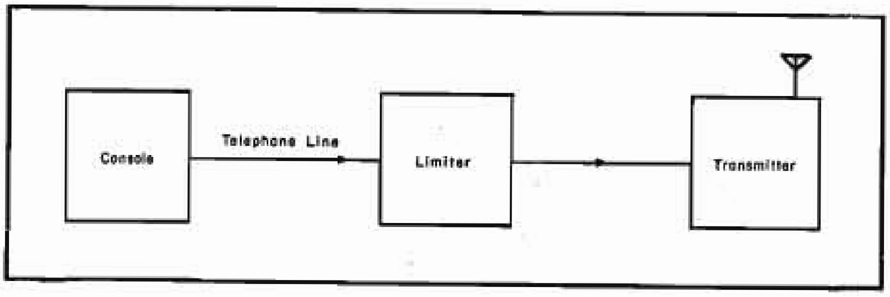


Figure 1
Block diagram of a typical broadcast station setup.

Figure 2
An overall test arrangement.

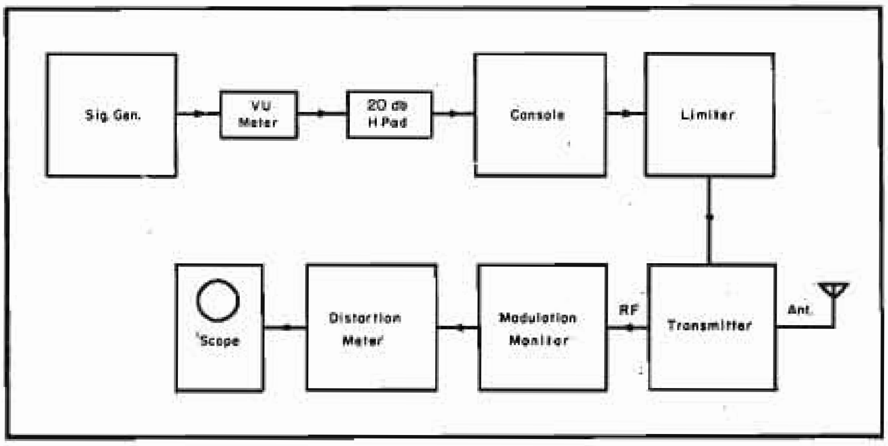
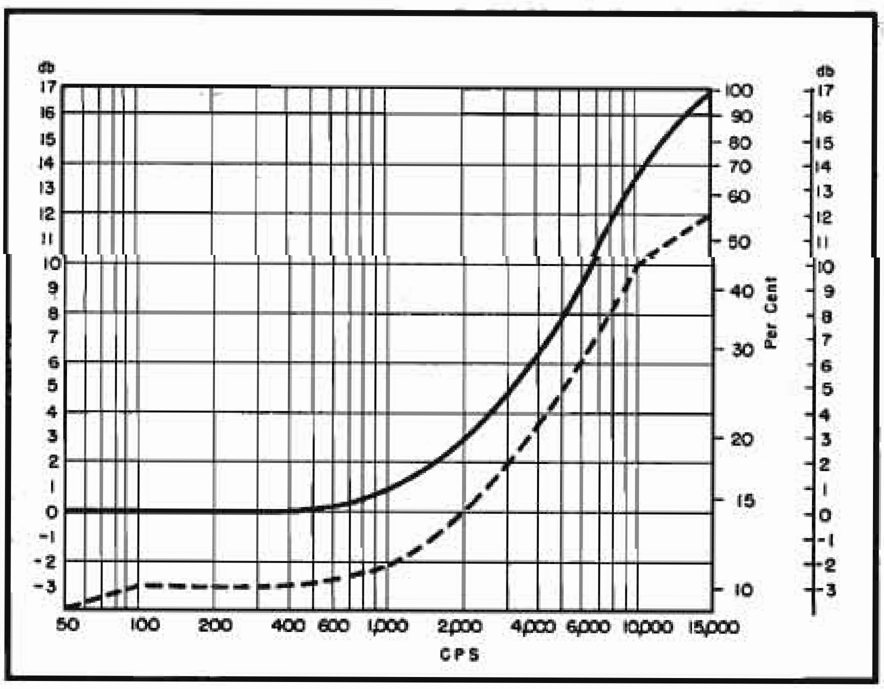


Figure 2a
Overall frequency response curve.



In the March and April issues of COMMUNICATIONS, appeared a two-part discussion of proof-of-performance by F. E. Talmadge. The analysis by Parker provides additional data on the subject and covers other test procedures which can be used.

WITHIN THE NEXT sixty days it will become mandatory to provide overall performance test data on all FM stations to the FCC.

In runs with our equipment, we have found that four basic instruments are essential for the measurement program:

(*1*) Audio signal generator or oscillator.
(*2*) Level indicator (*vu* meter).
(*3*) Modulation monitor.
(*4*) Noise and distortion meter.
(*5*) 'Scope (*optional*).

Since the performance requirements are quite stringent, it then follows that the testing equipment must exceed all these requirements in order to properly test the station apparatus. Otherwise, erroneous conclusions will be drawn in making the tests. Such equipment is readily available commercially and a great many stations already have the necessary equipment meeting the required specifications.

The Audio Signal Generator

This instrument should have available a standard 600-ohm output, and should cover the audio frequency range of 50 to 15,000 cycles, with an output of 15 dbm* and no more than ¼ of 1% (.25%) distortion at any frequency in this range. The hum or noise level should be at least 70 db below the 15 dbm output.

Level Indicator

A *vu* meter will serve admirably for this operation. It should have a flat frequency response curve, and accordingly only a high quality instrument[2] be used.

Modulation Monitor

This is often one of the weakest links in the chain. The monitor must be in good working order in every respect and correctly calibrated as to frequency and percentage modulation. Since all the monitors on the market have a suitable demodulated audio output provided specifically for test pur-

*15 dbm = 15 db based on a 1 milliwatt reference.

PERFORMANCE TESTS

Equipment Required and How It Should Be Used in Proof-of-Performance Tests, Which FCC Will Soon Declare Mandatory.

by B. E. PARKER

Head, FM Engineering Department
Gates Radio Company

poses, no further discussion seems required. However, the writer has found that the counter type is preferred over the discriminator type for ease and consistency in making the noise and distortion tests.

Noise and Distortion Meter.

This instrument should be capable of measuring noise down to –70 db and distortion down to ¼ of 1% (.25%) from 50 to 15,000 cycles.[3]

In these performance tests, primary interest is in overall frequency response, distortion and noise level. These three tests have to be made from the control console input to the demodulated output of the monitor. Figure 1 illustrates a typical station arrangement. Obviously, there are wide variations from this arrangement but each would present a special problem. Since this is a basic arrangement it will serve adequately for the basis of this discussion.

Figure 2 shows a block diagram of our overall test setup. No telephone line is shown between the studio and transmitter for simplicity of explanation. However, where a telephone line is employed, the services of two test men and a communication line between them will be required.

A level of –10 dbm should be fed into one of the remote channels of the speech input control console. An isolating and loss pad of 20 db must be inserted between the audio signal generator and the input channel of the console. The *vu* meter must be placed across the input terminals of this pad to insure proper response measurements. If the signal generator employed does not have a balanced output, then it may be necessary to connect an isolating transformer between it and the pad. The center tap of the 20 db *H* pad, as well as that of the isolation transformer, should be tied to ground.

The gain controls on the various pieces of equipment should be set at the proper levels for 100% modulation. Particular care should be exercised to assure that no unit in the chain is overloaded or operated at a level greatly different from that recommended by the manufacturer. To prevent limiting action in the limiter, the limiting control should be set below the limiting point, or else the limiting action should be disabled by removing the rectifier tube supplying the limiting voltage.

With the signal generator set at 400 cycles[4] and with the transmitter modulating 100%, the overall noise reading may be taken.

Should difficulty be encountered in obtaining the noise readings as outlined under the *FCC Limits* section, it will be necessary to isolate the noise pickup point by progressive elimination starting from the transmitter end.

Distortion should be measured at the same levels as just described. In addition, distortion measurements are required at modulation percentages of 50% and 25%. Checks at 50, 100, 200, 400, 1,000, 2,500, 5,000, 7,500, 10,000 and 15,000 cycles will give a good overall distortion picture. However, a fairly good picture may be obtained with only half these checks.

If distortion tests indicate that the overall performances do not meet the values outlined in *FCC Limits*, the progressive elimination method, as used in making noise tests, should be employed in determining the specific piece of equipment introducing the excessive distortion.

Overall frequency response tests are considerably complicated due to the pre-emphasis used in FM transmitters. The shape of the response curve is illustrated in Figure 2*a*. Since this is a radical departure from the normal straight line response sought in AM equipment overall performance tests,

(Continued on page 31)

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[2] Weston 862 has been found to meet all requirements.

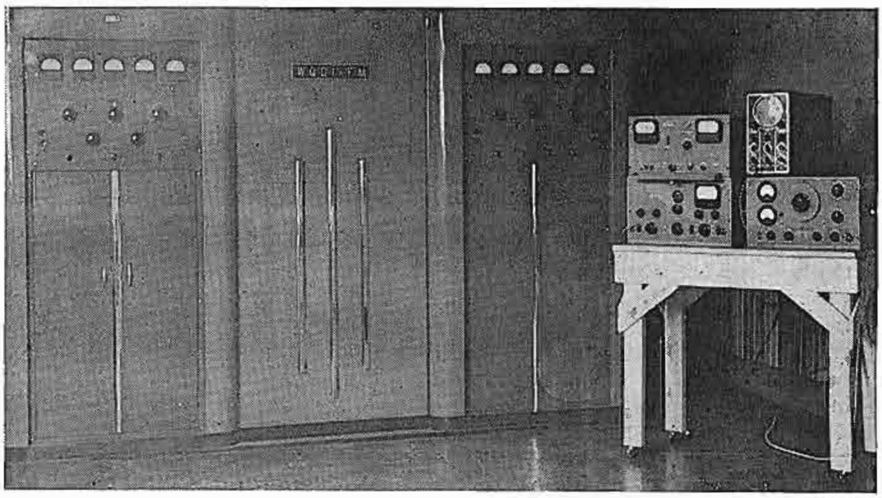
[3] Either the Hewlett-Packard or General Radio analyzer have been found to meet these requirements. They seem relatively free from the ill effects of internal *rf* pickup from the transmitting equipment.

[4] RMA recommendations are based on noise measurements using 400 cycles on all FM equipment.

Figure 3

View of a typical test setup for a 3 kw FM station.[1] The lower instrument on the left, on the portable table, is a noise and distortion meter[2] and above this is an FM meter[3]. To the right is an audio generator[4] and above this is a 'scope[5]. The use of the portable table permits moving to the desired test location while keeping the wiring between units intact. The 5" 'scope has often proved a decided asset in determining the nature of the noise or distortion present. The monitor has a jack for measuring the AM noise component of the FM carrier, when used in conjunction with a *vtvm*, such as the one incorporated in the noise and distortion meter illustrated here.

[1] Gates BF-3D. [2] Hewlett-Packard 330-C. [3] Hewlett-Packard 335-B. [4] Hewlett-Packard 205-AG. [5] RCA 160-B.



TUBE *Engineering News*

Application of Twin Triodes (6J6 and 19J6) in AM and FM Systems, Where One Section Is Used as a Mixer and the Other Section as a Local Oscillator. Highlights of TV Tubes, the 1X2, a T-6½ Miniature Rectifier with a 15,000-Volt Inverse Peak Rating, and the 6BQ6GT and 25BQ6GT Beam Pentodes.

THE PRINCIPAL advantage of a triode mixer is its low level of tube noise. The advantage is especially important at the higher frequencies at which most of the loading of the resonant circuits comes from the tubes. In the case of a pentode or a pentagrid converter, the major part of the output noise results from division of current between the plate and the screen circuits. In the AM broadcast band it is practical to use circuits of high enough impedance so that the noise from a pentagrid converter is less than the thermal-agitation noise from the input circuit. In the FM band, however, the advantage of lower noise from a triode can be fully utilized.

The local-oscillator voltage for a triode mixer may be applied at the control grid by inductive or capacitive coupling between the local-oscillator circuit and the control-grid circuit, or it may be introduced between cathode and ground. The control-grid bias must be sufficient to limit the grid current to a small value to prevent excessive loading of the input circuit. This bias may be obtained by use of a cathode resistor, or by use of a grid resistor of several megohms. In the latter case, the bias is obtained from the grid current caused by the oscillator voltage.

The output resistance of a triode mixer is substantially lower than that of a pentode mixer or a pentagrid converter. Consequently, the gain realized from the triode is generally lower. The lower output impedance of the triode must also be taken into account in the design of the *if* transformer.

Characteristics

In Figure 1 we have the conversion transconductance, plate current, and plate resistance obtained from one section of 6J6 or 19J6 as functions of the control-grid bias, when this bias is obtained by varying the local-oscillator voltage supplied to the control grid. These curves apply for a plate supply voltage of 100. The maximum value of conversion transconductance, 1700 micrombos, is obtained with a bias of 3 volts developed from a peak oscillator voltage of approximately 2.5. The plate resistance per section of either tube for this condition is about 16000 ohms and the plate current is 3.6 milliamperes. The curves show that lower values of oscillator voltage will reduce the plate resistance as well as lower the conversion transconductance. Higher values of oscillator voltage can be tolerated, but are objectionable because of increased radiation, particularly in receivers not using an *rf* stage.

Cutoff Voltages

The variation of conversion transconductance with control-grid bias when additional bias is supplied from an avc system, the oscillator voltage being held constant, is illustrated in Figure 2. This operation characteristic is obtained with 19J6 in an *ac/dc* receiver. In a receiver in which higher voltages are available, the cutoff voltage of the triode can be extended to larger negative values by obtaining the plate voltage through a series resistor.

Design of IF Transformer

The *if* transformer between the mixer plate and the grid of the first *if* stage must be designed to give satisfactory gain and selectivity when it is loaded on the primary side with an impedance of 16,000 ohms from the plate of the mixer tube. For the AM broadcast band, because it is desirable that the first *if* circuit shall not be loaded too much by the plate resistance of the tube, a low-impedance connection to the transformer primary is recommended. This connection may be conveniently obtained by using a winding similar to one used with a high-impedance tube (pentode or pentagrid converter) but with a tap located so as to present the desired impedance to the triode plate. If it is desired to obtain the same selectivity as would be obtained from a high-impedance tube, the voltage ratio between this tap and the high-potential side of the winding must be equal to the square root of the ratio of the plate resistance of the high-impedance tube to that of the triode. Thus, if the plate-resistance values compared are one megohm and 16,000 ohms, the voltage ratio should be approximately 8 to 1.

Use of Low L/C Ratio

A similar result can be obtained by using a low *LC* ratio in the *if* transformer primary. If the *Q* of the low-inductance winding is the same as that of the high-inductance winding for which it is substituted, the ratio of capacitances required for tubes with high and low values of plate resistance is the reciprocal of the ratio of output resistances. Thus, if the tube with a 1-megohm plate resistance requires a capacitance of 120 mmfd, a tube with a 16,000-ohm plate resistance would require a capacitance of 7,500 mmfd for the same selectivity. Such a capacitor, however, is likely to be rather bulky.

Increasing Gain

Selectivity may be sacrificed for amplification by the use of a higher

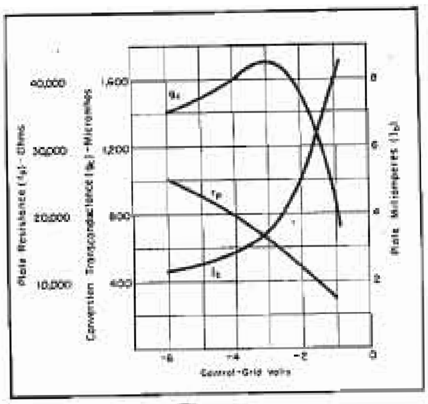


Figure 1

Operation characteristics of the 6J6 and 19J6 in mixer service. In calculating this plot the filament voltages used were: 6.3 for the 6J6 and 18.9 for the 19J6. The plate voltage was 100.

tap position or of a higher *LC* ratio than the values suggested above. In the FM band, it is common practice to use a primary circuit impedance several times higher than the tube plate resistance, so that the amplification obtained approaches the maximum possible value for the mixer tube.

Input Conductance and Feedback Considerations

In the AM band, the short-circuit input conductance of the 6J6 mixer is determined by the signal-grid current. For a bias of 3 volts and a resistance of 6 megohms, this current is .5 microampere. The corresponding conductance in micromhos is of the order of ten times this current value; that is, 5 micromhos, or a resistance of 200,000 ohms. A resistance of this value would load the input circuit considerably. When a tapped *if* transformer is used, however, the leakage inductance at the tap in conjunction with the plate-to-grid capacitance of the tube results in some negative conductance. At 1,600 kc, an inductance of 12.5 microhenries in the plate circuit would produce a negative conductance of 5 micromhos. The value of conductance will be highest at the *hf* end of the broadcast band, which is desirable because the effect of the circuit loading is also greater at higher frequencies.

In the FM band, the transit-time effect and the feedback produced by the inductance of the cathode lead result in grid-circuit loading. In addition, because the *if* transformer presents capacitive reactance to the signal frequencies, additional loading results should the *if* transformer comprise the whole of the plate impedance. It is desirable, therefore, to include series inductance in the plate circuit of the tube to produce enough regeneration to partially counteract these input loading effects. The inductance may take the form of a long lead, or a small, single-turn coil. At 100 *mc*, an inductance of .03 microhenry produces a negative conductance of 50 micromhos. Because the short-circuit input conductance of the 6J6 used as a mixer at 100 mc is in the order of 50 micromhos, a higher value of plate inductance would cause oscillation at the signal frequency.

(Data based on copyrighted information supplied by the tube department of RCA.)

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Hytron TV Tubes

Three tubes for television applications have been developed by Hytron.

Beam Pentodes

Two of the tubes, types 6BQ6GT and 25BQ6GT are beam pentodes designed specifically for use as horizontal deflection amplifiers in television receivers using magnetic deflection tubes. Their construction and processing make them suitable for the high peak inter-electrode voltages common in this service. The 6BQ6GT, with a 6.3-volt heater is for use in transformer-operated sets, while the 25BQ6GT with a 25-volt heater is suitable for use in sets employing series-heater connections. The tubes, which use a T-9 bulb, feature a plate brought out to a top cap for isolation of the high voltage and convenience in circuit layout.

The maximum peak heater-cathode voltage of these tubes is 135; maximum plate voltage, 300; maximum grid *No. 2* voltage* 200; maximum negative *dc* grid *No. 1* voltage, —50; maximum plate dissipation, 10 watts; maximum grid *No. 2* input, 2.5 watts; maximum plate current, 100 ma; maximum peak positive surge plate voltages**, 5,000; maximum peak negative surge grid *No. 1* voltage**, —100 and maximum grid *No. 1* circuit resistance, 0.5 megohm.

The heater voltage of the 6BQ6GT is 6.3, and the 25BQ6GT, 25. Heater current of the 6BQ6GT is 1.2 amp. and the 25BQ6GT, 0.3.

* Preferably obtained from plate-voltage supply through a series dropping resistor of sufficient magnitude to limit the grid-*No. 2* input to the rated maximum value for wide variation in grid-*No. 2* current.

** The duty cycle of the voltage pulse must not exceed 15% of one scanning cycle and its duration must be limited to 10 microseconds.

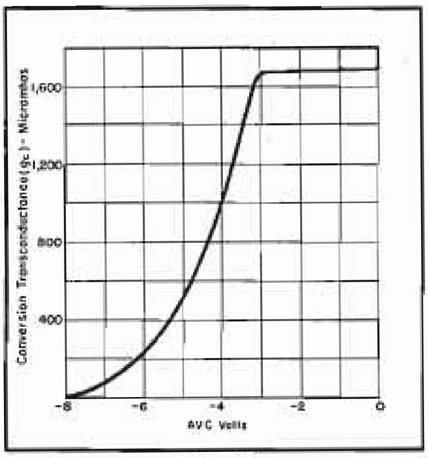


Figure 2

Plot obtained with the 6J6 and 19J6, using the same filament and plate voltages indicated in Figure 1, with additional bias supplied from an avc system.

The 1X2

The third Hytron TV tube is a 1X2, a miniature filamentary-type half-wave high-voltage rectifier designed to supply power to the anode of the picture tube. It was developed for use in both *rf* and flyback types of power supplies as well as for use at power-line frequency. In new equipment applications, the 1X2, which has a T-6½ bulb, when used within its maximum ratings, is a replacement for the 1B3GT/8016.

Filament potential of the tube is 1.25. Filament current, 200 ma. The voltage drop (approx.) at 7 milliamperes, is 100. Capacitance, plate to filament, is 1 mmfd.

Maximum Ratings . . . Design Center Basis

Maximum peak inverse plate potential of the rectifier is 15,000. Maximum peak plate current is 10 ma. Maximum *dc* load current is 1 ma, and the maximum frequency of supply voltage is 300 kc.

AIRBORNE ELECTRONIC

Mock-Up System Featuring a Shielded Room with 60 to 70 db Attenuation of External Noise, Developed During the War, Now Used Extensively by Government Agencies to Secure Invaluable Design and Operational Data. Information Available Covers Variety of Types of Interference: Pulse Type, *RF* Oscillator Leakage, Spurious Signals, Hash Type Produced by Video Signals, Etc. Tests Also Provide Data on Voltage Regulation, Sensitivity and Outputs, Power Loads, Etc.

by J. J. MacGREGOR and K. L. HUNTLEY
Senior Electronic Engineer — Electronic Engineer
Naval Research Laboratory

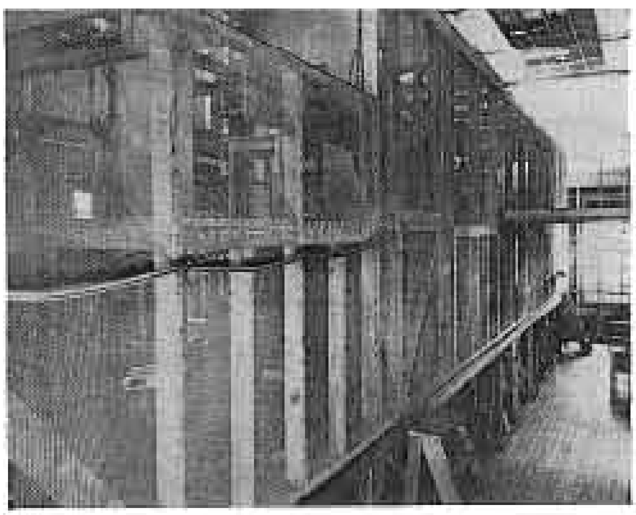
ONE OF THE IMPORTANT Naval wartime activities, about which little was known except by those immediately concerned and which due to its classification status received no publicity, was conducted at the Naval Research Laboratory in Washington, D. C. This activity was known as *Airborne Electronic Systems Analysis.** As a result of lengthy and careful consideration by the Systems Engineering Board of the Radio and Electrical Branch (now Electronic Division) of the Bureau of Aeronautics supplemented by conferences with representatives of NRL this activity was officially authorized by the BuAer in September of '43. Personnel were immediately assigned to the work at NRL and the arrangement for facilities begun.

Prior to the war aircraft electronic installations consisted of a very few units, employing a fairly narrow frequency range. Simultaneous operation was seldom if ever required. Except for ignition interference, which until the present ignition harnesses were developed, had always been a nuisance, there was little to interfere with normal operation of the equipment. While for years research and development work had been underway on many of the electronic equipments now in production, the war with its problems and demands not only accelerated this work but created a new conception of the enormous possibilities electronics could provide in modern warfare. Before the war, radio, radar, and other electronic devices were conceived and developed as individual units. The prime consideration was performance of a specific function by each of these separate units. For the most part they performed satisfactorily as such. The incorporation of these units into aircraft installations naturally was on a piece-by-piece basis as they became available, with little overall thinking in terms of a complete system. As a result many unpredictable and unsatisfactory characteristics appeared, among

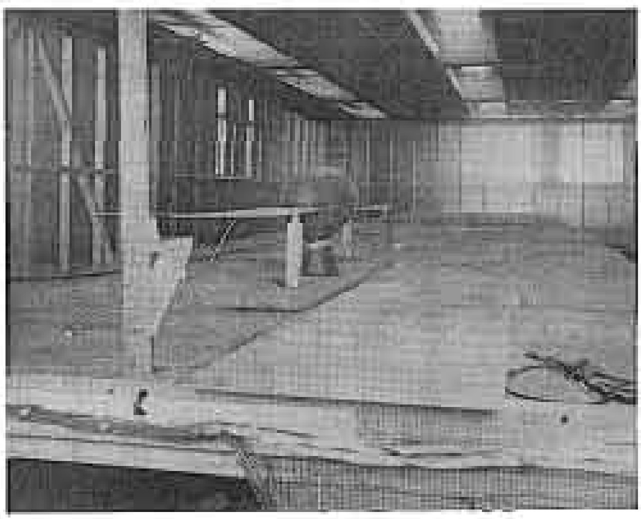
*A *system* is defined as a complete installation of all electrical and electronic units with their associated controls, indicators, etc., forming a composite interconnected system in a particular aircraft. Systems vary in accordance with the type of 'plane and include from eight major units for some single place fighters to as many as thirty-five units in the larger patrol planes. They vary also in the same type of aircraft depending on their tactical mission.

A *system analysis* is defined as an exhaustive study of the operational characteristics of each unit forming an integral part of the complete installation. The work of this activity, however, was carried beyond the scope of such a definition. It consisted of the equally important, and usually more difficult, phase of determining and incorporating corrective measures to all factors contributing to unsatisfactory or limited performance of the system. It also included determining any possible simplification or improvement of the system without impairment of its intended overall function.

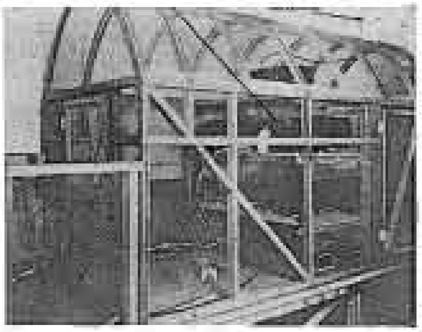
A patrol aircraft mock-up in a shielded room.



Topside view of a patrol aircraft antenna mock-up.



Systems Analysis in the Lab



(Above)
Mock-up of a small aircraft of the BT type.

the most serious of which were signal interference between units, output losses due to mismatched impedances, electrical interference, and interaction between controls. Briefly, equipments which functioned effectively alone did not always function satisfactorily upon integration into a system.

Another phase of the work was to ascertain to what extent open wiring could be used as a replacement for shielded cables. Prior to and during the early stages of the war interconnecting cabling was entirely of shielded cables. However, when copper and rubber became critical materials, it was necessary to conserve these materials wherever possible; hence the change over to open wiring. This was accomplished to the extent of open wiring being substituted for shielded cable up to 50% in the more elaborate and 100% in the simpler assemblies. The result was a saving of approximately 150 pounds in the largest airplanes, about equally divided between rubber and copper. This weight saving is in itself an important item in aircraft installations. Open wiring also reduces the possibility of failure of all equipments, such as might occur due to shell fire piercing a tightly bundled shielded cable. A major objection to open wiring is that it adds, in many cases, considerably to the difficulties of reducing interference between units.

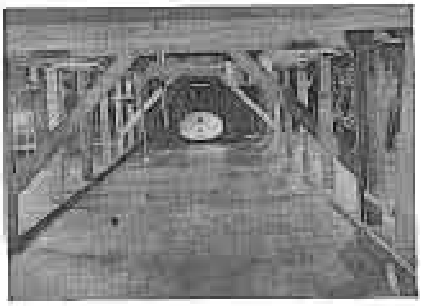
One of the first tasks of the group was to determine and provide the necessary facilities to accommodate the project. Since it was an entirely new activity there was practically no information, published or otherwise, to serve as a guide. Early consideration of the activity assumed that bench tests would suffice. However, it soon became evident that a mock-up of the 'plane housed in a shielded room would be required to obtain consistent results. Measurements indicated that two types of room shielding would provide the 60 to 70 db attenuation of outside interference, considered the minimum necessary for most of the investigations. Both were used in this work. In one method solid material (Sisalkraft) was applied to walls, ceiling, and floor along with adequate treatment of doors, windows and other openings. This type of shielding requires provision for lights, power lines, ventilation, heating, etc., all of which (excepting lights) must be completely covered with shielding and bonded to the walls where they enter the shielded room. In addition all light and power lines must be adequately filtered before entering the room. The second method, the double shielded type, consisted of a wooden frame of 2" x 4" members (the spacing between the inner and outer screens being the 4" dimension) covered with 4 x 4 hardware cloth on all sides, top, and bottom. Seams or overlapping joints have to be completely soldered. The inner shield may be grounded at one or several points. Heating and lighting must be provided externally. This eliminates all utility power circuits from entering the screened room except those required for electrical equipment necessary for the analysis. These power leads were isolated from the incoming line by an electrostatically-shielded transformer. Filtering was accomplished by special filters in each power lead. A special filter was also used to filter the 28-volt *dc* power entering the room.

The first method is the most expensive and difficult to provide and since the rooms using this method are single shielded they offer little, if any, attenuation advantages over the hardware cloth double shielding at frequencies up to 100 mc.

Careful Design of Mock-Ups

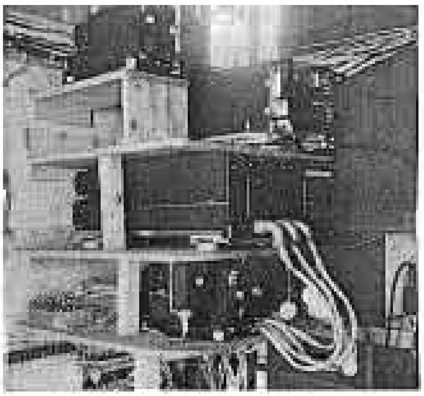
As mentioned a mock-up of the aircraft for which the system was intended was necessary to obtain consistent results since slight displacement of some units had a marked effect on the overall characteristics of the system. These mock-ups were constructed to conform very closely to the actual dimensions of the aircraft.

[To Be Concluded in the July Issue]

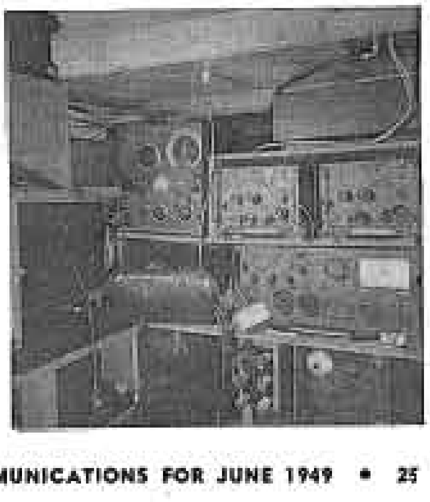


(Above)
Underside view of the antenna mock-up.

(Below)
Forward view in mock-up of the patrol aircraft operator's position.



An aft view of the patrol aircraft operator's position.



VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

The Spring Meeting

THE ANNUAL SPRING meeting in May, at the Fireplace Inn in New York City, attracted over forty members, who heard an enlightening talk on TV by Rodney D. Chipp, director of engineering of the DuMont TV network. Chipp took the boys behind the scenes at the station and in the field, disclosing the varied jobs which have to be performed, not only while the programs are on the air, but before, during rehearsals and during test periods. Many of the problems of patching in sight and sound from remotes, securing perfect sync operation between the station and the operators in the field and filling in with slides or movies during intermission points were also described by Chipp.

At the recent annual VWOA Spring Meeting in New York City (left to right): ye prexy William J. McGonigle; Rodney D. Chipp, director of engineering of Du Mont television, who was guest speaker, and William C. Simon, chairman of the VWOA board of directors and secretary of the association

Among those who listened in were . . . L. C. Munn, M. G. Cartier, R. S. Egolf, A. F. Rehbein, R. K. Davis, C. R. Shanholtzer, M. A. Churchill, H. B. Black, H. B. Koch, E. M. Stetson, G. N. Mathers, B. Morris, L. B. Victor, H. L. Cornell, E. H. Price, Eugene C. Cochran, John Lohman, Howard Williams, Fred McDermott, F. Orth, Ken Richardson, Earl P. Nelson, George Duvall, Benjamin Beckerman, Sam Schneider, R. J. Iverson, Ray Morehouse, Charles Cooke, Joseph L. Savick, Henry T. Hayden, Jr., George H. Clark, C. D. Guthrie, E. N. Pickerill, O. P. Penny, J. E. Quinn, V. P. Villandre, ye prexy Bill McGonigle and ye secretary Bill Simon.

Personals

WE WISH to correct an error in reporting that A. J. Stebbart had lost his wife. Arthur advises that it was his mother. . . . Capt. Fred Muller is touring down South and reports says that he is feeling much better. . . . The board has announced another winner of a VWOA Marconi Scroll of Honor for meritorious service during the USCG Eastwind and Gulfstream collision—Hernando R. Ruiz, who was chief radio officer of the Colombian steamer Republica de Colombia. . . . William R. Eberle has rejoined our ranks. Eberle was a VWOA member many years ago. An RCA man since 1917, he now works for RCA Communications. . . . H. T. Williams, also an old member, has rejoined. Williams started his career back in '16 as a radio operator aboard the Zulia. He served aboard several passenger and cargo ships until '22, when he transferred to Independent Wireless as a marine radio inspector. In '29 he went with RMCA with whom he remained until '33. From '33 to '46 he held several positions such as district manager of RMCA, Great Lakes. He's now with the sales department of Mackay Radio. . . . Another old timer, Clarence H. Scruggs, has also become a member. His wireless career began aboard the Delfina in '29. He has served on many ships such as the President Harrison, Orizaba, Dorthy Alexander and the Luckenbach ships until '41, when he started with the FCC. In 1946 he left the FCC and went back to sea. He is now on board the S.S. Junior of the United Co. . . . H. D. Taylor is now chief engineer of WTIC in Hartford, Conn. . . . Le Roy Thompson, Jr., is a major in the Signal Corps. . . . A. B. Tyrrell is wth RCA International, N.Y. C. . . . Not all of the stations are owned by the chains, because VWOA old timer Clinton R. White of Chicago owns WRCW. . . . G. V. Willets likes the redwood section of California so much that he has purchased a home in the redwood empire and finds that the simple life is ideal for writing. He also advises that he'll be unable to continue as VWOA rep in San Francisco because he is miles from cities. . . . Ben Wolf, who many of the *newcomers* will recall as having kept a close watch over their actions on the air at Grand Island, Neb., for many years, since his retirement last June now finds life more enjoyable because he can monitor the actions of the River Platte fish with no FCC forms to fill out. . . . Another Wolff, Sidney, is traffic radio chief of A. P., located way up in the Rockefeller Plaza buildings in N.Y.C. He can also be found in North Castle, N. Y., and can often he heard on his rig, W2HIG. . . . A. J. Martin, of Bristol, Conn., recalls with pleasure the days in '18 when he was with the CAC, U.S.A. in France. He's now with the Superior Electric Co., and also likes to talk with the boys over W1IFG. . . . J. R. Arkinstall, who for the last few years has been with the U.S. Maritime Academy at Fort Schuyler, must be very busy because we haven't heard from him in a *long* time. . . . We always thought the life of a radio op aboard ship was pretty *easy*, but R. E. Barber's doctor advised him to give up that life. Instead he now is in the building maintenance field, selling and renting maintenance and supplies. . . . E. N. Blackie reports from Redondo Beach, Calif., that he is with the Navy in the electronics group. He started as a ham back in '08, still operates W6WNZ and has a yen for the magnetic detectors and type *D* tuners of 40 years ago. . . . L. E. Bonduaux lives in Dumont, N. Y.

Dummy Loads

(*Continued from page 11*)

spots would develop and if they were not corrected that portion would burn out. These spots would occur due to heat produced by the proximity of the other elements. The condition would be corrected by increasing the space between the elements. *Ohmspun*[1] units were not available at that time or they would have been used.

Commercially Made Dummy Loads

For greatest accuracy and best all-round results a resistive unit, made just for the purpose of dissipating the heat caused by *rf* power, should be used. Such a unit is often referred to as a *toaster unit* because it resembles the wire arrangement in the common electric bread toaster. The complete resistor is made of special wire[2] so that its resistance changes very little between full load and its cold condition. Its reactance is very low. The most commonly used unit is rated at 285 watts. (This wattage can be increased 15% if a single unit is used.) Its inductive reactance measures about 11 ohms at the low end of the broadcast band and about 38 ohms at the high end. The resistance runs about 44 ohms in the broadcast band. Several of these units can be placed in a number of different arrangements to arrive at almost any desired resistance.

Common Uses of the Dummy Load

The most common use for the dummy load is measurement of power output from a broadcast transmitter. Sooner or later at all stations there comes a time when the antenna resistance is suspected of having changed due to a difference of readings on the transmitters i.e., to obtain the correct *rf* reading in the antenna, a higher power or lower input must be run. This can be usually traced to any one of five problems:

(*1*) Antenna resistance has changed.
(*2*) *Rf* antenna meter has lost its accuracy.
(*3*) Final stage meters have lost their accuracy.
(*4*) Poor connection in output stage, coupling lines or antenna.
(*5*) Weak tubes in transmitter.

The easiest way to check the antenna resistance is by use of the dummy load of known resistance. The load should be measured by a reliable *rf* bridge, when constructed. If possible it should be adjusted so that its readings are exactly that of the antenna. This resistance is placed across the *rf* transmission line in place of the antenna and in series with a newly calibrated *rf* ammeter. With the transmitter operating at normal meter readings, the ammeter reading through the dummy

[1, 2] Ohmspun, type WR-37-A, produced by The States Co., Hartford 6, Conn.

Characteristics of dummy loads at 60 cycles

	Ohm-spun	Flat Element	Spiral Element	100 W Lamp	300 W Lamp
Hot E	114	113	112	114	113
Cold E	114	112	111		
Hot I	2.495	5.50	5.90	.8	2.62
Cold I	2.52	5.80	6.10		
Hot W	284.1	622.	661.	91.3	296.
Cold W	287.5	650.	676.		
Hot Z	45.7	20.55	19.	142.5	43.2
Cold Z	45.25	19.35	18.22	9.82 (600 kc)	3.58 (600 kc)

The above figures are not extremely accurate due to the use of a standard ac voltmeter, standard *rf* ammeter (accuracy 2%) and the use of a slide rule.

load should be noted and the power calculated by the use of the formula:

$$Power = I^2R$$

Sometimes dummy loads will have a small amount of reactance. This can usually be tuned out by adjusting the final plate tuning slightly. If this stage is properly neutralized, you should tune for maximum power output. Plate current dip should be very close to this point.

A dummy load is also useful when a transmitter is being tuned up when you're off the air, during the daylight hours. It has been found that a 5-kw AM transmitter's carrier cannot be heard over approximately two miles, when operating into a dummy load, and the operating frequency is on the low end of the broadcast band.

Dummy Load for a 5-Kw AM Transmitter

Sometime ago the writer was asked to tune up a 5-kw AM transmitter, the final stage being a Doherty amplifier, which was to operate into a directional array of three towers. An old transmitter of the same power was on the air in another room and its output excited the phasing unit that would have to be moved into a new operating room beside the newly purchased transmitter. In other words, the Doherty amplifier would have to be tuned and operated for at least a month (to remove *bugs*) without the benefit of the phasing unit and antenna system. The answer, of course, was a resistive load, having the same resistance and reactance as the input to the phasing unit. To do this job a 11,400-watt unit was assembled. A high wattage factor was selected since we wanted to make measurements at 100% modulation with a sine wave and of course in this condition, the output of the transmitter increases 1.5 times its normal carrier output.

It was thus possible to tune the transmitter so that it matched correctly into the composite dummy load. Then the phasing unit was moved in beside the new transmitter and the longer leads from the three towers connected to it. It was then readjusted so that its input on directional and non-directional operation was the same as before, or that of the dummy resistance.

The load is made up of ten banks of parallel resistors (44 ohms each), each bank containing four resistors connected in series. It can be seen then that the total resistance should be somewhat less than one-half that of any one resistance. The resistance of the load as measured on a G-R *rf* bridge was 18.6 ohms, with an induc-

(*Continued on page 30*)

(Continued from page 29)

tive reactance of 6.7 ohms at 600 kc.

The frame which supports the dummy load resistors was made up, in our case, of two main parts. This station already owned a frame which would hold up to twenty of the ohm-spun units. Angle iron and iron strapping was used to add the extra frame to support the additional units.

The load has been in use for over 18 months and provided very satisfactory results.

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Remote Equipment

(Continued from page 13)

holding attention, and it is must equipment with large audiences. Even on the familiar *man on the street* broadcast the *pa* is useful, so that all can hear, not merely a half a dozen crowded around the mike.

We have found that a 30-watt system supplies enough power for almost any need; in addition a ten-watt system is used for the smaller jobs. Almost any commercial *pa* amplifier can be modified in an hour by installing a line-to-grid transformer in the phono input circuit.

Out on the job, the amplifier is set up by bridging its input across the remote line. The volume of the amplifier is adjusted after the remote amplifier is turned on and then operated for correct gain control settings. Usually one setting of the *phono* fader on the *pa* system will suffice for the show. Subsequent volume adjustment can then be made with the remote amplifier faders. Attachment of the *pa* system across the 600-ohm line causes little loading effect since the resistors offer a high-bridging resistance.

No special *pa* mike is required, unless it is desired to use one for warm-up prior to show time. This move permits a clear remote line, and the cues can be heard without interference. After the remote goes on the air, the *pa* mike can be turned off, and the broadcast mikes used.

With the use of the *pa*, there is the everpresent feedback problem. The best way to avoid feedback is employment of good operating practices; cautious manipulation of the *pa* volume control, and the careful determination of *levels* prior to air time. Then when the broadcast starts, it will not be marred by an ear-splitting burst of feedback that will make you want to forget public-address systems forever!

EITEL-McCULLOUGH VACUUM PUMP

A vacuum pump, the HV-1, an oil-diffusion type, has been announced by Eitel-McCullough, San Bruno, California.

Pump is said to offer speeds up to 67 liters per second, attainable vacuum of 4×10^{-7} mm Hg, clear glass pump barrel, no liquid cooling and no charcoal trap.

* * *

FTL SLOTTED LINES

A slotted line, FTL-30A, designed for making impedance and wavelength measurements in the range of 60 to 1,000 mc, has been announced by Federal Telecommunication Laboratories, Inc., 500 Washington Ave., Nutley 10, N. J. Measurements can also be made with somewhat slightly reduced accuracy in the range between 1,000 and 2,000 mc.

Unit is a coaxial line 250 centimeters long having a surge impedance of 51.0 ohms ±0.5 ohm.

* * *

AMPERITE MICROPHONE STAND

A microphone stand designed for pulpit and footlight use, is now available from the Amperite Co., Inc., 561 Broadway, New York 12, N. Y. Can be adapted for use with standard Amperite ribbon microphone.

Stand can also be used on the desk for inter-office communications and for dictating with recorders.

* * *

TURNER MICROPHONES

Two microphones have been announced by the Turner Company, Cedar Rapids, Iowa: models 25X and 25D, available in a choice of crystal or dynamic circuits. Crystal mike (25X) is said to be equipped with a moisture sealed crystal; has an effective output of 52 db below 1 volt/dyne/sq cm, and flat response from 30-9,000 cps.

The dynamic (25D) features Alnico V magnets, output level of 54 db below 1 volt/dyne/sq cm at high impedance, and flat response from 50-10,000 cps.

Other features include 90° tilting head and ⅝"—27 coupler mounting.

Turner has also redesigned their model 77 cardiod-type microphone. The interior retains the features of a combination circuit using both velocity and dynamic type generators, and the new design is said to further improve performance; engineered with a wide range pickup at the front and a sharply attenuated output at the rear with approximately 15 db discrimination between front and rear at all frequencies. Response is said to be substantially flat from 60 to 10,000 cps. Output is rated at 63 db below 1 volt/dyne/sq cm at high impedance. Built in switch affords choice of 50-200-500 ohms or high impedance.

* * *

B & W FREQUENCY MULTIPLIER

An all-band frequency multiplier has been announced by Barker & Williamson, Inc., 237 Fairfield Avenue, Upper Darby, Pa. Unit, designed to keep power requirements low, covers 80-40-20-15-11 and 10-meter bands.

Can be used with either *vfo* or crystal input, at an output of not less than 25 watts on all bands.

* * *

SYLVANIA WAVEGUIDE WINDOWS

Glass waveguide resonant windows, designed to permit silver soldering, without damage, to micro-waveguide systems operating from 3,000 to 40,000 mc, have been announced by the electronics division of Sylvania Electric Products, Inc.

Windows are said to eliminate glass stress at relatively high temperature differentials required for silver soldering. Power losses range from .02 to 1 db. The new windows for frequencies above 3,500 mc, will stand pressures up to 65 pounds per square inch absolute.

Applications include pressurized or gas-filled waveguide systems for all types of radar including navigation, fire control, long and short range search and those for gas analyses and meteorological uses. They are also used in the construction of TR and ATR switching tubes and to isolate portions of vacuum systems.

* * *

TRANSVISION PLIERS

Front-cut pliers, featuring a sharp, tempered cutting edge and a *long nose* for probing into small places such as miniature sockets, etc., have been announced by Transvision, Inc., New Rochelle, N. Y.

Overall length: 6¼"; width tapers from 2" maximum on the handle to $\frac{3}{16}$" on the extreme tip.

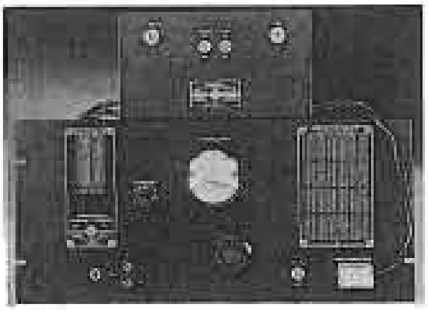
The Industry Offers

G-R UHF INTERPOLATOR

An *interpolating frequency standard* for use with heterodyne frequency meters in making accurate frequency measurements at *uhf* up to about 3,000 mc, has been announced by General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Instrument provides a series of harmonics of a nominal 1-mc signal, whose fundamental is adjustable over a range of 1%. At the 100th harmonic and above, coverage from one harmonic to the next is obtained. Consequently, when a frequency lying between 100 and 200 mc is measured approximately on a frequency meter, it can be matched and determined accurately with the interpolating frequency standard.

Designed particularly for use with the G-R 720-A heterodyne frequency meter, which covers a fundamental range of 100 to 200 mc. Series of harmonics, based on a 0.1-mc fundamental, is also generated by the device, for use with the G-R 620-A heterodyne frequency meter, for measurements in the range between 10 and 300 mc.



* * *

G. E. TV TUBES

Two TV tubes, a miniature triode for use as a grounded-grid *rf* amplifier and local oscillator for TV receivers and a beam power amplifier, have been announced by the tube division of G. E.

The triode, the 6AB4, is one triode section of the 12AT7, twin triode. It features a redesigned heater which is said to give improved microphonic qualities and reduce hum-level.

The 6AB4 heater voltage is 6.3, while the heater current is 0.15 ampere. As a class A amplifier, with plate voltage at 180, the grid bias voltage is —1, the amplification factor 60, transconductance 6,600 micromhos, and the plate current 11 milliamperes.

The beam power amplifier, the 19BG6-G, designed for horizontal-deflection circuits, may be used with picture tubes operating at less than 10 kv.

The *dc* plate voltage is 500 v, while the *dc* plate current is 100 ma. Peak heater-cathode voltage is 250 with heater positive or negative in respect to cathode.

* * *

C-D DISCHARGE-TYPE CAPACITORS

Heavy duty discharge type capacitors, type AVL 1204, with a capacity and voltage rating of 20,000 mfd, 150 working volts, have been developed by the Cornell-Dubilier Electric Corp., South Plainfield, N. J. Over-all dimensions (rectangular case) is 6" by 8" at the base, with a height of 11". Features are copper bus bars and heavy wire leads, individual units connected in parallel, with individual capacitors housed in hermetically sealed aluminum containers, which are insulated from the outer housing.

* * *

RCA FM/AM ISOLATION UNIT

An FM/AM isolation unit designed to transfer FM power across the insulating zone of an AM antenna tower to feed an FM antenna mounted atop the tower, has been announced by the RCA Engineering Products Department.

The unit (type BAF-14A) has swivel flanges at both input and output, which connect to standard 3⅛" 51.5-ohm flanged line which extends from top and bottom of the unit.

The isolation units consists of two series resonant circuits coupled together to such a degree as to provide effective band-pass characteristics over the 88 to 108-mc band. The inductors consist of solid copper loops, and the capacitors consist of built-in concentric line reactances which are concentric with the input and output conductors. The input assembly is insulated from the output assembly.

(Continued from page 31)

instances this has been attributed to insufficient or improper grounding. A copper sheet placed underneath the transmitter and extending under the equipment racks often proves quite satisfactory as a common ground.

As has been previously pointed out, operation of the various audio amplifiers at the proper levels is of paramount importance for two reasons:

(1) The highest signal-to-noise ratio or level is obtainable consistent with the output level recommended by the manufacturer. If this output is too low, then the signal-to-noise ratio suffers proportionally.

(2) The output operating level of the amplifier must be within the levels recommended by the manufacturer if excessive distortion is to be avoided. It is comparatively easy to unknowingly exceed these levels. For this reason it is worthwhile to measure the input and output levels of the various pieces of audio equipment by means of a vu meter.

In making the frequency-response checks, one often used method consists of maintaining 100% modulation at all frequencies. The attenuator controls on the signal generator offer an attractive temptation to do this since they are calibrated in db steps. The response curve is then drawn by adding or subtracting the attenuator setting from that of the reference frequency setting. This sometimes leads to serious errors, often as much as 2 or 3 db. This is true of even the leading makes of commercial equipment. It is by no means a reflection on the quality of the instrument as it represents a compromise in the degree of accuracy necessary to sell the instrument at a reasonable price.

These errors are largely due to the following causes:

(1) Frequency response errors of the attenuating networks. Working into a resistive load with only a relatively small amount of attenuation, these seldom exceed one db. However, in practice, we may find our load is reactive since a transformer does not present a pure resistance at all frequencies. This latter condition may double or triple the error factor.

(2) Commercially available attenuators cannot be economically manufactured to exact db steps. In other words, twenty separate db steps may prove to be a total of 21 or 19 db actually, since the individual error is additive.

Due to these errors inherent in the above method, it is not to be recommended for overall performance tests. In the previously described method, the accuracy limitations are only those of the operator in reading the meter and the modulation monitor meter. The latter is fixed by FCC approval of the instrument.

Measurements may be made from a microphone input rather than a remote input channel if desired. Should a microphone input channel be used, the input level should be —50 dbm. In using mike channels, extreme precautions must be exercised in balancing the feed as well as insuring that there is no frequency discrimination in the pads or attenuating network. This latter often proves troublesome and most difficult in the field due to the low signal level. It is recommended that measurements first be carried out using a remote channel before attempting measurements through a mike channel. This will permit concentration on the most difficult portion of the overall checks and will not be the limiting factor of the test setup.

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Triodes and Tetrodes for HF

(Continued from page 17)

in brazing operations. In compact tubes, it is difficult to braze one joint without excessively heating other parts of the tube. These problems are under good control now, either by localized heating using induction heating or simultaneous brazing of many joints at once.

Alternative electrode designs use electron guns rather than fine wire grids. Such structures are more difficult to design, from the electrical point of view of achieving good electron bunching, but of course have advantages over the fine wire type in rigidity and ease of cooling.

Conclusions

Whereas power levels of 5 to 10 kw present some formidable problems at the high frequency end, they are obviously not unsolvable. Proper design to insure adequate stability of electrode position, freedom of insulators from thermal strains, improvements in cooling means, and additional experience with low impedance lines are required. Economically, it may be more suitable to use a number of tubes in a cavity rather than to use a single tube. The latter would require very large diameter seals of short length, which are difficult to make.

FM Performance Tests

(*Continued from page 21*)

different test techniques must be used.

It has been found that the following method is perhaps the simplest and most foolproof of several methods tried:

The audio signal generator is set at 5,000 cycles and the gain control advanced until 36% modulation is indicated on the modulation monitor. The level should be noted on the test ow meter attached to the 20 db pad and maintained at this level throughout the frequency check.

The signal generator is then shifted to 7,500 cycles and the monitor reading noted and the plot marked (Figure 2a). The same procedure should be used at the following audio frequencies: 10,000, 15,000, 50, 100, 400, 1,000 and 2,500.

This will provide nine points on the curve and enable drawing a response curve by connecting these points. If the response exceeds the top curve at any frequency the whole curve may be dropped down by this amount.

Since the various amplifiers in the chain, the telephone line and the transmitter may all be down one or two db at the extreme frequency points (50 and 15,000 cycles), these may be additive and accumulative causing the overall curve to fall outside the *FCC* limits.[5, 6]

Special Considerations

Special consideration to test equipment grounds is of paramount importance. Short unshielded lengths of interconnecting leads are especially susceptible to *rf* pickup. This pickup is rectified in the grid circuits and often shifts the bias on that tube or introduces a hum component in the test signals. The latter is probably introduced by slope detector action. These conditions are most troublesome when the test equipment is close to the transmitter and its associated field of direct radiation. Obviously it is advantageous to move the test equipment as far as possible from the transmitter when this becomes evident. Often the same kind of noise pickup is present in new installations due to *rf* pickup in associated audio equipment. In most

(*Continued on page 32*)

[5] The latest Gates' FM transmitter models have incorporated in the basic exciter a control to compensate for external response drop off at 15,000 cycles. This purposely provides only a small amount of equalization and should not be used to compensate for operational difficulties, or for equalization where the telephone line response at 15,000 cycles is more than 1 db below the 7,500 and 10,000-cycle level.

[6] See April, 1949, COMMUNICATIONS, pages 22 and 23, for FCC limit rules.

News Briefs

INDUSTRY ACTIVITIES

The Microtone Company, Minneapolis and St. Paul, Minn., hearing aid manufacturers, have purchased the Audiometer Division of the Audio Development Company, Minneapolis.

Ralph E. Allison, president of the Audio Development Company, has joined Microtone as director and technical adviser of the Audiometer Division. **S. C. Rynn** is president of Microtone.

Eitel-McCullough, Inc., will manufacture metal 16-inch TV picture tubes at their Salt Lake plant. Plans call for completion of tooling prior to the first of the year.

PERSONALS

Charles G. Roberts has been appointed television equipment product manager for General Electric's transmitter division.

G. W. DeSousa has been named manager of sales administration for the G. E. tube division.

R. V. Bentecou is now staff assistant to the manager of the G. E. tube division.

L. E. Record has been named supervisor of the development and testing laboratories for the G. E. tube division.

Paul F. Walker, formerly with The Andrew Corporation, has joined the engineering staff of The Cleveland Container Company.

Ethan D. Bassett is now government sales supervisor of the F. W. Sickles Co.

Sam Bialek and **Leon Adelman** have become Permoflux manufacturer's reps in the greater metropolitan New York area.

Leslie J. Woods has been appointed vice president, director of research and engineering, to direct all engineering and research activities of Philco Corp.

Woods will be assisted by David B. Smith, vice president—research and engineering.

Cozzens and Farmer, Raytheon broadcast equipment reps for the Mid-West, are now located at 720 Main Street, Evanston, Ill.

Jack Perlmuth of Perlmuth-Colman and Associates, Raytheon reps, Calif., visited recently the radio receiving tube division plant of Raytheon Manufacturing Co., at Newton, Mass.

H. O. Edson, assistant treasurer of the Kellogg Switchboard and Supply Company, has devised a simplified system of record keeping for small telephone operating companies.

The simplified system will soon be published and released as a free service to small independent telephone operating companies. The forms are presently being tested under practical conditions in various typical locations so that any obvious complexities may be eliminated before the system is generally distributed.

In the preparation of the forms, consideration has been given to individual state requirements as prescribed by the utility commissions through their account classification manuals. Special instructions coordinating the system to the particular State Utility Commission requirements will be furnished to those operating companies within the various states affected.

Those operating companies who are interested in reviewing the system and putting it in use in advance of the general distribution date may write directly to Kellogg or any of its sales representatives. . . . Attention: Small Company Service Division.

LITERATURE

The American Cyanamid Company, 30 Rockefeller Plaza, New York 20, New York, have published a 12-page booklet describing molding materials and resins. Illustrated with color photographs.

Cannon Electric Development Company, 3209 Humboldt St., Los Angeles 31, Calif., have released a desk size (38x50) Army-Navy connector specifications (AN-C-591) chart with insert arrangements shown in detail at half scale. Illustrations of all basic AN shell types are included with exploded views of one receptacle and one plug.

Wells Sales, Inc., 320 N. LaSalle St., Chicago 10, Ill., have released a 4-page relay catalog, with specifications, ratings and prices of a variety of relays. Also included are many types of miniature switches, dry disc and crystal rectifiers, transmitting tubes and pilot and flashlight bulbs.

Aerovox Corp., New Bedford, Mass., have published an illustrated folder on the Aerovox capacitance and resistance bridge for jiffy-checking capacitance, resistance, power factor, shorts and opens, leakage, etc.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., have prepared a bulletin, B-5, describing type BW ½, 1 and 2 watt low wattage wire-wound resistors.

The Shallcross Manufacturing Co., Collingdale, Pa., have prepared a booklet (R-3) describing forty-seven standard precision resistor types including seventeen types designed for JAN R-93 specifications.

Booklet indicates mounting styles and other adaptations in which the various types are available and includes data on factors such as time versus temperature; temperature coefficient; wire sizes and alloys, etc.

The Andrew Corp., 363 East 75 Street, Chicago 19, Ill., have released a 24-page general price list bulletin (30B) covering coax cables, fittings, line accessories, tower lighting equipment, antennas, components, etc.

The E. F. Johnson Co., Waseca, Minn., have published a 4-page bulletin describing their recently announced *Roto Matic* antenna array, which is available with parasitic or driven elements.

The Bliley Electric Co., Erie, Penna., have have released a 12-page technical bulletin covering crystal units, crystal-controlled oscillators and general crystal information, including a frequency-range characteristic chart, etc.

Last Minute Reports . . .

THE COAXIAL CABLE had a birthday a few weeks ago, its twentieth. This outstanding development was conceived by two oldtimers at Bell Labs, Lloyd Espenschied and Herman A. Affel, who in 1929 installed an experimental cable at Phoenixville, Pennsylvania. . . . Roger M. Wise, now engaged in tube research and development for Philco, has been awarded the Presidential Certificate of Merit. . . . Emil J. Maginot is now sales manager of National Union Radio Corporation. . . . The new field of *magnetic amplifiers* was discussed recently by Professor Ernst Weber, chairman of the Graduate School of Electrical Engineering, Brooklyn Polytechnic Institute, in a joint meeting of the Instrument Society of America and the Radio Club of America. . . . Charles A. Powel, assistant to the vice president in charge of engineering at Western Electric, has become a lecturer in electrical engineering at M. I. T. . . . The seventh television technical program, held recently by RCA at their plant in Camden, featured talks and demonstrations by Capt. William C. Eddy, technical director of WHEN, Syracuse, on *TV studio lighting*, and Otto Schade, RCA development engineer, on *50 cycle non-sync operation*. Among those in attendance were:

Neil Arveschoug, WDHN, New Brunswick, N. J.; H. A. Audet, CBS, Montreal, Canada; C. L. Soucy, Canadian Aviation Electronics, Montreal, Canada; H. R. Hilliard, CBC, Toronto, Canada; R. Horton, CBC, Toronto, Canada; Samuel Liles, WPTF, Raleigh, N. C.; G. R. Hagerty, Westinghouse Radio Stations, Washington, D. C.; K. R. Cooke, WGBI, Scranton, Pa.; H. E. Goeden, WTMJ, Milwaukee, Wisc.; D. Readwin, CJCJ, Calgary, Canada; S. Gilbert, CFAC, Calgary, Canada; W. Obermuller, RCA Brazil; Oistein Mittag, Radio Department Electrisk Bureau, Oslo, Norway; Daniel L. Falsani, H. L. Higgins, W. Morris, C. Miller, John Early, R. F. Barry, George Washein, B. L. Wolfe, Ed Carroll, W. H. Wagner, W. Ludes, Joseph Morrow, Frank Martin, Fred Betz, Patrick Lynch, H. E. Ehrhart, F. Lewis Sturgatch, Ed. Harper, Sam Sabaroff, Irvin Gubin, Dave Gillette, A. W. Gengenback, John L. Polser and Donald Murphy of WCAU, Philadelphia; C. P. Fulk, WOAI, San Antonio, Texas; Carl Lee and John Fetzer, WKZO, Kalamazoo, Michigan; E. Fernandez and V. Montes, CMQ, Havana, Cuba; J. Anlage, WFIL, Philadelphia; John Bargamian, WNAP, Providence, R. I.; Donald Parton and Norman S. Hurley, WAPI, Birmingham, Ala.; F. B. Vandermark, WMBR, Jacksonville, Fla.; Dr. Edoardo, Cristogaro, RAI, Italy; Luigi Sponzilli, RAI, Italy; Vincent Chandler, WMUR, Manchester, N. H.; Bernard Holbert, KSAC, Manhattan, Kan.; L. H. Nafeger, and Bill Orr, WBNS, Columbus, O.; Kenneth Peterson, WPIX, New York; Leroy Fiedler, WKBW, Buffalo, N. Y.; R. G. Artman, KMBC, Kansas City, Mo.; Walker Blake, CKUA, Edmonton, Canada; Russell Adams, Harlow L. Lucas, and John A. Diddine, WBNS, Columbus, O.; William H. Johnson, Jr., KYW, Philadelphia; Robert Almon, WTHI, Terre Haute, Ind.; H. R. Griffith, WJAC, Johnstown, Pa.; James Schultz, KQV, Pittsburgh, Pa.; T. G. Callahan, WBT, Charlotte, N. C.; H. G. Cole, WSBT, South Bend, Indiana; G. Pearson Ward, KTTS, Springfield, Mo.; J. Howard Bair, WCMB, Lemoyne, Pa.; C. J. Auditore, G. T. Brazee, and H. L. Hadden, WOR, New York; and R. Marshall, WFIL, Philadelphia. . . .

The Four State Chapter of the Associated Police Communications Officers, Inc., recently held their spring meeting at Erie, Pennsylvania. Members from New York, New Jersey, Pennsylvania and Connecticut attended. . . . Wilbur Schramm, director of the University of Illinois Institute of Communications Research will represent this country on the international commission which will meet in Paris to study technical requirements in mass communications.

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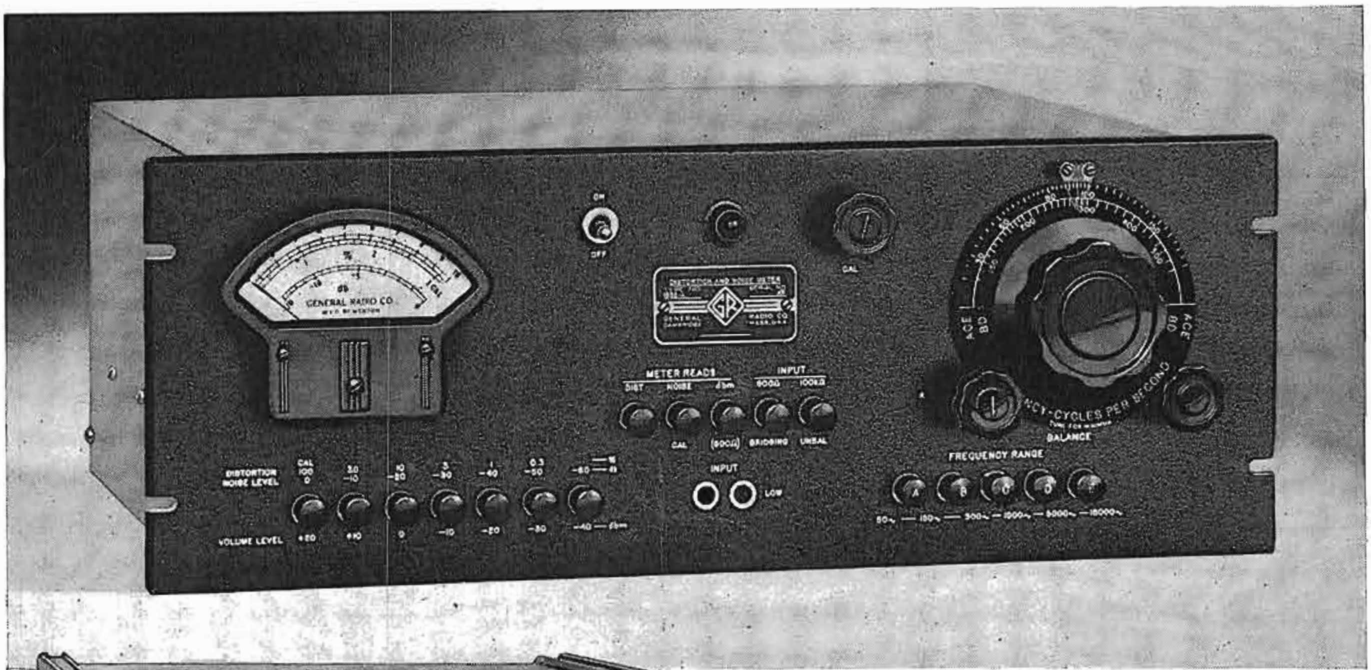

Type 1301-A Low-Distortion Oscillator

Here's Your "PROOF-OF-PERFORMANCE"

AS ANNOUNCED by the Federal Communications Commission,* effective August 1, 1949 all a-m and f-m broadcast stations will be required to make proof-of-performance checks of over-all noise and distortion of the complete station at least once a year.

Many stations already make these measurements at frequent intervals as routine operating maintenance to insure the continuous high-quality service the modern transmitter system is capable of supplying.

General Radio instruments for these measurements have been available for some time, and are in regular use by the leading stations where this equipment has given accurate, convenient-to-use and trouble-free service.

The G-R Type 1932-A Distortion and Noise Meter meets all of the F.C.C.'s requirements for measurements of this type for both a-m and f-m services; the Type 1301-A Low-Distortion Oscillator is the ideal companion unit for use with the Type 1932-A. Both of these instruments are relay-rack mounted and can be supplied in panel finishes to match most existing installations.

TYPE 1932-A DISTORTION & NOISE METER

For measurements of sine-wave voltages, distortion and noise throughout the audio range. Over-all pass-band of the voltmeter circuit extends to 45,000 cycles, thus including all noise and distortion products contained in this range; particularly the 3rd harmonic of a 15,000-cycle test is included.

This instrument is continuously adjustable and can be set to any frequency quickly since it has only one main tuning control plus a small trimmer. With it measurements can be made on a-f distortion in radio transmitters, line amplifiers, speech amplifiers, speech input equipment to lines; noise and hum levels of a-f amplifiers, wire lines to the transmitter, remote pick-up lines and other station equipment.

Full-scale deflections on the large meter read distortions of 0.3, 1, 3, 10 or 30 per cent; range for carrier noise measurements extends to 80 db below 100% modulation, or 80 db below an a-f signal of zero dbm level. The a-f range is 50 to 15,000 cycles, fundamental, for distortion measurements and 30 to 45,000 cycles for noise and hum.

Type 1932-A Distortion and Noise Meter: **$575.00**

TYPE 1301-A LOW-DISTORTION OSCILLATOR

Especially designed for rapid measurements, this highly-stable oscillator has exceptionally low distortion. By means of push buttons, 27 fixed frequencies between 20 and 15,000 cycles may be selected in logarithmic steps. Any frequency between steps can be obtained by plugging in external resistors. The distortion over the entire range will not exceed the following percentages: with 5,000-ohm output, 0.1% from 40 to 7,500 cycles; 0.15% at other frequencies. With 600-ohm output 0.1% from 40 to 7,500 cycles; 0.25% from 20 to 40 cycles and 0.15% above 7,500 cycles.

The oscillator is calibrated to within $\pm(1\frac{1}{2}\% + 0.1$ cycle); the calibration is not affected by changes in load or plate supply voltage; drift is less than 0.02% per hour after a few minutes operation. The operation of the oscillator is unaffected by ordinary climatic changes.

Type 1301-A Low Distortion Oscillator: **$395.00**

*F.C.C. Rules and Regulations, Sections 3.254 and 3.46, as amended

GENERAL RADIO COMPANY

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