RADIO & TELEVISION NEWS

DECEMBER 1950

RADIO-ELECTRONIC ENGINEERING EDITION

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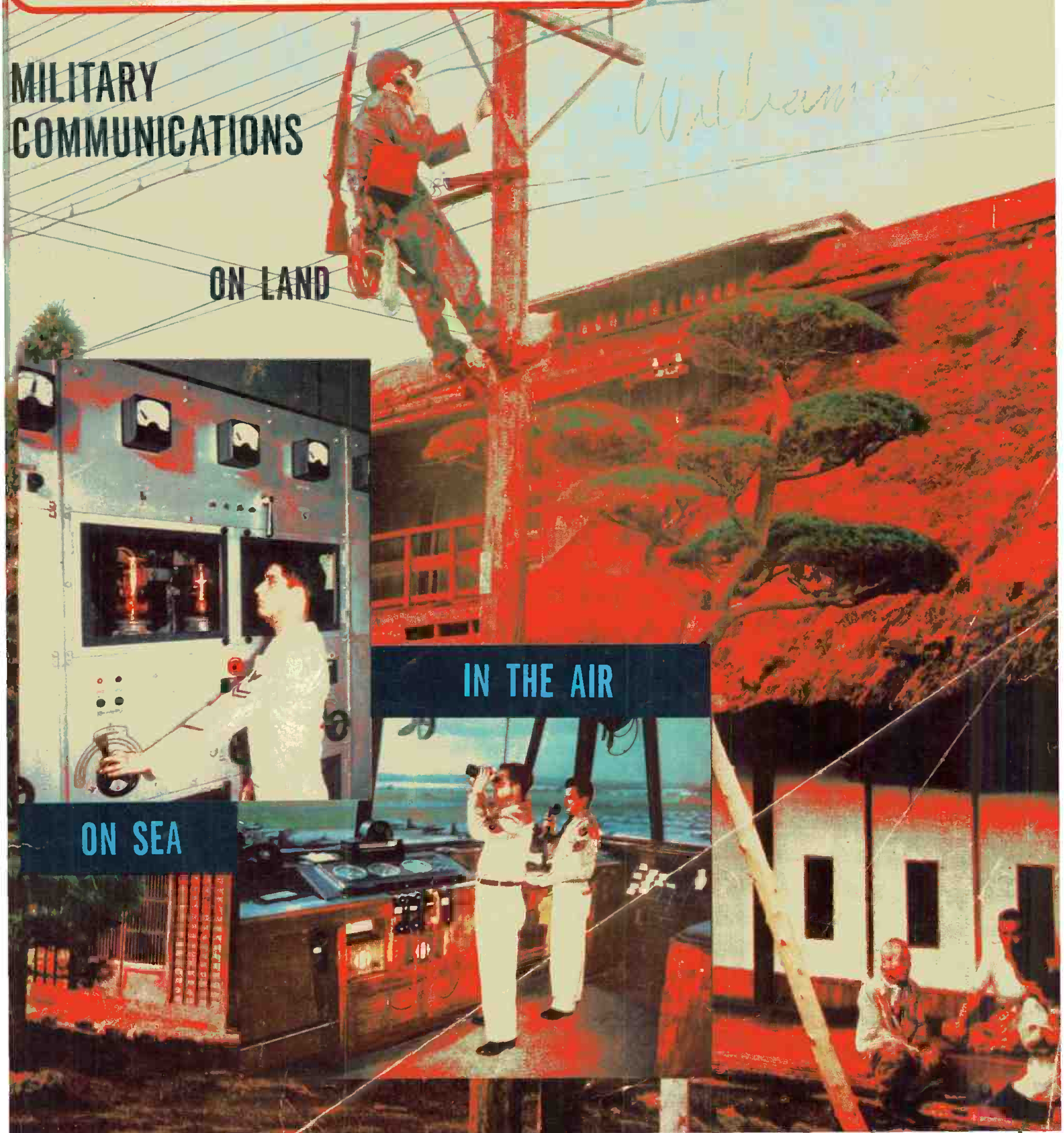

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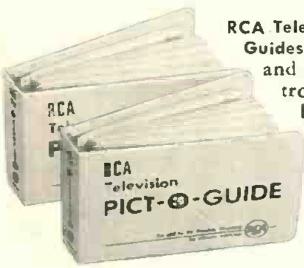

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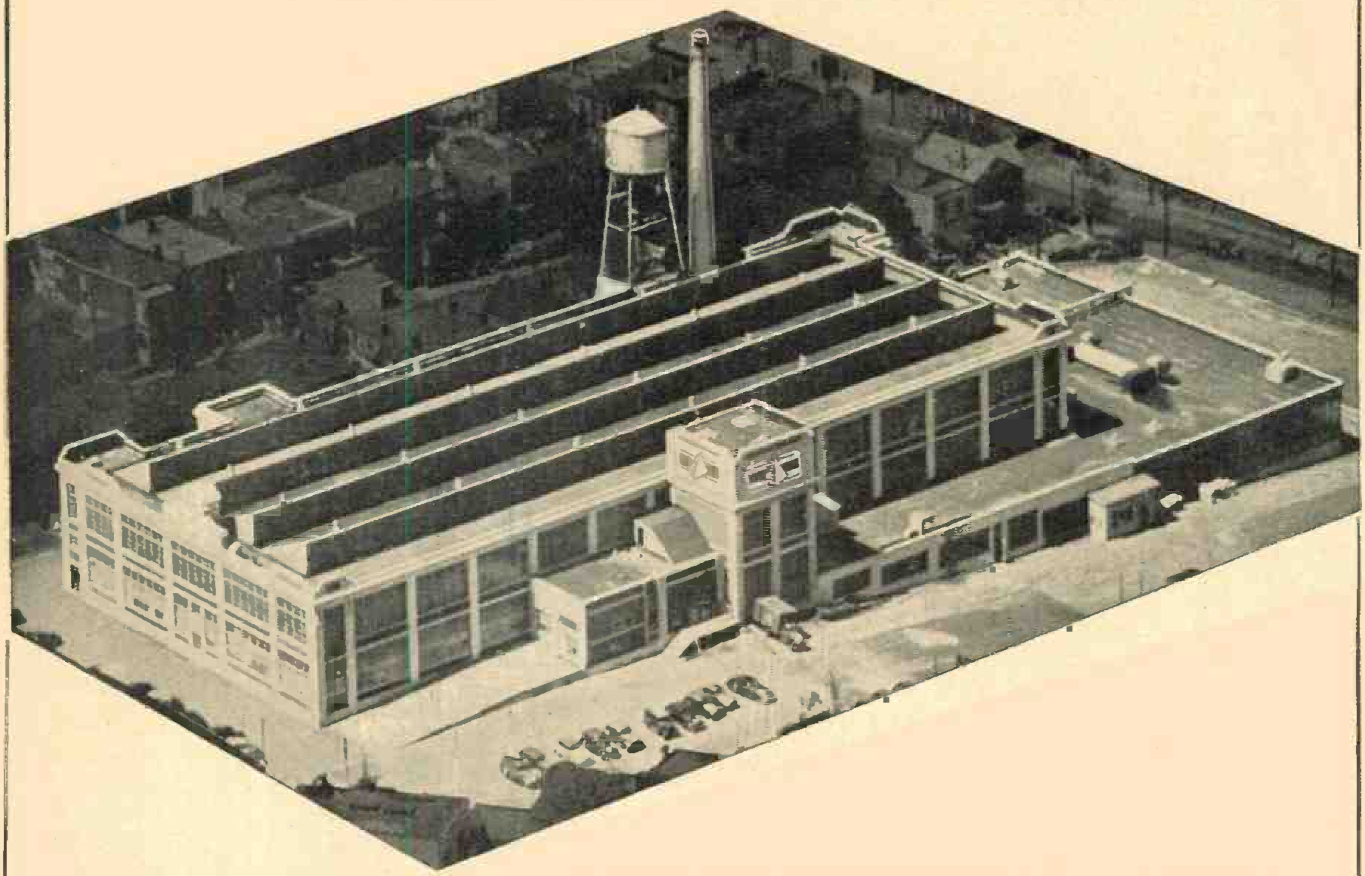

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For the RECORD

BY THE EDITOR

WE REPEAT—WHY THE RUSH FOR COLOR TELEVISION?

AFTER talking to many industrial leaders, especially manufacturers of television sets, it becomes quite apparent that the television industry thinks of the FCC as a group of Federal "eager beavers" in their endorsement of the CBS color television system.

It is generally known that the much touted ballyhoo for a compatible television system, suddenly switched to one which is completely incompatible and highly impractical. The result—more confusion and dilemma to the Industry, and particularly to the public.

In an editorial (February, 1950 "For The Record") titled, "Why The Rush For Color Television?" we took issue with those seeking to literally force a color television system on the public. We were not ready for color television then, and we are not ready now, some ten months later.

May we again ask, "Why The Rush For Color Television?" Don't we have enough headaches now in attempting to maintain nearly 10,000,000 monochrome receivers now in service?

Dealers and servicemen are already feeling the impact, not only of the FCC's color decision, but the attendant publicity which implies that color service will soon be available on full schedule. Such publicity creates doubt in the minds of the public as to the advisability of purchasing a present black and white television set. At best it would be many months, perhaps even years, until any color system would receive any favor from the advertiser. Millions of dollars are spent annually on television programming and there is nothing whatsoever in the FCC's color decision that indicates that monochrome telecasting service will be discontinued at any time in the future. It is generally believed that color television programs, when they do become available, will be a supplementary service. The acceptance of color will depend entirely upon the type and quality such programs will provide. At this moment, however, the public is not ready to be sold on an incompatible device.

Must we chop receiver cabinets and make other major alterations, including the masking of large television picture tubes into smaller ones, so a clumsy motor and scanner can be slid into place? Must we constantly tell Junior not to fool with the various gadgets that stick out for all to tinker with?

With the present limit to 10—12½" size for the CBS system, there will be required a high speed revolving color disk, placed in front of the picture tube, rotating at 1440 r.p.m. The disk for a 10" tube is about 24" in diameter and 28" for a 12½" tube. The trend has been toward larger picture tubes. Therefore, to adapt a 16" set for CBS color would require a disk of about 36". That's like turning a round card table in front of a screen.

Must servicemen be emissaries in the home of John Q Public in an attempt to convince him that the FCC just couldn't wait for some practical method for color television that, according to most engineers, can be fully developed within a reasonably short time? Is it not reasonable to assume that within a short length of time there will be developed an acceptable compatible television system, employing new developments and making use of those already under test?

We have talked to many television set users and without exception, they have stated that their present black and white sets are perfectly satisfactory and that they saw no point in converting to color in the near future. Some ask, why don't they (the FCC) give the manufacturers more time to perfect a compatible system? Didn't the Motion Picture Industry eliminate flicker from early technicolor?, etc.

These United States are blessed with the finest electronic technicians in all the world. Is it not probable that this "brain power" will develop a real honest-to-goodness compatible television system for the public? Developments in recent months have definitely shown real progress in the dot-simultaneous system, the tri-color tube and others, to the point where it is quite probable that the entire goal in achieving a flicker-free compatible color television system may be almost at arms reach.

This feeling is shared by the vast majority in the television industry who know what can be perfected to give the public what it really wants, and not what the FCC and CBS want it to have.

It now appears that the CBS system (except for superior color rendition) is so impractical that it may die out when the public learns all the facts. Time will tell. In the meantime—we're stuck with second best and we'll have to make the best of it and prepare for things to come by studying conversion techniques (now in preparation) and to carry the hope that competition will ultimately force a compatible color system. . . . . . O.R.

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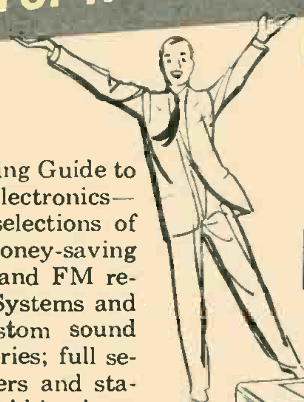

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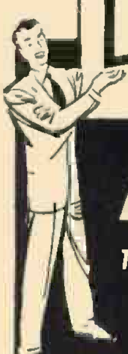

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Service Dept. Manager

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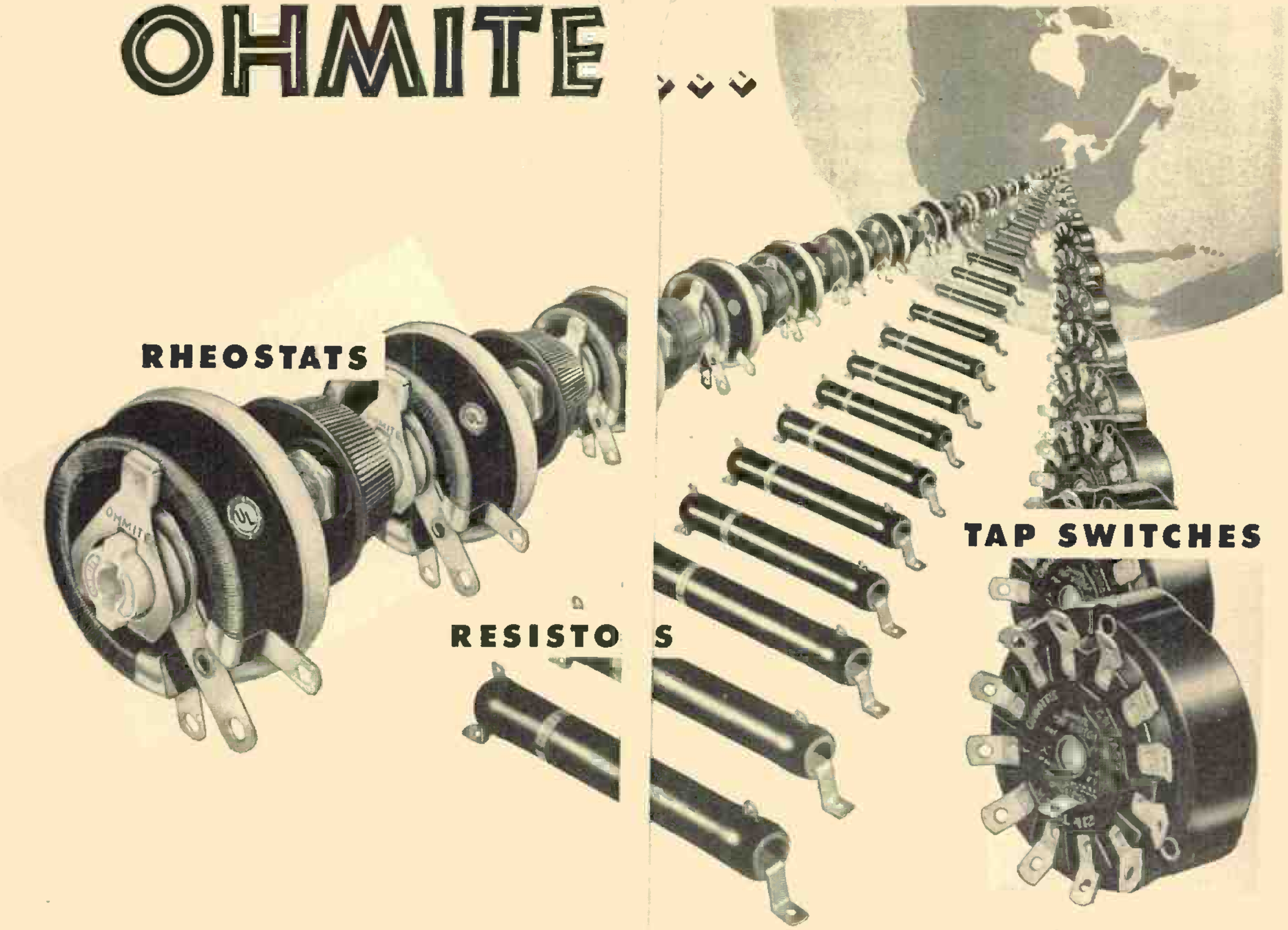

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WASHINGTON EDITOR

COLORCASTING, rifled with conflicting theories for over a decade, shelved quite emphatically by the D.C. ether policemen a few years ago, now appears to have found a legal haven with the warm approval of the lawmakers of the land, at least some of them. With the issuance of that second report by the Commission has come the news that the whirling shaft or Goldmark's pinwheel, as it has been dubbed by some, will be the official medium for huecasting, news which rocked most of industry and caused many to predict that the disks will speed to an early demise.

Indications that field sequential would win, at least the first phase of the color war, appeared in many sections of the first report. The bracket-standard time table was the most significant rough spot, for the sixty-day limit was immediately conceded by many as an impossible deadline date. The mechanical switch requirement was another stumbling block, practically all in industry stating that they didn't even know how to include the 405-525 line provision in an effective way in so short a time. In addition, there were the statements declaring that unless the proponents could produce equipment that would unqualifiedly meet the Commission's criteria, all bets were off and *CBS* would be declared the winner for the time being. After reviewing the criticism heaped on the other two systems, citing that neither method appeared to be capable of rapidly overcoming their innate defects, the consensus was that in the short time allotted little could be done to alter the legislators' opinions.

The second report reaccented the majority views of the airwave judiciary. For instance, there appeared the statement that in the opinion of the Commission . . . "the *CBS* system squarely meets the test of adaptability and convertibility. . . . It is the *CTI* and the *RCA* systems that fail to meet the test, for neither *CTI* nor *RCA* demonstrated a practical converter and hence failed to meet the test of convertibility." Describing the basis under which the new standards were being adopted, the Commission said that the new rules being promulgated were the result of . . . "expert calculations based on the characteristics of the present standards and the evidence concerning the *CBS* field-sequential color system. It is clearly within the province of the rule-making proceedings, as prescribed by the Administrative Procedure Act, to adopt such standards without the necessity for further proceedings."

As in the first report, contrary remarks appeared throughout many paragraphs which attempted to explain the Commission's reasoning behind the conclusions reached. For instance, in a review of the problem of horizontal interlace, it was pointed out that the record shows quite clearly that if this technique is successfully developed for the CBS system, and it can be added at a later date, horizontal resolution would be increased and provide an appriate picture improvement. However, said the Commissioners, if it had been possible to adopt bracket standards now (which it couldn't because of the reluctance of industry to go along) the Commission could . . . "determine whether to increase *vertical* resolution as well as *horizontal* resolution. . . . Since receivers without brackets could not be adjusted to a different line rate, our inability to adopt brackets at this time probably means that as a practical matter, when and if horizontal interlace is adopted for the color system, the improvement may be confined to horizontal resolution." Thus any suggestions for improvement of vertical resolution may be bypassed.

The problem of long-persistence phosphors, cited as means of providing better and brighter pictures with no objectionable flicker, may have to be overlooked now too, because of the immediate adoption of the *CBS* setup. In the words of the FCC: "Had it been possible to adopt brackets now, then if developments in the field of long-persistence phosphors turned out to be sufficiently impressive, the Commission could consider lowering the field rate and increasing the resolution without objectionable flicker."

Ripping into those who were requesting new hearings because of improvements in color systems, the second report declared that in the Commission's opinion . . . "a new television system is not entitled to a new hearing or reopening simply on the basis of a paper presentation." Citing that in the radio field many theoretical systems exist and that it's a long step from a description to a successful

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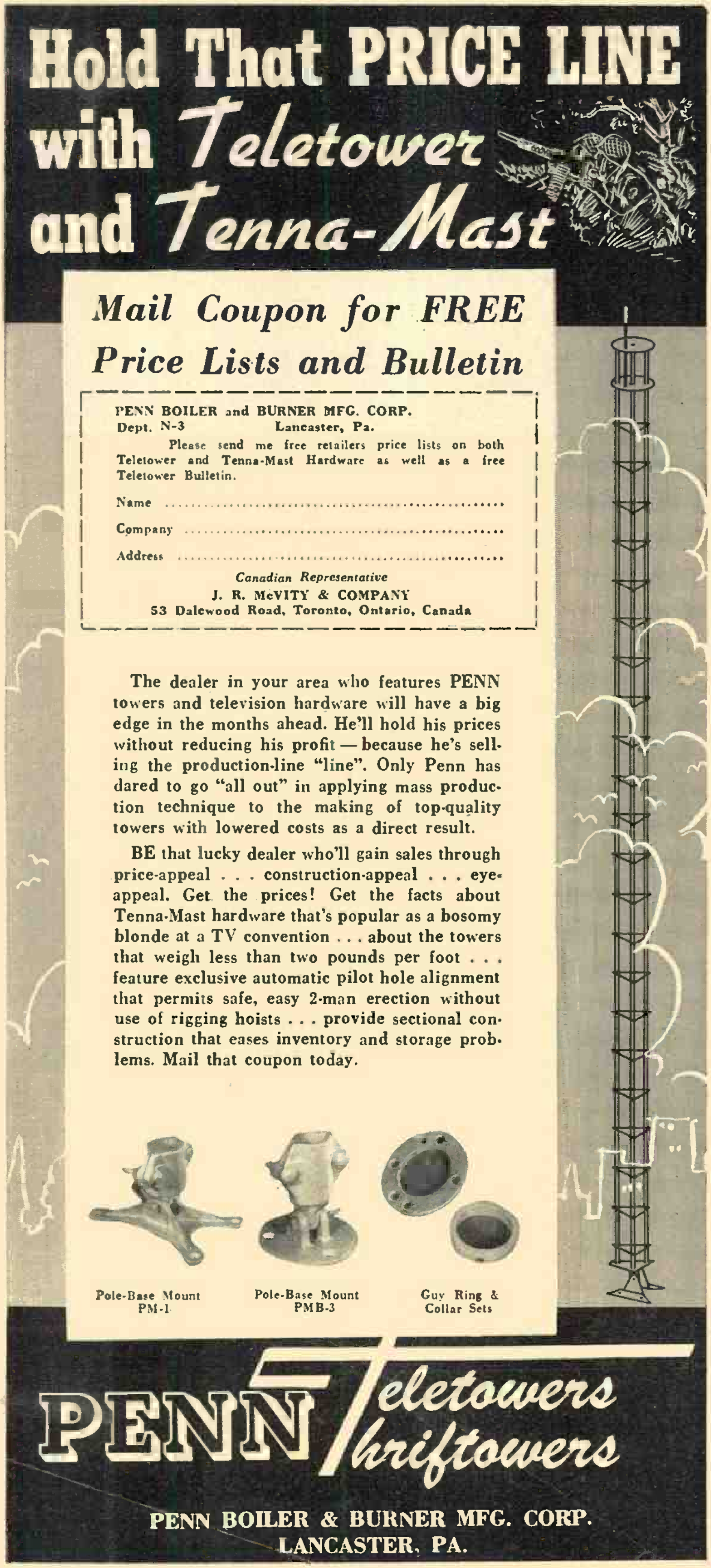

operation, the Federal experts added: "There can be no assurance that a system is going to work until the apparatus has been built and tested."

The denial of an appeal for a test by *RCA* a few days before the second report was issued, presaged the stern beliefs the Commission had on reopenings. In denying this petition, the ether guardians rebuked the dot-sequential proponent, declaring that the . . . "state of television is such that new ideas and new inventions are matters of weekly, even daily occurrence . . . the question of approving a color television system which will best serve the interests of the American people is one which has been before the Commission for almost ten years . . . in all proceedings such as the instant one a point is reached which calls for administrative finality . . . and in the sound discretion of the Commission a delay in reaching a determination with respect to the adoption of standards for a color television service . . . would not be conducive to the orderly and expeditious dispatch of the Commission's business and would not best serve the ends of justice."

Notwithstanding the Commission's sharp rejoinder, *RCA* announced that they were not only going ahead with their color research, but would hold a series of demonstrations in Washington, during which the latest improvements in compatible all-electronic high definition color would be shown. In a telegram to all licensees, *RCA* said: "At this demonstration we will supply you with information about our latest simplified circuits, the converter and the tri-color tube. We shall continue to give you further demonstrations periodically so that you may see the successive steps in our progress. . . . By June 30, 1951, we will show that the laboratory apparatus which heretofore has been demonstrated has been brought to fruition in a commercial, fully-compatible all-electronic system . . . available for immediate adoption of final standards."

Blunt addresses by FCC headman Wayne Coy before advertising and engineering groups, days before the *CBS* edict was issued, also served as a forecast of how the color-wind blew in Washington. Discussing the demonstrations, Coy said that during all of the tests the dot and line-sequential proponents had . . . "trained operators who worked assiduously before each demonstration to make sure that the equipment was adjusted in tip-top shape and who hovered over the equipment . . . continuously making adjustments to insure optimum performance. . . . Despite all of these efforts . . . the proponents were unable to maintain accurate registration and color control. . . . You can imagine what the situation would be like in the ordinary home where children or untrained adults had to operate such receivers. . . . The conclusion seems to be inescapable that *CTI* and *RCA*

(*Continued on page* 109)

DECEMBER, 1950

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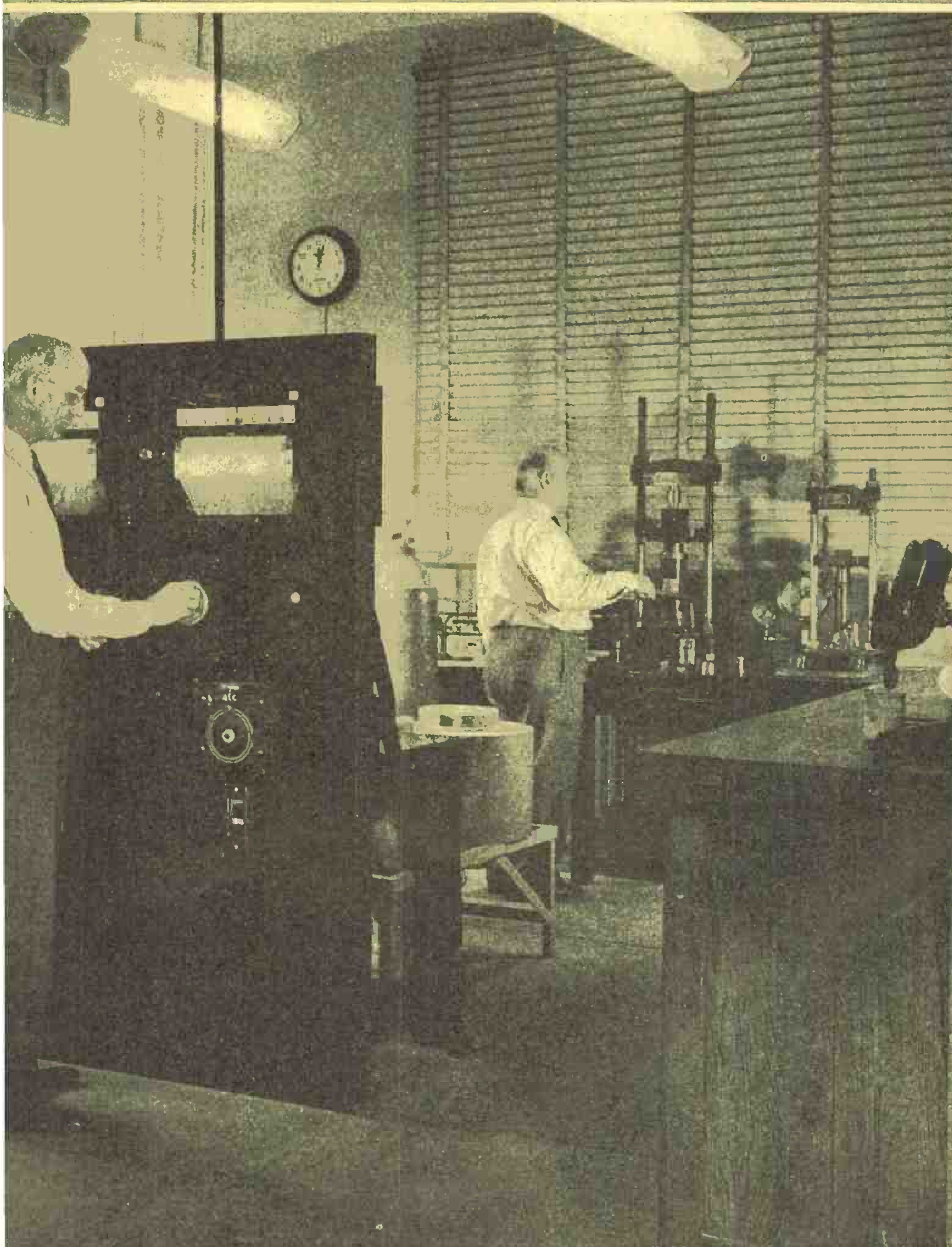
Engineering



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COVER PHOTO—Courtesy of National Bureau of Standards

General view of the laboratory where high-dielectric ceramic capacitors under development at the National Bureau of Standards are produced. Batches of systematically varied compositions are processed into capacitor plates of 0.003 to 0.006 inch thickness, and the performance properties then studied.

ZIFF-DAVIS PUBLISHING COMPANY

ELECTRODES for H.F. HEATING

By R. A. WHITEMAN
Consulting Engineer, Chicago

A discussion of the performance of electrodes as a component part of h.f. dielectric heating equipment.

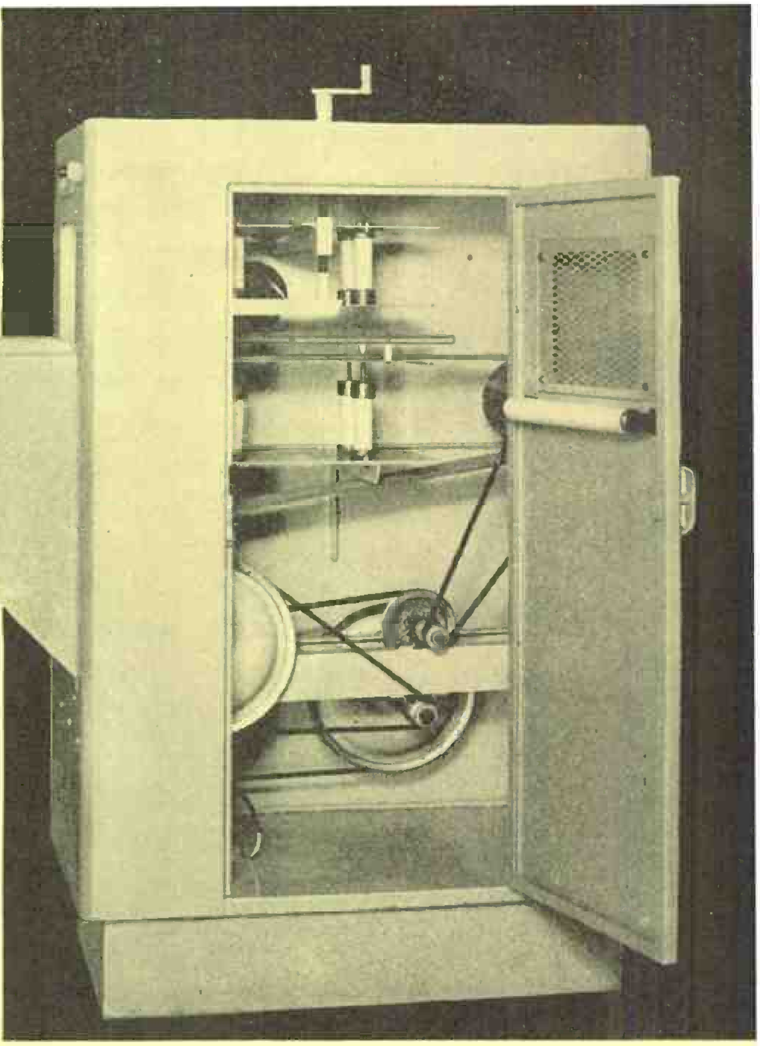


Fig. 1. Conveyor belt arrangement for dielectric heating showing electrodes and transmission line through side of cabinet.

THE h. f. heating of dielectric material has reached new production heights in recent years. With this increase in production there has been a parallel increase in the diversity of applications and also design problems. These applications include the heating of plastics, melting frozen foods, deinfestation of pharmaceutical products, and the gluing of wood. The design and application problems range from the d.c. power supply through the power-oscillator circuit to the final arrangement of the electrodes. This article will deal specifically with the performance of the electrodes as a component part of the h.f. dielectric-heating equipment. The effectiveness of the electrodes naturally depends upon their shape as well as the shape and dielectric properties of the material being heated.

A statement of certain fundamental high-frequency properties of dielectrics is of value at this time in order to emphasize the important design parameters which must be considered. These fundamental relations depend upon the theory that nonmetallic solid materials have few free electrons and the effect of the electric field on the dielectric molecules becomes very important. In accordance with this theory, the electric field causes a definite displacement of the electrons within the atoms and also a displacement of the atoms within the molecules. These displacements have translational as well as rotational components and are most important in the range of frequencies used for radio-frequency heating. As the electric field components of the molecules are rotated to line up with the electric field, a displacement of charge within the material takes place. As a result of this effect, the displacement current in the circuit is greater due to the presence of the dielectric material than that occurring due to free space. The ratio of the former to the latter displacement current for a given electric-field intensity is defined as the dielectric constant of the material.

Since the changes in the molecular configuration impart kinetic energy to the thermal motion and are due to the applied electric field, an equivalent displacement current must flow into the material in phase with the voltage impressed on the material.

If the power loss in watts for each cubic inch of the dielectric is P and the electric field intensity in volts per inch is E, then by definition the ratio of the power P to E^2 is the effective conductivity σ. The numerical value of σ is generally a very involved function of the frequency and is not a constant.

For materials that have a very small conductivity, the algebraic relation for σ is:

$$\sigma = 2\pi f \varepsilon p \qquad (1)$$

where ε is the dielectric constant at the operating frequency f and p the power factor of the dielectric material. By equating the right member of Eqt. (1) to the ratio of P to E^2 and solving for the power dissipated in a cubic inch, the result becomes:

$$P = 2\pi f \varepsilon E^2 p \qquad (2)$$

Although this equation is a simple relation between the power dissipated and the fundamental parameters of the dielectric circuit, it clearly indicates the dependency of the power dissipation upon the power factor, frequency, dielectric constant, and the electric field intensity. It is possible to make the frequency f as well as the dielectric constant ε independent of the electrode shape. It is, however, impossible to make the electric field intensity throughout the dielectric material independent of the electrode shape. In order to have a uniform distribution of power density, it is necessary to have a uniform electric field intensity, which can be achieved in practice by properly arranging the electrodes.

The objective in dielectric heating is to first develop a sufficient power density for the required heating time interval and then the problems which follow must be solved as secondary items. Thus, it may seem advisable at first to have the equipment operate on one of the lower frequency channels in order to obtain a uniform potential across

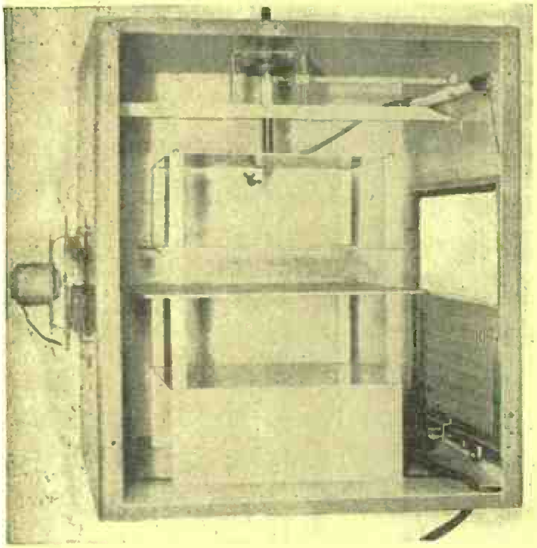


Fig. 2. Adjustable height work oven for heating dielectric materials.

the surface of the electrodes. This would be accomplished by having the wavelength large compared with the size of the electrode. However, with this condition, the voltage will be uniform on the electrodes but the electric field intensity E will be high and flash-over as well as internal sparking within the dielectric material will exist. This means that a higher frequency f must be used and the field intensity E will then be within a numerical value which does not produce dielectric breakdown. In some applications the electrodes will then be large compared with the wavelength and means of compensating for the variation in voltage along the electrode must be included in the design of the electrodes.

This undesirable effect is very well exemplified in large electrodes used in the high-frequency wood-gluing process. It is quite common in this industry to glue sheets of wood from 10 to 20 feet and sometimes longer and use frequencies in the region of 37 megacycles. With the average dielectric constant of the wood and glue equal to ε, the wavelength of the voltage wave on the long electrodes is given by the formula:

$$\lambda = \frac{984}{f\sqrt{\varepsilon}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where λ is the wavelength measured in feet and f is the frequency in megacycles. The voltage wave will have a maximum at the open end of the electrode and a minimum at a quarter wavelength from the open end. If the wavelength of the voltage wave is very much greater than the length of the electrode, it is possible that the ratio of the maximum voltage to the minimum is greater than 0.9. To accomplish this desirable voltage distribution, however, the frequency would be entirely too low and the power concentration for a permissible operating voltage would be insufficient for a reasonably short gluing cycle. This condition can be improved somewhat by feeding the voltage to the center of the electrode plates with each half of the press considered separately, thereby enabling the frequency to be twice that where the voltage is applied at one end. If it is physically permissible, it is advisable to introduce auxiliary tuning of the long electrodes by using small inductances spaced along the electrodes. These inductances should be connected in parallel across the electrodes and tune the capacitance of the press to parallel resonance. To accomplish this, each inductor should have n times the total inductance required to tune the loaded electrodes. This is expressed by:

$$L = \frac{n\,10^6}{4\,\pi^2 f^2 C} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where n is the number of equally spaced inductors, f is the frequency in megacycles, C is the capacitance of the loaded electrodes in micromicrofarads and L is the inductance of each coil in microhenrys. At resonance the load will present a resistive impedance of:

$$Z = \frac{2\,\pi\,f\,L}{\tan\,\theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where $\tan\,\theta$ is the ratio of effective resistance to the capacitive reactance of the dielectric load.

The distance between the tuning inductors in feet is given by:

$$d = \frac{5.48}{f\sqrt{\varepsilon}} \cos^{-1}\frac{E_1}{E_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where the ratio of E_1 to E_2 is the ratio of the minimum voltage to the maximum voltage on the electrodes and is generally made greater than 0.9.

As a typical example to illustrate this method of using special electrodes for high-frequency heating, consider the following set of conditions:

$f = 37$ megacycles
$\varepsilon = 2.5$
$\tan\,\theta = .05$
$l = 20$ feet
$E_1/E_2 = 0.9$
$C = 1000$ micromicrofarads

$$d = \frac{5.48}{37\sqrt{2.5}} \cos^{-1} 0.9 = 2.44 \text{ feet}$$

is the spacing of the inductors. In an application very similar to this example, 7 tuning inductors were used in order to provide a fairly uniform voltage along the electrodes. The inductance of each coil was:

$$L = \frac{7 \cdot 10^6}{4\pi^2 \cdot 32^2 \cdot 1000} = .130 \text{ microhenrys}$$

and the impedance of the dielectric load:

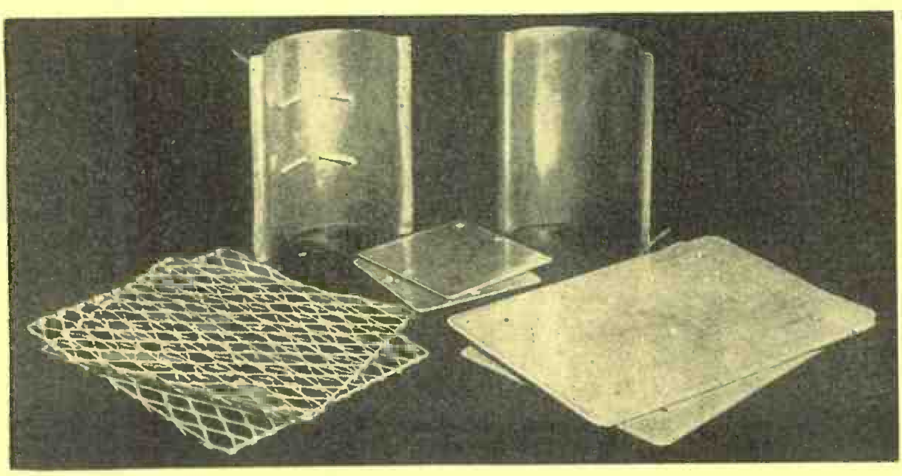
$$Z = \frac{2\pi \cdot 37 \cdot .130}{7 \cdot .05} = 86 \text{ ohms}$$

This example illustrates the application of a special electrode for high-frequency heating where the geometrical length of the electrode is very much greater than ¼ of an electrical wavelength.

In applications where the electrodes are short compared with the quarter wavelength, problems of voltage variation do not exist. Compensation by tuning is, therefore, not necessary and the only adjustment necessary is that of varying the distance between electrodes. This condition exists when heating plastic preforms and is illustrated in Fig. 2. In the case of heating plastic preforms it is usually necessary to supply an air movement parallel to the electrodes. The air movement is provided by the fan and removes water vapor and volatile chemicals, thereby preventing them from condensing on the upper electrode.

If instead of having the electrode long, it is short compared with ¼ of the electrical wavelength, then the voltage applied to the electrodes will be uniform. The electrodes under these circumstances may be considered to be equipotential surfaces and the electric field intensity will be substantially uniform within the dielectric if the dielectric has a special shape. In general, any piece of dielectric will require electrodes of a special shape in order to obtain a uniform electric field intensity within the given dielectric.

Fig. 3. Curved and flat electrodes used in dielectric heating equipment.



A general solution of this type of problem may be easily expressed but not always easily evaluated. For the general solution, refer to Fig. 4 where the electrodes are above and below the x-axis and the electric field is parallel to the y-axis within the dielectric. Let the potential within the dielectric be:

$$V_i = f_i\,(\rho_i,\,\theta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

and must satisfy the relation $\delta V_i/\delta y$ = a constant to insure that the field intensity within the dielectric is a constant. With a uniform field within the dielectric, the equation of the potential external to the dielectric is:

$$V_e = f_e\,(\rho_e,\,\theta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and the potential at an external point through which the electrode must pass:

$$V_e' = f_e\,(\rho_o,\theta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

To find the equation of the equipotential surface with a potential equal to V_e', set V_e in Eqt. (8) equal to the constant potential of Eqt. (9) as follows:

$$V_e = V_e' = f_e\,(\rho_e,\theta) = f_e\,(\rho_o,\theta) \quad (10)$$

and solve for ρ_e in terms of the angle θ and the constant ρ_o. Then the equipotential surface can be expressed as:

$$\rho_e = F\,(\theta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

A metallic electrode which is constructed so that it satisfies Eqt. (11) will be coincident with the equipotential surface and thereby produce the desired electric field. This mathematical approach is generally cumbersome and can be replaced by one which is not as accurate but easier to apply. By referring to Eqts. (7), (8) and (9) and rewriting them for rectangular coordinates they become:

$$V_i = g_i\,(x,\,y) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

$$V_e = g_e\,(x,\,y) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Then since the voltage across the electrodes is a constant for any one application, this voltage is:

$$V_t = \int_0^s E_i\,dy + \int_s^a E_e\,dy \quad . \quad . \quad . \quad . \quad (14)$$

$$V_t = E_i\,(s + a\,\varepsilon) \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where s is the thickness of the dielectric and a is the distance of a flow line through the air gap between the dielectric and the electrodes. Since the total applied voltage V_t and the internal electric field intensity are constants, then $(s + a\,\varepsilon)$ must be a constant for small values of a.

It is readily observed that the position of the electrodes can be located point by point using Eqt. (15). This method not only applies to dielectrics with flat surfaces but to surfaces of any shape even though it is understood that the numerical value of a must be small compared with s. In general, the shape of the electrode surface will not be a plane but will resemble such surfaces as shown in Fig. 3.

In many applications, it is not necessary or advisable to attempt to form the electrodes to conform with an equipotential surface providing an alternate solution to the problem is available. In many heating procedures, moving the object to be heated has long been standard practice. This same procedure may and is being used to advantage when dealing with the high-frequency heating of dielectric material. If the dielectric material is moved or passed between electrodes of the required shape the higher intensity electric fields will shift from one region of the dielectric to another. Such a change or shift will enable the heat generated within the dielectric to conduct from the hotter to the cooler portions, thereby producing a more uniform heating of the material. The procedure is very well applied in the *SIECO* dielectric belt oven shown in Fig. 1. The oven is loaded from the long end which projects to the left of the photograph. The dielectric material moves on a traveling belt of specially treated fabric. The speed of travel through the oven is adjustable over a wide range and the vertical spacing between the upper and lower electrodes is also adjustable from ½ inch to approximately 6 inches. The electrodes generally extend 18 inches along the belt and are slightly wider than the belt. These electrodes are used under an applied voltage of 8000 volts at 27 megacycles. This belt driven system is constructed to be used with a *SIECO* dielectric heating unit with the aid of a transmission line connection. This type of connection is shown in Fig. 5. The oven is equipped with a stop button both at the loading end and at the exit end so that in the event of a mechanical fouling of the dielectric material, or for any other reason, the operator can then shut off the entire machine including its radio frequency power by one simple stop button operation. The fluorescent lamp located and visible inside the door is grounded at the near end and at the far end is equipped with a 4-inch long antenna which picks up sufficient radio-frequency power from the adjacent heating electrode to operate the fluorescent tube and to give a soft uniform light of good intensity indicating normal operation of the oven. Also visible in the photograph is a safety interlock switch so that if the door is opened the entire equipment is disconnected from the power line. This equipment provides an excellent method of production-line handling as well as a method of obtaining uniform heating of dielectric materials. It has been used for protective deinfestation of pharmaceutical and plastic products.

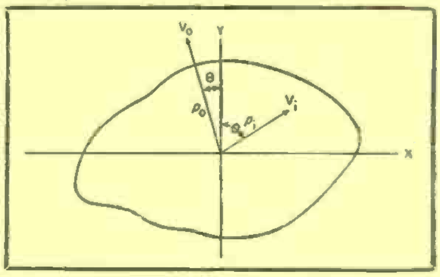
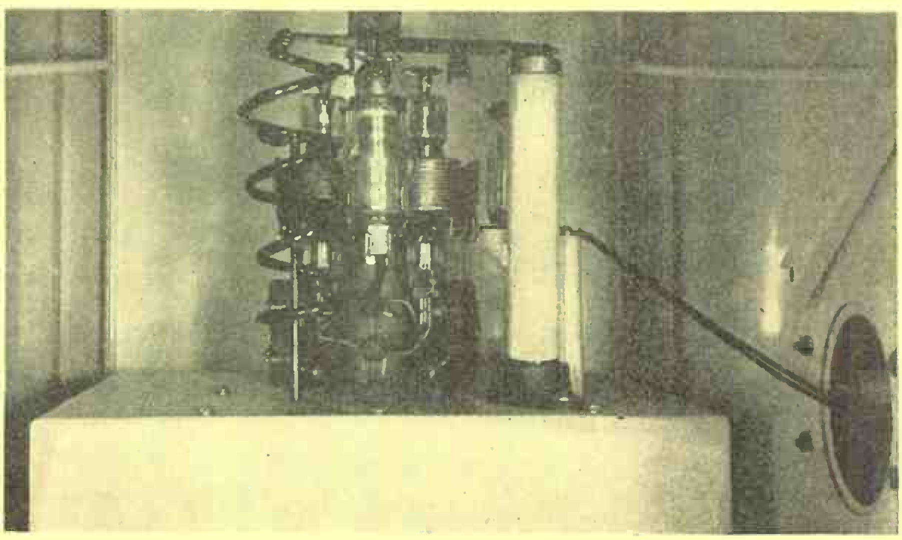


Fig. 4. A section of dielectric symmetrical about the z-axis with internal and external potentials indicated.

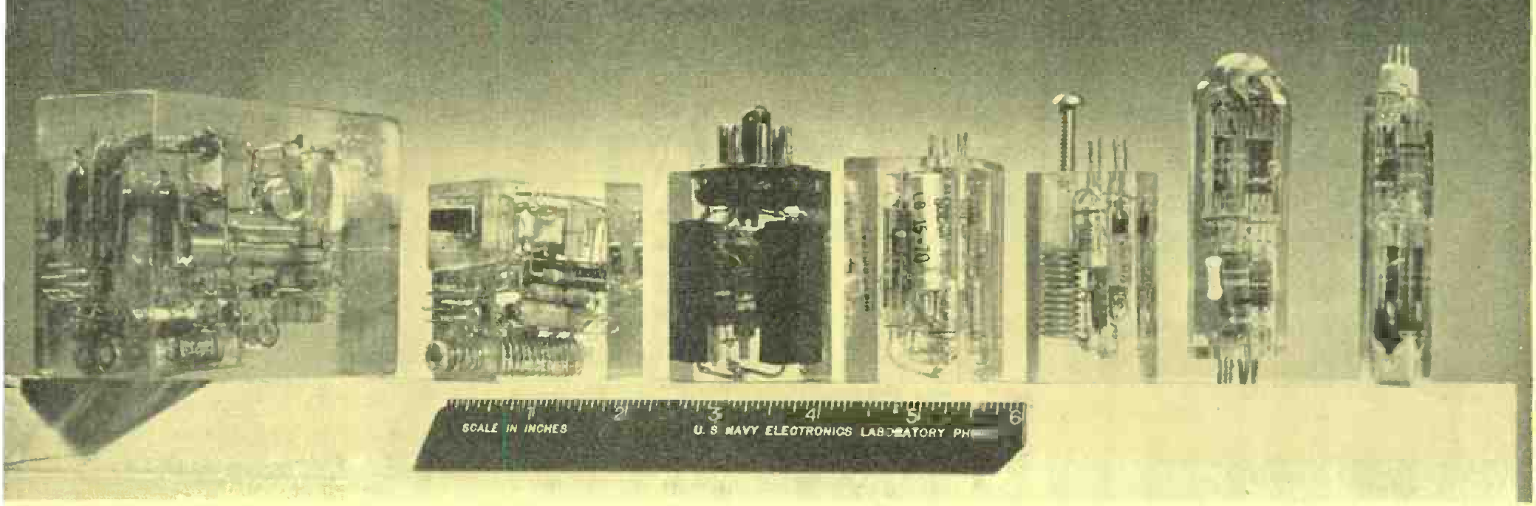
This analysis has indicated the various conditions which must be considered when selecting electrodes for high-frequency heating of dielectric material. The primary requisite in this work is that of uniform heating of the dielectric in order to avoid "hot spots."

The author wishes to thank *Sherman Industrial Electronics Company* of Belville, N. J. for the accompanying photographs and other helpful information.

Fig. 5. 27 mc. oscillator showing transmission line connection to adjacent electrode enclosure.



Potted Electronic Circuits



Miscellaneous units cast in NEL casting resin.

By HAROLD E. BRYAN

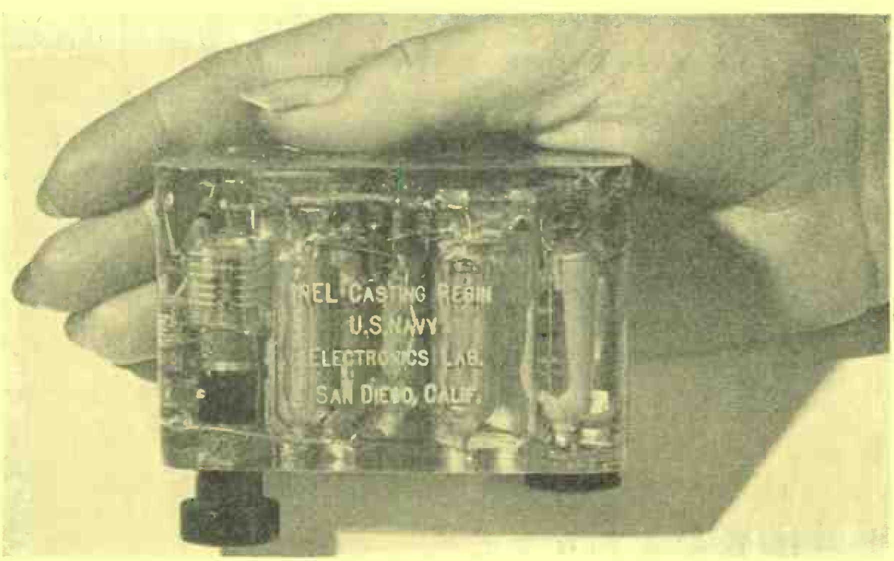
Casting or potting materials protect electronic circuits from effects of humidity, fungus, shock, and vibration.

IT USED to be standard practice to construct electronic equipment for the Naval forces in a most rugged and substantial manner, in order that it might continue to operate and withstand the rigors of the service. This worked fine, and the equipment did indeed stand up in Naval shipboard operation. However, with the coming of the late war the electronics art progressed very rapidly. Ships no longer are able to carry all the electronic equipment considered desirable, or even in some cases essential, if it is built in the usual rugged and massive manner.

Attention has therefore been directed to the miniaturization and subminiaturization of the many electronic devices required by modern Naval warfare. The advent of miniature and subminiature electron tubes, as well as the production of smaller and smaller components such as resistors and capacitors, has made the reduction in size not only desirable but possible.

This reduction in size of components and complete units has, nevertheless, not been achieved without new complications. True miniaturization of a circuit requires the elimination of the common chassis as it is usually known, since such a base occupies considerable space by itself. Making the components more or less self-supporting, or using very small flat sub-chassis where required for support, can in itself save a very substantial amount of volume.

Top view of a complete receiver encased in NEL casting resin.



Other problems which must be met in the new designs are those involving damage from such things as high humidity, fungus growths, and mechanical damage from handling and shock and vibration. It has been stated that in certain areas during the last war as much as 60% of the electronic equipment was useless as received, due primarily to the effects of humidity and fungus. This is a very high casualty rate for equipment that has not even been used!

Attempts have been made to meet the attacks of humidity and fungus by means of hermetic sealing. This would seem to be ideal, since all moisture and other effects would be excluded from the start, and it would not be impossible to repair the units, given the necessary facilities. However, most such attempts have met with failure. It appears almost impossible to obtain a true seal, very small pin-holes invariably appearing in the solder joints sometimes after several cycles of expansion and contraction due to temperature changes.

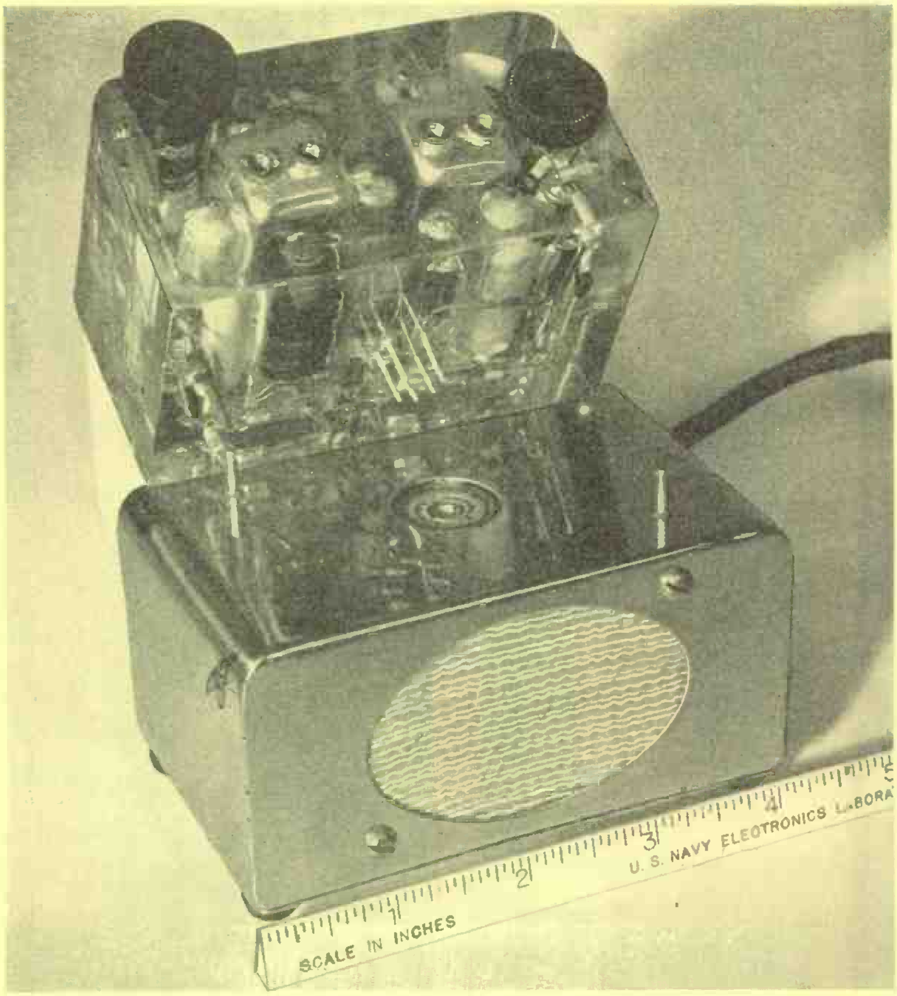
The use of casting or potting materials has been put forward in an attempt to overcome these difficulties;

when embedded in the plastic, the electronic components are thoroughly protected from the effects of humidity and fungus. Considerable protection is, of course, also provided from mechanical damage due to handling; and the effects of vibration in particular are reduced because of the damping produced by the plastic surrounding the components.

There are other problems which appear, however, when potted circuits are used. For one thing, it is obviously impossible to repair a defective unit in most cases. This increases the maintenance problem, when it is considered in the conventional light. However, modern electronic equipment is becoming so complex that it is very difficult to obtain qualified Naval personnel for maintenance. It is desirable therefore to increase the ease of repair of the equipment itself. This may be done by designing units in small subassemblies which plug into the main assembly. In this way, when defects appear they may be remedied in service rapidly and effectively by replacing the defective subassembly. Admittedly this is expensive in that it throws away good as well as defective components; but it reduces the training necessary for the service personnel to a considerable extent and makes unnecessary the carrying of large quantities of spare parts, each individually protected from the elements. Instead, a relatively small volume of replacement subassemblies is carried.

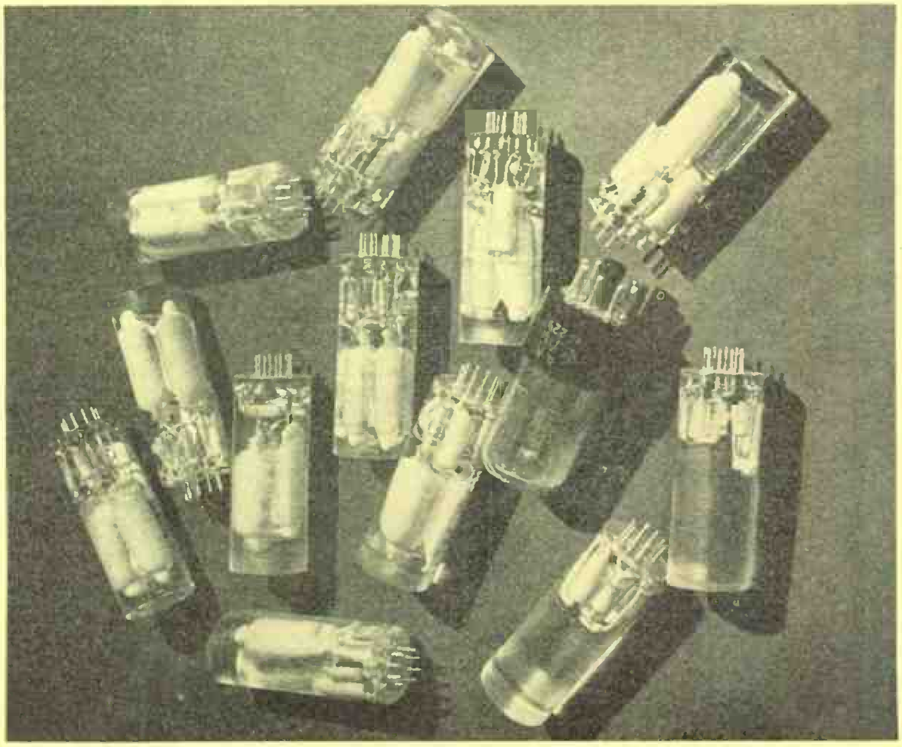
One other effect is of importance in miniaturized circuits. Usually there is just as much power dissipated in the small units as in the equivalent large ones, but there is less surface area to carry away the resultant heat. Operating temperatures are therefore in general much higher than for the larger units, making things difficult for the components involved. Fortunately new and better components are being produced all the time, and it is possible to reduce the temperatures to at least some extent by proper thermal design.

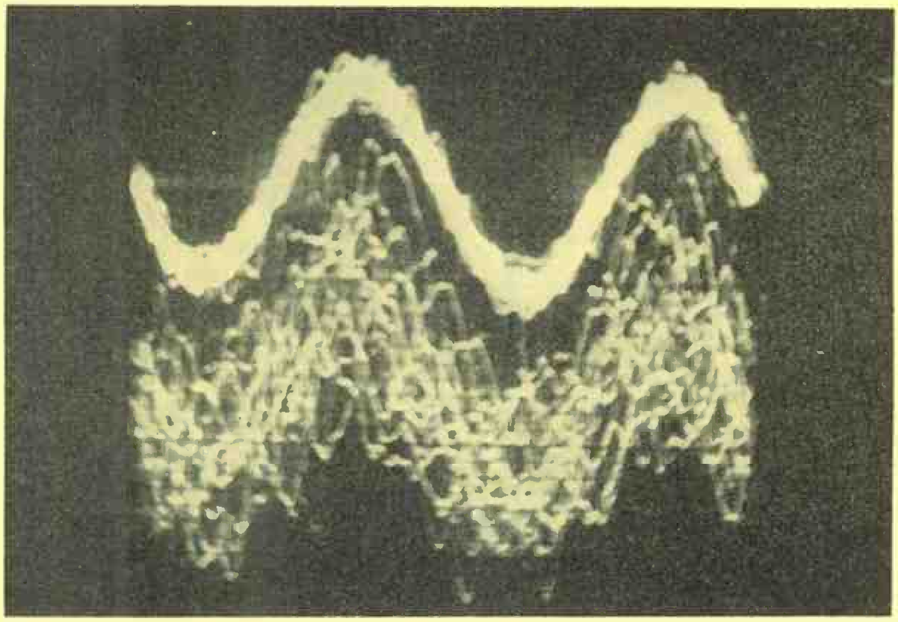
Early in the studies of potted electronic circuits at the Navy Electronics Laboratory it was found that there were no entirely suitable casting materials then available. All which could be obtained had some faults, either electrically or mechanically. The casting resin developed by the National Bureau of Standards, commonly known as NBS Resin, while excellent from the electrical standpoint was unsatisfactory mechanically. Electrically it was equivalent to polystyrene, very good indeed; but it was also otherwise similar to polystyrene, being soft, flowing at a low temperature, and fairly difficult to machine. In addition, it was expensive and the ingredients difficult to obtain.



Another view of the six tube receiver shown on P. 6A, complete with power supply and speaker. Note size of fly on speaker case.

Typical cylindrical plug-in assemblies encased in NEL casting resin. An octal tube is included to indicate size of the castings.





Comparison between two identical amplifiers mounted on vibration table. Top oscilloscope curve shows output of potted unit; bottom, conventional subminiature chassis construction.

Other materials available at that time were usually good, or at least fairly good, mechanically but poor electrically. These no doubt would be suitable for many low frequency applications encountered, but it was felt that something which could be applied to both high and low frequency units was desirable.

The material currently in use at the Navy Electronics Laboratory, designated NEL-177 Casting Resin, while not ideal, is at least usable at frequencies as high as 100 megacycles and has fair mechanical and heat-resisting properties. Dielectric constant and power factor are of the order of 3.0 and 2% respectively at 10 megacycles, and do not depart from these values appreciably at other frequencies. When properly cured, surface temperatures as high as 100 degrees Centigrade can be withstood satisfactorily, and internal temperatures of the order of 200 to 250 degrees are not excessive. Surface checking tends to take place at higher temperatures, and if the internal temperature is too high the material changes in color from almost water-white with a slight amber tint to a dark brown in a relatively short time. When operated at elevated temperatures the color normally changes slightly, gradually darkening.

While the ingredients used in NEL-177 are cheap and readily available, they must be pure and fresh if satisfactory results are to be obtained. The base stock in particular deteriorates with time even when stored under refrigeration and eventually will become unusable for electronic applications. Considerable variation in properties, particularly mechanical, will be experienced with its deterioration. In addition, the manufacture of the base ingredient is not controlled to as fine a point as might be desired. There are therefore small changes from one batch to another which in some cases result in appreciable changes in properties. Fortunately these do not appear to be reflected to any great extent in the electrical properties.

There is nothing at all difficult about the formulation of the material which makes trained personnel necessary. Anyone who can read and weigh out the ingredients accurately can do it. Also there are no critical temperatures or processes involved in the casting and curing of the resin.

Mold requirements are easily met, since the material is poured in the form of a liquid over the circuit to be cast. This makes it possible to make unusual shapes without difficulty. The main requirement of course is that the molds be made of some material that does not react with or adhere to the casting resin. This restricts the choice to a relatively small field, but no difficulty is experienced in finding suitable materials. In some cases lucite has been used. There is no reaction between the lucite and the resin, but the mold must be machined from the casting if it is desirable to remove it. Since lucite is readily formed to shape this is not a great disadvantage, especially if there is no point in removing the form. Polystyrene cannot be used in the same manner, because it is seriously affected by the casting resin. Certain acetates perform satisfactorily as forms, since they neither adhere to nor are attacked in any way by the resin; and they are very flexible in application.

The principal disadvantage of plastic molds is that they are usually either destroyed or otherwise made unsuitable for further use. A type of mold which can be used over and over, which has been found very useful at NEL, consists of chromium-plated metal. The metal is of course not destroyed in removing the casting, and the chromium plating produces a smooth mirror-like surface. Since the plastic does not adhere to the chromium surface if it is clean, the casting is easily removed after curing. This type of mold has been used extensively for manufacturing cylindrical plug-in sub-assemblies, the only machining required on the finished casting being the cutting of the unit to the required length.

Although cured in the mold, there is a certain effect on the surface of the castings, apparently caused by the oxygen of the air. This has been overcome by curing the plastic in such materials as pure linseed or cottonseed oil or glycerine. The resulting surface then has the same properties as the interior of the casting. This is accomplished by removing the casting from the mold after it is sufficiently gelled and completing the curing immersed in the oil.

The change from a liquid to a solid in these resins is due to a chemical process known as polymerization. During this process a certain amount of heat is generated, and this must be controlled if satisfactory castings are to be obtained. If too much heat is generated, the polymerization will take place too rapidly and the resulting casting will in all probability contain large cracks or fissures. If too little heat is produced curing will take too long for practical application. The control of the amount of heat generated is accomplished at NEL in part by refrigeration. After the unit has been poured, it is held at a low temperature for as long as is required for the plastic to thoroughly gel. This is usually five to six hours, but depends upon the size of the casting involved. After the casting has gelled sufficiently it is removed from the refrigerator, taken out of its mold and placed in an oven for several hours, at which time the cure is essentially complete. It is possible to allow the cure to take place at room temperature but considerably more time will be required—unless of course it is summer and room temperature is up around 100 degrees Fahrenheit. In this case no oven is needed since the room is one anyway. In any case, carrying on this latter cure at elevated temperature is best done with the casting immersed in oil as described above. No excessive temperatures are involved in such a process, so no damage is done to components.

The plastic materials generally used as casting resins all shrink from five

(Continued on page 27A)

3-PROBE METHOD of IMPEDANCE MEASUREMENT

By EDWIN N. PHILLIPS
Research Div., Collins Radio Co.

Derivation of a chart for determining impedance from voltage readings at three fixed probes spaced 1/8 wavelength apart.

WELL-KNOWN methods of impedance measurement at high frequencies include the use of a slotted coaxial line and the use of directional couplers. Another method involves the use of three voltage probes which are spaced an eighth wavelength apart. On occasion, this method can be of considerable utility: when the frequency is low (with a corresponding long wavelength), or when measurement at a fixed frequency is being performed, this latter method is more easily set up and interpreted than the first two methods.

One difficulty which, possibly, may have inhibited the wider use of this method stems from the fact that the loci of constant voltage-ratios are circular only on a rectilinear map. The chart presented herewith eliminates this difficulty, since these loci are transformed onto a closed chart.

It will be recalled that the voltage at any point x units distant from the load on a lossless line is given by:

$$E_x = E_R \cos\left(\frac{x}{\lambda} 360^\circ\right) + jI_R Z_0 \sin\left(\frac{x}{\lambda} 360^\circ\right) = E_R \left\{ \cos\left(\frac{x}{\lambda} 360^\circ\right) + j\frac{Z_0}{Z_R} \sin\left(\frac{x}{\lambda} 360^\circ\right)\right\} \text{ volts} \quad (1)$$

where λ is the wavelength (the free-space wavelength for principal mode, the guide-wavelength for guided modes) and E_R is the voltage across the load. If, now, a probe at the load reads E_1, a probe located an eighth wavelength down the line reads E_2, and a probe located a quarter wavelength from the load reads E_3, then these voltages are given by:

$$E_1 = E_R \quad (2)$$

$$E_2 = \frac{E_R}{\sqrt{2}}\left(1 + j\frac{Z_0}{Z_R}\right) \quad (3)$$

$$E_3 = j\, Z_0/Z_R \quad (4)$$

From these three quantities, two ratios can be formed:

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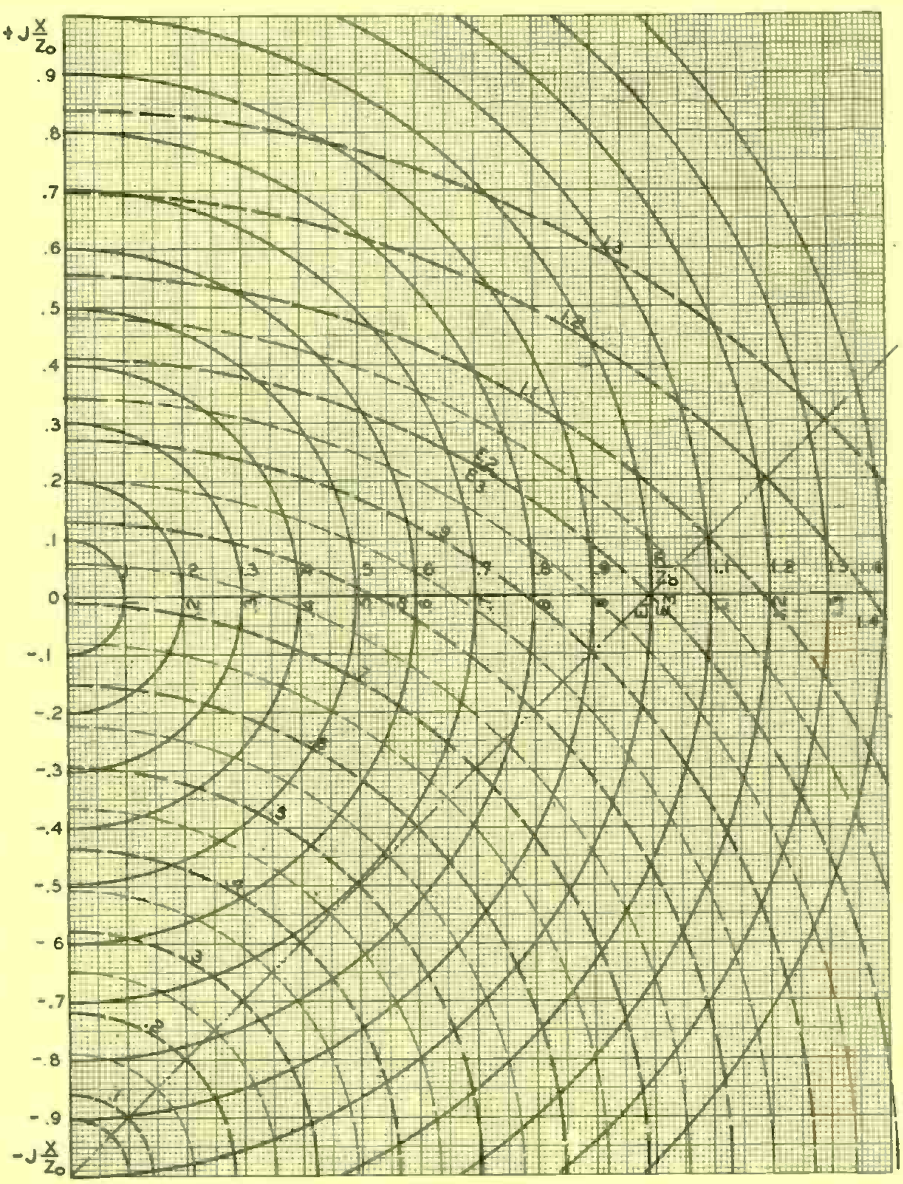


Rectilinear map for use with 3-probe method of impedance measurement.

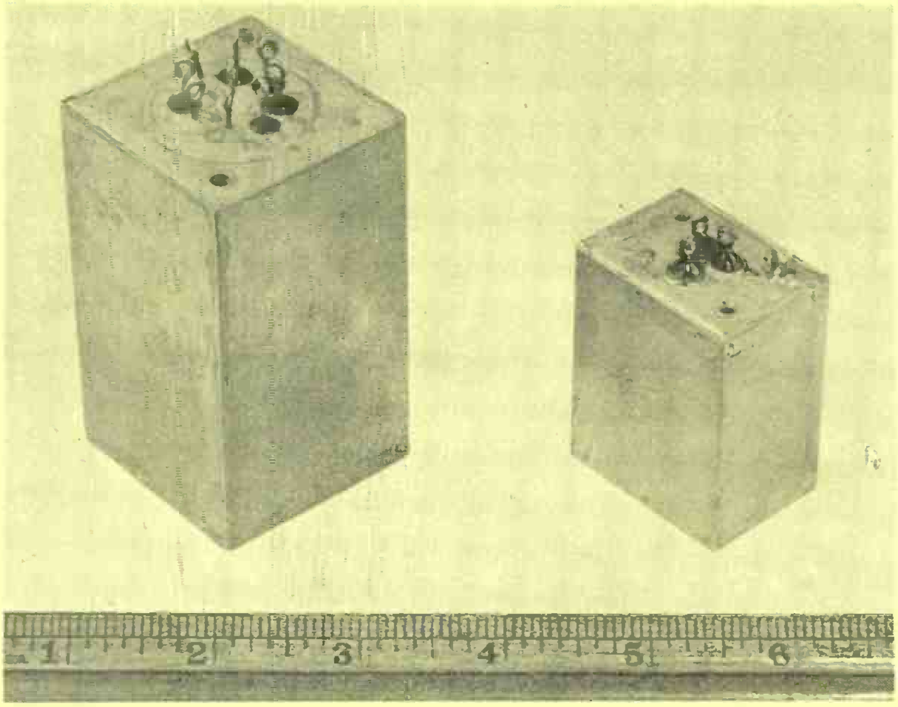
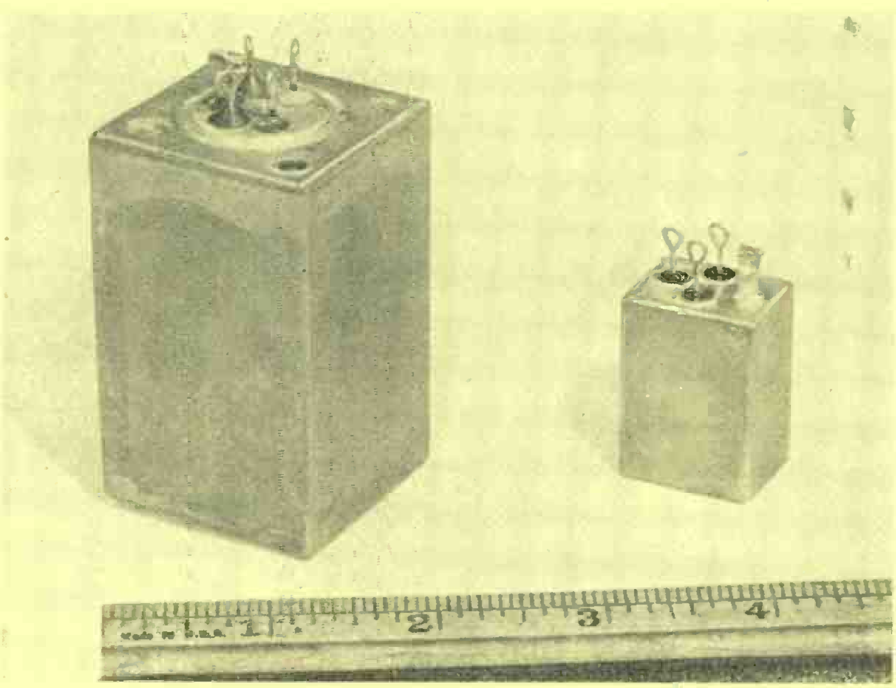


Fig. 1. Comparison between typical 400-cycle 14 VA transformer and miniaturized version, which supplies 33 VA, weighs ¼ as much, and takes up 68% less volume.

MINIATURIZATION of Electronic Equipment

By SAM MILBOURNE, Eng. Dept.
Eclipse-Pioneer Div., Bendix Aviation Corp.

Fig. 2. Conventional excitation transformer (left) compared with miniaturized version, which occupies 1/9 the space and weighs 1/10 as much.



Smaller components and improvements in design reduce size and weight.

A PRACTICAL, if somewhat whimsical, definition of equipment miniaturization is that it is the design process wherein the size and weight are progressively decreased while the use is progressively increased until the resulting equipment takes up no space, weighs nothing but does everything.

Miniaturization of electronic circuits and components—for both military and non-military use—is demanding the greater interest and attention of design engineers. Rapid strides have been made in lightness and compactness—particularly in modern airborne electronic equipment. Fig. 3 illustrates a recently developed plug-in assembly which is part of a complete airborne equipment. Fig. 4 shows the underside. The chassis or "card" is of plated aluminum and measures 5" x 12" x 2¾" over-all. The complete assembly weighs only one pound thirteen ounces! The assembly comprises five two-stage push-pull output amplifiers with a total of fifteen tubes. Small parts such as resistors and condensers are connected between glass-bead through-type terminals which are soldered into the card. Besides the fifteen tubes, the card carries 5 output transformers, 30 resistors, 32 condensers and two plugs—a total of 84 components!

Improvements in non-military electronic equipment are often the outgrowth of previous military equipment improvement. Present television progress can be traced in no small measure to military radar developments. Thus, it can be expected that future non-military miniaturization will be greatly aided by developments in military equipment miniaturization.

It should be remembered that the requirements for military electronic equipment are much more rigid than those for non-military use. Military airborne electronic equipment design is pointed toward a maximum of accuracy, dependability and ruggedness. Extremes of temperature, humidity and barometric pressure as well as resistance to fungus, salt-water, chemicals, vibration, etc., all add their problems. Any miniaturization must be accomplished without serious sacrifice of the above.

Specifically, the general requirements for military airborne electronic equipment can be stated in terms of "Maximum" and "Minimum" as:

Maximum

1. Operational life.
2. Safety in use and in the event of equipment failure.

3. Ambient temperature range.
4. External pressure (altitude) range.
5. Resistance to water immersion and salt spray.
6. Ability to withstand shock and vibration.
7. Resistance to chemicals.
8. Resistance to fungus.
9. Ease of service with minimum technical knowledge.
10. Electrical and mechanical efficiency.
11. Dissipation of developed heat.
12. Use.

Minimum

1. Size.
2. Weight.
3. Lost space.
4. Internal heat rise compatible with minimum size.
5. Number and types of power supplies.
6. Number and types of parts.
7. Size and weight of individual parts.

Although there may be other requirements in certain applications, the above breakdown presents the designer with his major problems.

Now, how can equipment be made smaller and lighter?

To accomplish this, our first approach was to eliminate the unnecessary in circuits and parts. The design was pared to an absolute minimum of parts. Every resistor and condenser having no real purpose was eliminated. Resistance-condenser coupling between stages was used in place of transformer coupling where possible. Autotransformers and tuned chokes were utilized where practical. One master power supply was designed in place of several smaller ones.

Next, we attacked the problem of reducing the size and weight of component parts, starting with the largest and heaviest parts and working down to the last nut and screw. The success of such a program was positive. A twenty per-cent reduction in the final weight of the complete system under the weight requirements of the development specification was accomplished. It can be stated that in terms of previously designed comparable equipment this represents more than a fifty per-cent reduction in weight.

Transformers and chokes (power and audio) exhibit the greatest weight density per cubic inch of all electronic parts. Previous design experience indicated an average weight of one ounce per VA (approximate) for hermetically-sealed transformers and chokes. This type of airborne transformer is designed with ordinary silicone steel "E-I" laminations, potted in compound and housed in copper or brass cans.

To illustrate what can be done to reduce size and weight in this direction, Fig. 1 shows a typical 400-cycle excitation (power) transformer operating from 115 volts and supplying 14 VA.

Fig. 3. A plug-in assembly using miniature tubes and parts.

This transformer measures 3" x 1¾" x 1¾" over-all and weighs 12 ounces. Also shown is the resulting comparable miniaturized version. Supplying over twice the VA (33 VA), it measures 1⅞" x 1$\frac{9}{16}$" x 1⅛" over-all, takes up 68% less volume and weighs but 3 oz.!

Acknowledgment by the electronic engineer must be made, not only to the mechanical engineer, but to the chemical engineer. It is through the use of new products and new processes that space and weight reductions can be accomplished. The best results can be achieved by a welding of the knowledge and efforts of these men.

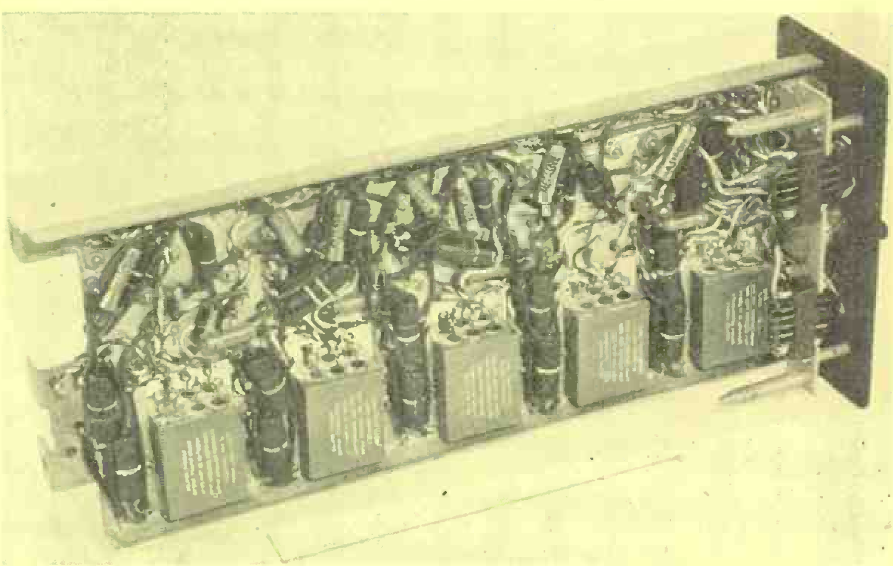
Specifically, how was this size and weight reduction accomplished in the above mentioned transformer?

It was felt that sometimes unreasonable safety factors crept into the design of airborne transformers, particularly when the design passed through several hands—each adding a bit to the over-all safety factor. It was also felt that too little attention was sometimes paid to absolute limits of safe operation. Too many "rules of thumb" seemed to be used. Too little attention seemed to be paid to the requirements of each specific design.

In the design of this transformer, we first studied the core. A toroidally oriented-silicone prefabricated core was finally chosen because a 15% to 30% weight reduction was indicated over standard "E-I" laminations—without altering transformer characteristics or increasing core losses. More rigid control of magnetic characteristics, faster assembly and no high temperature de-

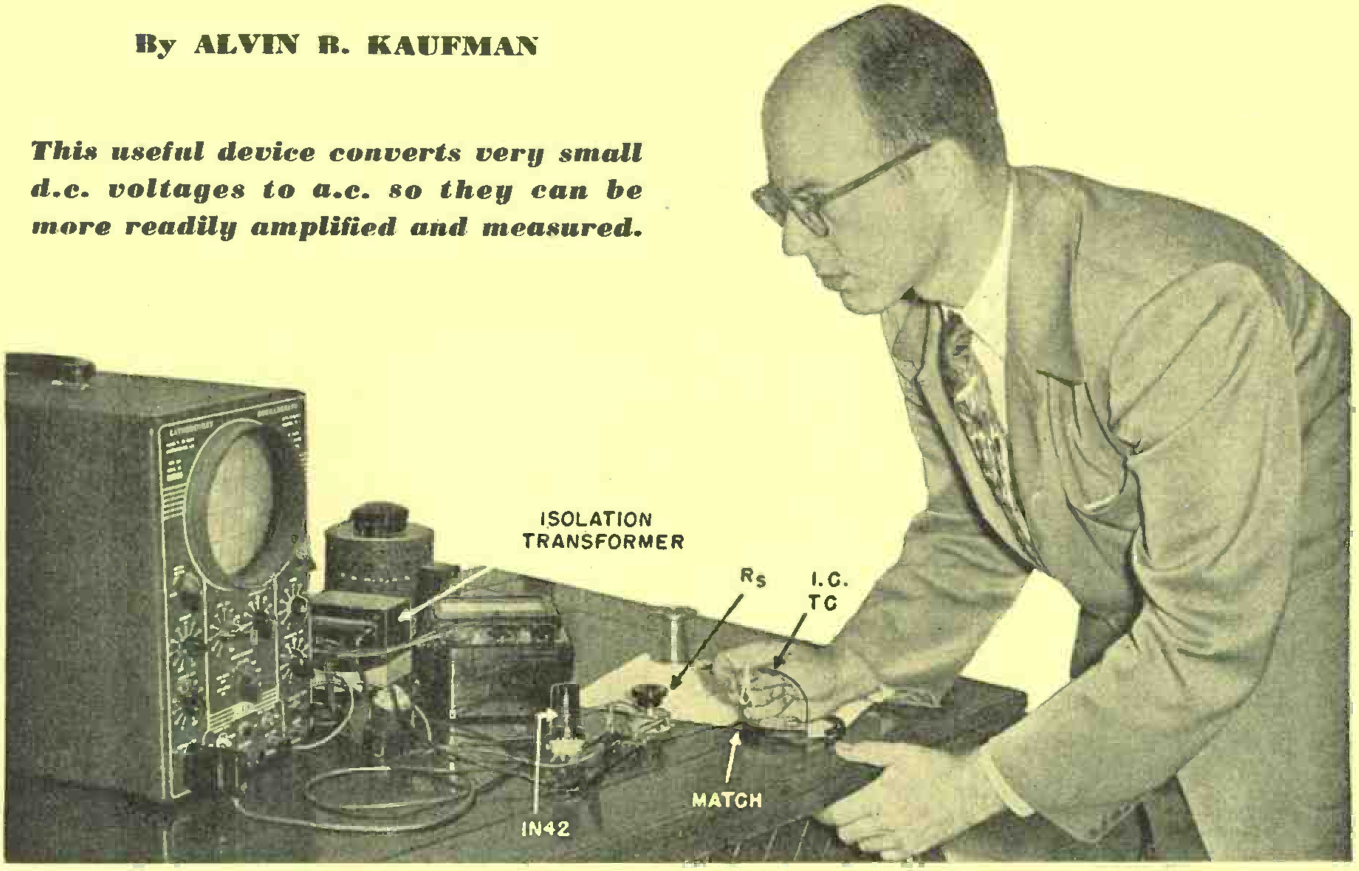
(*Continued on page* 28A)

Fig. 4. Bottom view of assembly shown in Fig. 3. Five driver amplifiers are included—a total of 15 tubes, 5 output transformers, 30 resistors and 32 condensers.



By ALVIN B. KAUFMAN

This useful device converts very small d.c. voltages to a.c. so they can be more readily amplified and measured.



Experimental setup for testing the chopper with an iron-constantan thermocouple.

Electronic D.C. Millivolt Chopper

THE amplification of small d.c. potentials is an old problem. That this problem is of much importance may be seen by examining the literature on methods of d.c. amplification.

Application of d.c. amplification systems has been made for strain gauge signals, thermoelectric potentials, electrometer output potentials and in medical, industrial, and experimental fields.

Amplification systems are generally of one of the following types:

1. Mechanical-electrical chopper (vibrator) and a.c. amplifier.
2. D.c. Amplifier.
3. D.c. Modulating R.F. Carrier System.[1]
4. Magnetic Amplifier.
5. Electronic Chopper (Bridge Type); a) Neon, b) Resistive. c) Tube, d) Varistor.

Most of these types have been discussed quite liberally in engineering literature and there is little need of recapitulation of their problems of drift, complexities and general unsatisfactoriness.

The "Electronic Chopper" discussed herein is not presented as a cure-all, but a substantial simplification of the d.c. amplification problem as applicable to many laboratory and industrial problems.

The very use of the word chopper signifies the use of an associated a.c. amplifier and detector. As the chopper may be referenced to the amplifier output voltage, a "phase sensitive system" or a conventional carrier detection system may be employed. Unlike the mechanical chopper system of a vibrator or carbon button hummer, the bridge modulator, to be described, may be operated at frequencies as high as five or six megacycles allowing full dynamic recording of d.c. potential variations up to signal intelligence of 600 kilocycles. This feature also allows simplified filtering of the rectified a.c. or carrier signal to produce smooth d.c. output, where required. Of course industrial line frequencies of 60 cycles, or aircraft frequencies of 400 cycles may be used to operate the "chopper" and regulate its frequency of operation.

The electronic chopper utilizes two basic principles. The first is that if a signal is applied to the grid of an amplifier tube through a series resistance and the grid is intermittently shorted to the cathode, the d.c. potential on the grid will vary from zero to its full value. This is roughly the action of the electronic chopper. The electronic chopper does not create a dead short from grid to ground, but does effectively create a varying resistance, which in combination with the series resistance causes voltage divider action and a variation of the d.c. potential impressed on the tube grid. The method of impressing this varying resistance between grid and cathode is the second basic innovation. It is well known that a bridge with four equal legs will have zero voltage difference between its conjungate output terminals. Therefore a bridge circuit is used. Its "output" terminals are connected between grid and ground and a.c. (the carrier frequency) applied to the source terminals. The bridge output terminals must not develop any output voltage, but must vary in resistive value at the carrier frequency rate. The bridge elements, then, are the major consideration.

The bridge modulator may consist of any of a number of entirely different elements, operating technically different, but producing the same end result to varying degrees. Four basic types with several modifications will be discussed.

The resistive bridge modulator consists of four equal resistive legs of fine wire with a high coefficient of thermal resistance change. With each half-cycle of carrier current applied to the bridge, all four legs heat up and increase in resistance. Thus the modulator output is at twice carrier frequency. This modulator is limited by the thermal characteristics of the wire, and the heating and cooling resistive changes of all four legs. The resistance change available without burning out the wire is the major limitation of output, while the dynamic resistance tracking of all four legs on their heating and cooling cycle regulates the undesirable output of bridge carrier voltage and this regulates in turn the value of the lowest possible d.c. signal that may be amplified. If all four legs do not remain equal in value, then the bridge supply will cause an output voltage to appear on the grid of the tube without a d.c. input signal and this consequently regulates the signal-to-carrier (or noise) ratio, as indicated. It is this ratio which limits the value of the d.c. potential which may be amplified: These factors limit the use of the resistance bridge modulator and it is not too satisfactory, but may be improved with research.

The neon bridge modulator has a much better resistive output variation, possessing as its does a variation between almost zero and infinity ohms. With no potential (or carrier) applied to its bridge, the neon lamps are unlit and at the low d.c. signal potential applied to them will not ionize and therefore present a high impedance to the tube grid. As each half-cycle of carrier is applied to the bridge the neon bulbs ionize (or light) and form a low impedance path from grid to cathode. Any resistive unbalance between neon lamps is balanced out by the slide wire potentiometer forming the other half of the bridge. On the nonconducting portion of the carrier cycle, the bridge is balanced capacitively by the padders. It is apparent that this modulator also puts out a frequency twice the carrier frequency.

The neon modulator works quite well and its limitations are due mainly to the dynamic resistance characteristics of the neon lamps, firing point and inverse resistance characteristics. The lowest d.c. potential which may be amplified satisfactorily because of these limitations is approximately 50 millivolts, varying with the modulator components and associated equipment. Another variation of the neon modulator is the replacement of the neon bulbs with vacuum tube diodes. The system faces similar problems of capacity balance and matching of dynamic characteristics, along with not too satisfactory a variation in impedance and Edison effects causing performance not to be any more satisfactory than the neon modulator.

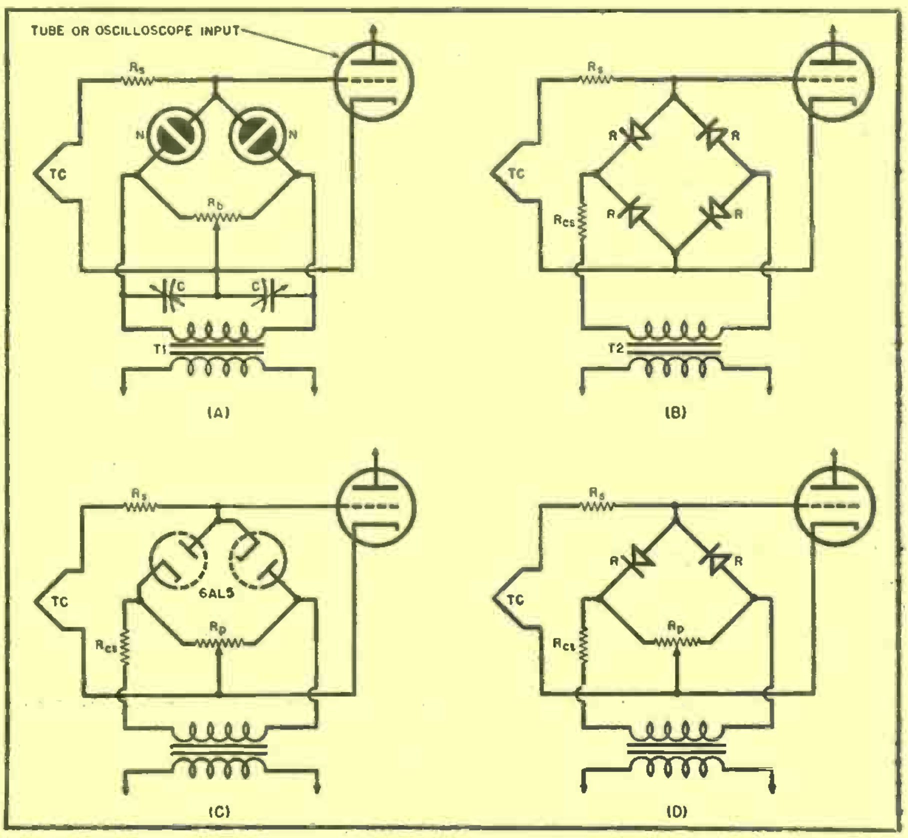
Possibly the best bridge modulator is that used in telephone and radio work as described by Terman, "non-linear rectifiers" in his Handbook of Radio Engineering. This modulator is commercially described as a "Bridge Modulator", "Copper Oxide Modulator", and under varying other synonyms. Here four non-linear rectifiers consisting either of copper oxide, selenium, or germanium are wired together identical to that circuit used in a full wave bridge instrument rectifier. However the lead away connections employed are entirely different. A.c. or the carrier is applied to what would normally be the plus and minus output connections, and what would be the input a.c. connections are tied grid to cathode.

As with the three other modulators the dynamic and static resistance characteristics of the four non-linear rectifiers which form the four legs of the bridge, limit the useful input signal level. The theory of operation is simple. The forward resistance of such rectifiers is very high at extremely low current, dropping off to a low value at full current rating. The d.c. signal potential is insufficient to cause appreciable current flow and therefore the bridge is effectively an open circuit. With application of the carrier signal, full current flows through the rectifiers on the conducting half of the cycle and the bridge output resistance (grid to cathode) falls to a low value. As the bridge only conducts every other half cycle, the amplifier will effectively produce the same output frequency as the carrier supply. Of course there is a certain shunting effect from the impedance of the carrier exciting transformer, particularly with the full bridge circuit, which may be limited however by the addition of a series resistor of high value in one of the carrier exciting leads. The carrier series resistor should be five to ten times higher than the value of the series grid limiting resistor.

For high efficiency the signal-to-carrier voltage ratio should be ten or higher. Actual values will depend on the dynamic characteristics of the rectifiers used and the d.c. signal potential. A carrier current value should be selected that gives best signal to noise (or carrier) output.

The interelectrode capacity of such rectifiers is usually insignificant at carrier frequencies up to several thou-

Fig. 1. Circuit diagrams of several versions of the d.c. millivolt chopper.



sand cycles, balancing possibly being required at five or six megacycles. Load impedances are generally of little importance except at the higher frequencies where the shunting effect of the rectifier capacities may become appreciable.

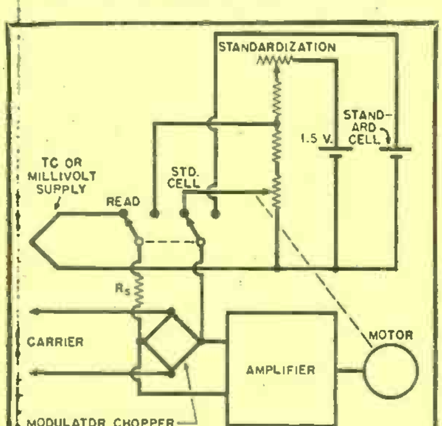
The inverse resistance characteristics of the rectifiers if dissimilar may cause an undesirable output on the non-conducting half of the carrier cycle. As indicated before, static matching is not sufficient; the dynamic, static, and inverse resistance characteristics must be the same.

Tests were conducted by the author using a *Conant* instrument rectifier Model 160 B and a *Sylvania* Varistor type 1N42. The instrument rectifier was not intended for this service. The *Sylvania Electric Company* Varistor, consisting of four matched germanium diodes, is specifically designed, among other uses, for use as a bridge modulator.

Considering the *Conant* instrument rectifier first, wired exactly as Fig. 1B, good readable signals from 10 millivolts d.c. could be observed on an oscilloscope with its gain adjusted for fairly straight line output with no d.c. input signal. Smaller signals could not be read above the noise (unbalance carrier) level. The observed signal was, of course, at carrier frequency. 60 cycle carrier was used. This rectifier is rated at 5 volts r.m.s. input, maximum current 5 milliamperes. Possibly twice this rated current could be run on the half duty cycle as used in this configuration, if necessary. The series grid limiting resistor finally selected was 300 ohms, but was not critical. The carrier supply across the bridge was 3.3 r.m.s. volts, supplied through a half-watt 10,000 ohm carrier resistor. The millivolt source was an iron-constantan thermocouple of low resistance.

A number of factors must be considered; the impedance of the d.c. signal source, the correct value of the grid or series limiting resistor, optimum impedance matching, and the optimum carrier voltage. Some of these questions may be answered quantitatively while others must be qualitative, depending largely upon components and amplification equipment.

Fig. 2. Simplified schematic diagram of an automatic potentiometer.



The impedance of the d.c. signal source should preferably be small in comparison with the input impedance of the amplifier with its modulator and series limiting resistor, or excessive shunting of the signal source impedance will occur with a corresponding reduction of the d.c. signal potential. The input impedance of the modulator and amplifier should be its highest possible value, *i.e.*, with the modulator not conducting, when used for calculations. In the conducting state we are trying to reduce the signal as much as possible and the shunting is not serious.

The series limiting resistor value may best be determined empirically, approximations being made by formula. Part of this problem hinges on the fact that in determining by test the forward or inverse impedances of these rectifiers, the analyzer current must be of the same value as the operating carrier current or erroneous data will be secured. Also, this operating carrier current in itself will depend somewhat on the value of d.c. signal and the value of the series limiting resistor. As much carrier current should be used as will allow substantial dynamic tracking of all four rectifiers, generally less than one-half rated current of the rectifier. This must be determined empirically with an oscilloscope. The carrier current should be adjusted to the value where maximum change of output signal occurs for a given d.c. input signal. This may in some cases result in a background level or signal which may be balanced out in the detector or output circuit.

If the bridge modulator effectively changed resistance between infinity and zero ohms, then no series resistance would be necessary, except to prevent loading of the signal supply source or excessive bridge current for high values of d.c. signal potentials. In practice this optimum condition does not exist. The fact that the modulator does not open to infinity ohms is the main problem in determining the series limiting value. With a very low impedance signal source, if no limiting resistor were used, the d.c. signal could not be attenuated sufficiently because the modulator resistance does not go to zero ohms. Thus to reiterate, to prevent loading or reaction on the signal source and limiting by the action of the modulator a series limiting resistor is generally necessary. Optimum series resistance value for low values of d.c. input potentials is approximately: R series $= R_{nc} - R_c$ of the bridge, where R_{nc} and R_c are respectively the nonconducting and conducting grid-to-cathode impedance of the bridge. R_c depends upon the carrier voltage and consequential rectifier currents. This series resistance may vary widely in value with variations of d.c. input signal and input impedance. High values of d.c. input potential require the use of a higher series grid resistor than normal to maintain the ratio between carrier and signal currents.

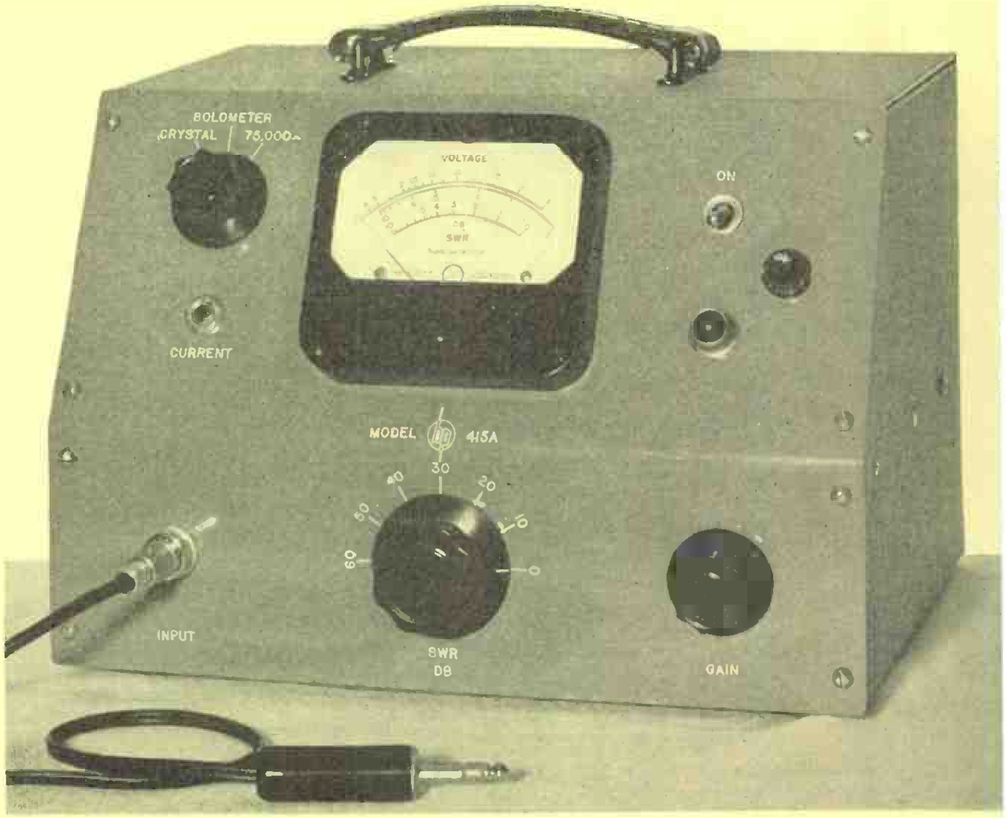
Where intermittent loading of the signal source, at carrier frequency, is permissible it is often possible to secure much higher output by eliminating the series limiting resistor. This depends, however, on three factors: the input impedance, the d.c. input level, and the characteristics of the particular modulator used. This is satisfactory only where: *R source* $>$ R_c *modulator.*

A half-bridge modulator may also be used quite effectively, in which case only two rectifiers are used and these need not have identical static resistance values, as this may be balanced out by the potentiometer forming the other half of the bridge. Dynamic slope characteristics must still be close. Under these conditions, although possessing less available change in resistance than with the full bridge, it is sometimes possible to use more of the resistance change available because of decreased matching problems and thus secure higher outputs for a given d.c. input signal. The potentiometer forming the other half of the bridge should have a resistance of: $R_p \gtreqless R_c + R_c$ where R_c is the conducting resistance of the rectifiers at the rated carrier current. Optimumly, the potentiometer should be of as low a value as consistent with reasonable carrier current through its half of the bridge.

The *Sylvania* Varistor bridge modulator (shown in photograph) performed excellently and is to be preferred over the other units because of its availability as matched units, making hunting for individual matched components unnecessary. This would be especially important for commercial equipment.

As with the other circuits, the millivolt d.c. supply consisted of an iron-constantan thermocouple with about five ohms lead resistance. This supply was chosen as a convenient standard signal source for comparsion of chopper efficiency. The thermocouple (about 28 gauge wire) was heated to cherry red with a match, supplying about 40-50 mv. peak. R_s was empirically determined optimum at 500 to 1000 ohms when R_c was 10,000 ohms. With 60 cycles as the carrier, optimum carrier voltage was 6-10 volts r.m.s. across the

(*Continued on page* 29A)



Power meter for measuring standard wave ratios on slotted line. The r.f. is modulated at 1000 cycles and is detected, amplified, and measured by this instrument.

MICROWAVE MEASUREMENTS

Part I. Equipment and techniques for measuring impedance and power at microwave frequencies.

By
J. RACKER
Federal Telecommunication Labs.

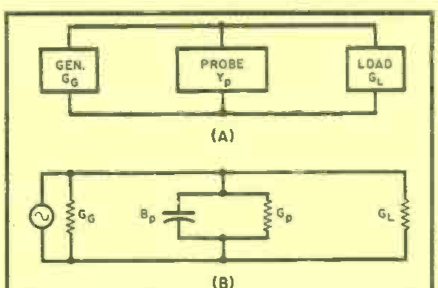
THE design principles described in the previous articles in this series provide the engineer with the basic approach to a given microwave problem. Once this approach is established the details of design, *i.e.*, configuration, size, and position of the various elements, will be determined primarily on an empirical trial and error basis. This procedure is employed in many other fields, but it is particularly necessary in microwave techniques because of the mathematical complexity of even relatively simple circuit calculations. For example, a cavity filter is desired between antenna and mixer in a receiver. The exact position of the input and output probes must be determined to effect proper matching between antenna and filter, and filter and mixer. The mathematical solution to this problem involves very complex computations and is completely impractical, while it is a relatively simple matter to adjust probes for maximum power output and minimum standing-wave ratio.

Several years ago the measuring equipment necessary to effect such a trial and error procedure was not readily available and the engineer frequently had to design and build these instruments himself. Sometimes this was the most difficult part of the project. Today, due to the expanded use of microwave systems, a wide selection of commercial equipment is on the market. In this article, the author will be primarily concerned with the theory of operation and practical application of these units.

Not only are the techniques themselves different, but the electrical characteristics of interest in the microwave region are, in several instances, not the same as those of interest at longer wavelengths. For example, we are more concerned with the electric field than in potential difference; in fact, voltages are difficult to define in most microwave elements other than coaxial lines. For this reason, the output of an oscillator or signal generator is specified in terms of power delivered to a load matched to the transmission line rather than in terms of available voltage across a given impedance. Similarly, instead of inductance or capacitance, measurements are usually made of the normalized impedance of unknown loads.

In previous articles[1,2] it was shown that when a transmission line was terminated in an impedance equal to the line characteristic impedance, no reflections from the load occurred. If the load impedance was not equal to the line characteristic impedance, part of the energy would be reflected back down the line and standing waves would be developed. The magnitude of these standing waves would be proportional to the impedance mismatch ratio. The position of the maxima and minima along the line would be a function of the phase difference between the two impedances. Thus it is seen that knowing the impedance of the line, the standing-wave ratio, and position of the maxima and minima points, it would be possible to determine the impedance of a given load.

Fig. 1. Equivalent circuit for probe in (A) block diagram form and (B) schematically with probe represented by $G_p + jB_p$.



The impedance Z_n is known as the normalized impedance and is equal to the actual impedance, Z, divided by the characteristic impedance of the line, Z_o. For most transmission line matching applications (particularly in wave guides) the normalized impedance is a more useful parameter than the actual impedance. The normalized impedance of the load is related to the reflection coefficient, K, by the following expression:

$$Z_n = \frac{1+K}{1-K} \quad \quad (1)$$

The reflection coefficient, K, may be a complex number having both magnitude

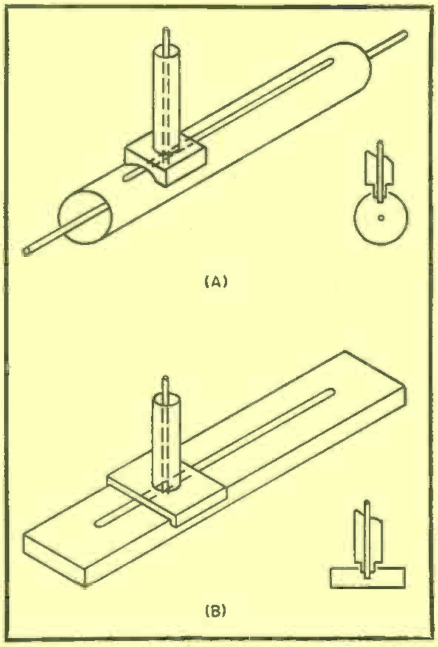


Fig. 2. Slotted line with probe for (A) coaxial and (B) wave guide line.

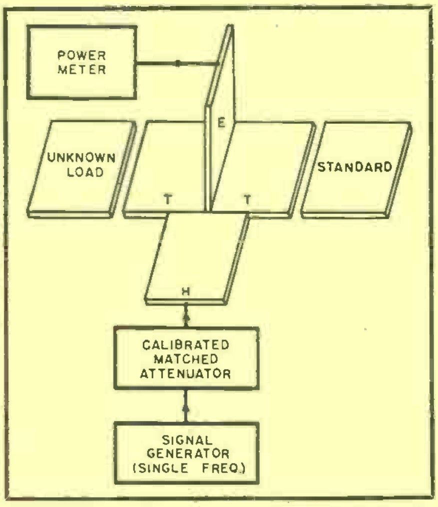


Fig. 3. Single frequency "magic T" impedance measuring bridge.

and phase components. The magnitude of K can be determined empirically by measuring the standing-wave ratio (power) and using the following equation:

$$|K| = \frac{\sqrt{\rho}-1}{\sqrt{\rho}+1} \quad . \; . \; . \; . \; . \; . \; . \quad (2)$$

The phase of K is determined by the minima on the line, being equal to zero at these points. (Maxima points correspond to a phase angle of 90°). Knowing the phase at any one point, N, it is possible to determine the phase at point, M, by the following expression:

$$K_N = K_M\, e^{j2\beta x} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (3)$$

where x, the distance between the two points, will be positive when M is nearer to the generator, and negative when N is nearer to the generator. β is equal to $2\pi/\lambda$, where λ is the signal wavelength in the transmission line.

Standing waves are measured through the use of slotted lines which consist of a section of transmission line into which a small probe is introduced through the slot. Fig. 2 shows two types of slotted lines, *i.e.*, coaxial and wave guide. The probe extracts a small fraction of the power flowing through the line and this power is measured in an external circuit. (The external circuit will be described later in this article when power measurements will be discussed).

By moving the probe along the slot, the standing waves can be determined. In order to minimize distortion of the field configuration, the slot should run parallel to the lines of surface current. In coaxial lines, due to symmetry the slot can be placed anywhere parallel to the axis, but in the $TE_{1,0}$ wave guide the slot should be placed at the center of each of the broad sides. It is very important to maintain the width and depth of the slot constant and its direction parallel to the axis. If the probe insertion varies by as much as 0.001 inch as the carriage is moved along the slot an error of several per-cent in the measured value of standing-wave ratio may be introduced. This imposes very close mechanical tolerances in the construction of the line.

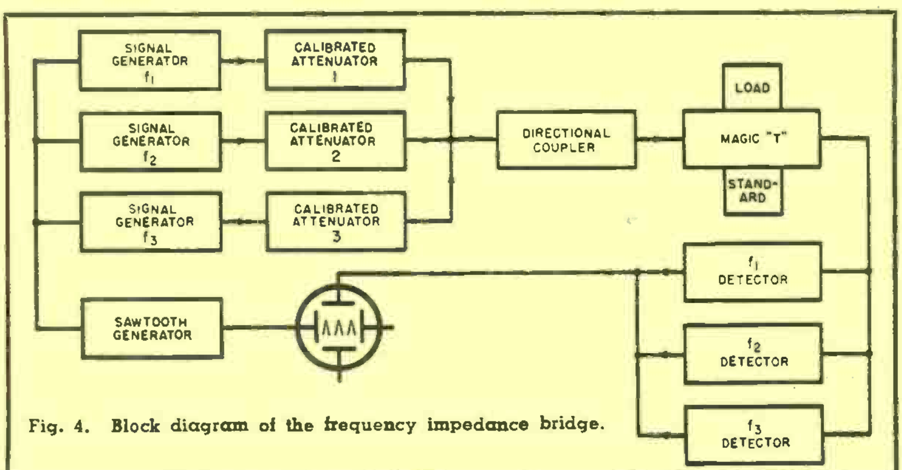


Fig. 4. Block diagram of the frequency impedance bridge.

Assuming proper construction and reflection-free matching between line and load, there are two factors that may require consideration in the evaluation of the results. One is the standing wave introduced by the slot and the other is the standing waves caused by the presence of the probe. It can be shown that the characteristic impedance of a coaxial line varies due to the insertion of the slot by approximately:[8]

$$\frac{\Delta Z_0}{Z_0} = \frac{1}{4\pi^2}\,\frac{w^2}{D^2 d^2} \quad . \; . \; . \; . \; . \; . \; . \quad (4)$$

where ΔZ_0 is the change in original characteristic impedance, w is the slot width, and D and d are the radii of the outer and inner conductors. The reflection coefficient K will therefore be equal to:

$$K = \frac{\Delta Z_0}{2 Z_0} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (5)$$

For very precise work this effect may be troublesome. It may be avoided by compensating for the change in impedance caused by the slot by increasing the diameter of the inner conductor.

In a wave guide the impedance due to the presence of a slot is approximately equal to:[8]

$$Z_s = Z_g\left(1 + \frac{w^2 \lambda_g^2}{8\pi b a^2}\right) \quad . \; . \; . \quad (6)$$

where Z_g is original guide impedance.

The presence of the slot also affects the propagation constant of the wave guide, and increases the guide wavelength by the same factor as the impedance. This factor is not too important, however, since (as will be indicated later) it is recommended that the wavelength of the guide be determined by actual measurement.

Probe Effects

An ideal probe would be one whose presence in no way altered the field within the transmission line and which, nevertheless, provided an indication of the intensity of the electric field within the line. This ideal is not attainable, of course, and usually some compromise between probe sensitivity and mismatch effects must be made.

For most practical applications where the probe dimension parallel to the slot is small compared to a wavelength, the probe can be represented as a shunt admittance across the line as shown in Fig. 1A and B. The impedances shown in this diagram are normalized so that $Y = 1$ represents an admittance equal to $1/Z_0$.

Assuming that the generator is matched to the line and that B_p can be made to be equal to zero by tuning it out (both assumptions are valid for most applications) then $G_L = 1$, the ratio between standing-wave ratios with and without probe can be given by:

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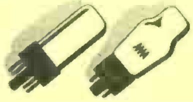

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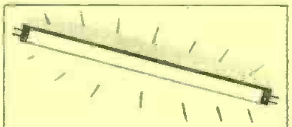

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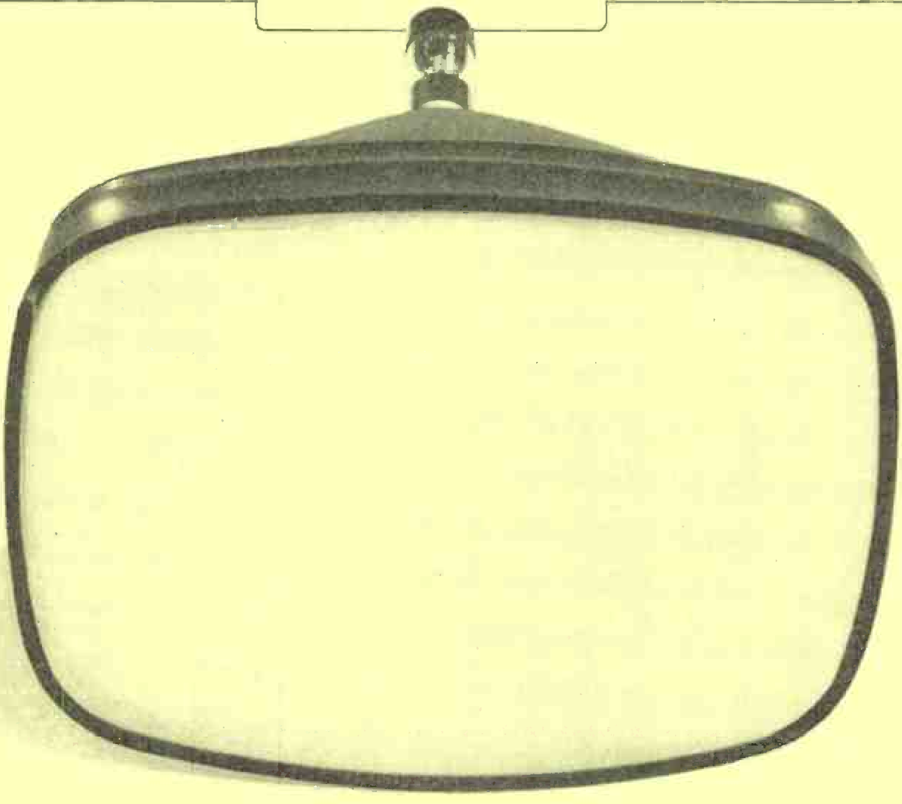

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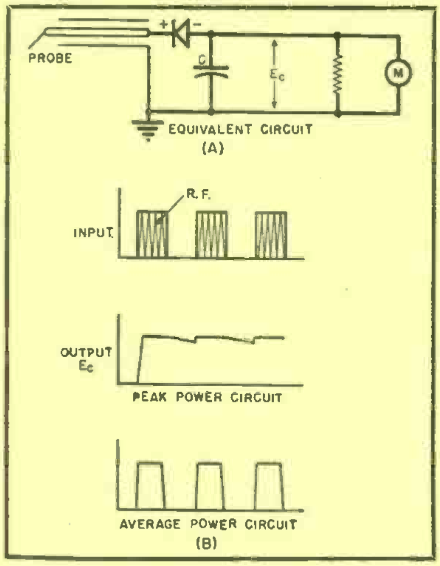


Fig. 5. Crystal detector power meter.

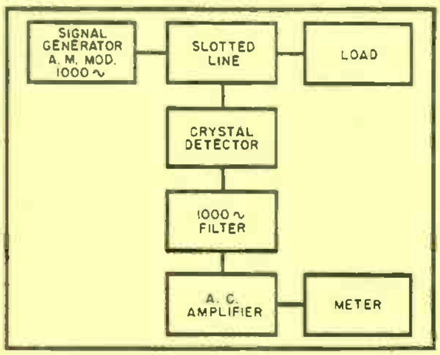


Fig. 6. Power meter (with slotted line) employing 1000 cycle modulation of r.f. to effect sensitivity.

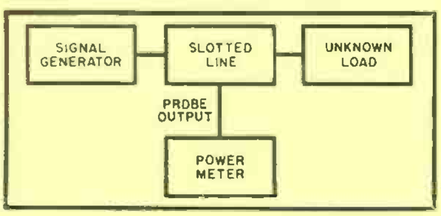


Fig. 7. Block diagram of typical impedance measuring setup.

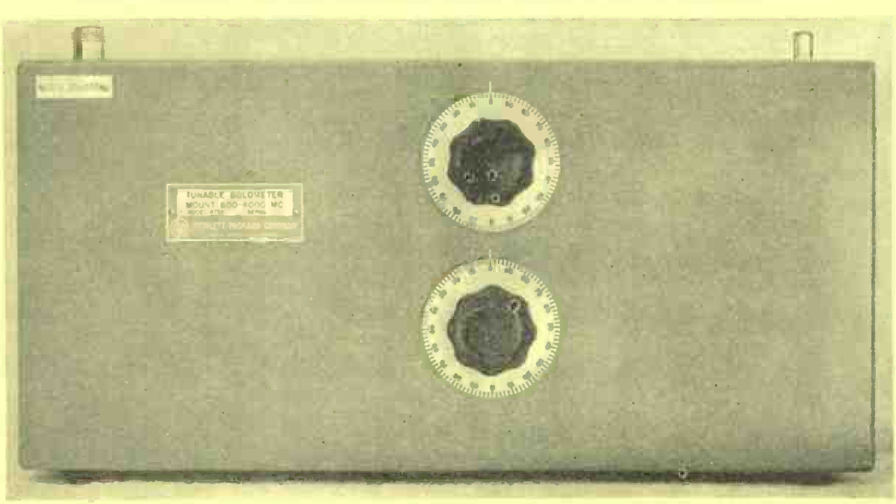
$$\frac{P_s}{P} = \frac{1 + P + G_p}{1 + P + PG_p} \quad \ldots \ldots \quad (7)$$

The quantity G_p determines the amount of power extracted by the probe, and is called the coupling coefficient of the probe. As previously indicated, every standing-wave measurement poses the problem of compromise between a very small coupling coefficient necessitating relatively elaborate external equipment to obtain sensitivity, or extracting more power by increasing G_p and thereby encountering a larger discrepancy between measured and true readings.

Fig. 7 shows a typical impedance measuring test setup using a slotted line. To determine the impedance of the load it is necessary to measure the standing-wave ratio and distance from the first minimum to the load impedance. Equations (1) and (2) are then used to calculate the load impedance. It should be noted that Eqt. (2) is expressed in terms of power standing-wave ratio. In some instruments voltage standing-wave ratios, ρ_v, are measured, in which case the substitution $\rho = \rho_v^2$ should be made in Eqt. (2).

The determination of the distance from load to first minimum may be complicated by the fact that for some loads, such as antennas, it is not apparent exactly where the load starts. In these cases it is necessary to calibrate the slotted line in terms of distance from the desired load. The following procedure is used to effect this calibration: the signal generator is first set to a frequency at which the load acts as an open or short circuit. Antennas, for example, have a finite bandwidth beyond which they act as short circuits. With the load presenting a short, the first minimum will occur exactly one-half wavelength away from the load, with the second minimum the same distance ($\lambda/2$) from the first one. By measuring the distance between second and first minima, the load starting point becomes known and the line can be calibrated in terms of distance from this point.

Tunable bolometer mount used for measuring power at microwave frequencies.



"Magic T" Impedance Measuring Bridge

Slotted lines are used extensively for impedance measurements; however, they do have the disadvantage of being time consuming. In some applications it is desirable to determine the reflection coefficient instantaneously. For these applications a device, somewhat equivalent to the Wheatstone bridge, using a "magic T" wave guide, shown in Fig. 3, is employed. The magic T, as previously described,[1] has the property of dividing the power fed into the H-arm equally between the two test arms if these arms are properly terminated in reflectionless loads. If these arms are not properly terminated, some of the energy reflected from the load will go into the E-plane arm.

For impedance measurements, one test arm is terminated in a standard load which represents a reflectionless match over the desired band. The load of unknown impedance is placed across the other test arm. A signal at the desired frequency is applied to the H-plane arm. If this load does not match the test arm at this frequency, some power will be reflected into the E-plane arm. The magnitude of this power is proportional to the square of the reflection coefficient, K. Hence, a detector placed in the E-plane arm can be calibrated in terms of voltage or power standing-wave ratios. It should be noted that the phase of the unknown impedance cannot be measured by this method. However, in many applications, only the value of the reflection coefficient is of interest since the power lost due to mismatch is a function of this parameter only.[2]

The simplest type of magic T device is the single frequency bridge shown in Fig. 3. In this equipment impedance measurements can be made at one frequency only for a given setting of the instrument. To determine the impedance characteristics over the desired band, the frequency must be varied and individual readings noted at each point.

It is possible to measure the reflection coefficient over a band of frequencies instantaneously by feeding several radio frequency signals simultaneously, as shown in Fig. 4, through proper attenuators into the H-plane arm of the magic T. The output of the E-plane arm is fed to an oscilloscope through appropriate frequency selection, amplifying, and detecting apparatus. The radio frequency signals are so spaced in time that they will appear in proper time sequence on the scope. Hence, the scope

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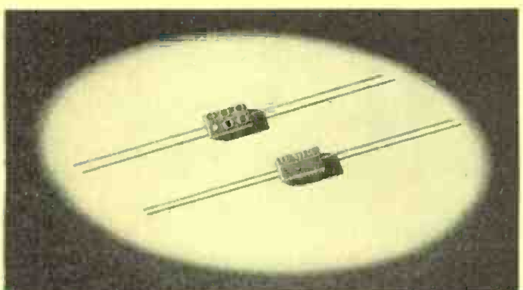

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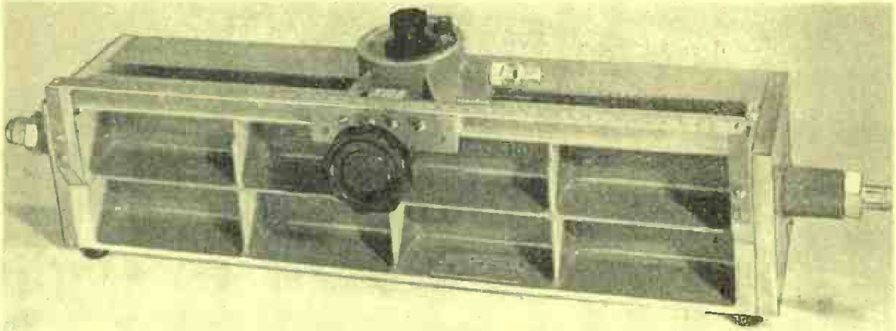


Typical slotted line used for microwave impedance measurements.

will display these signals as a series of pips, the magnitude of each pip being proportional to the reflection coefficient at the frequency involved. Thus the bandwidth response will be noted instantaneously.

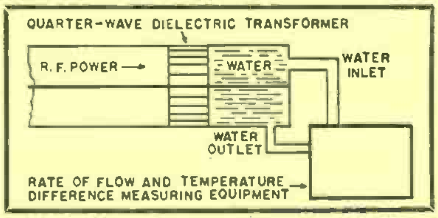


Fig. 8. Coaxial line calorimeter.

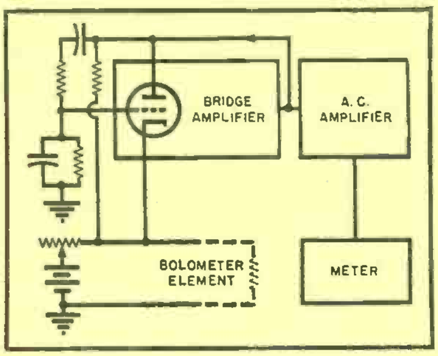
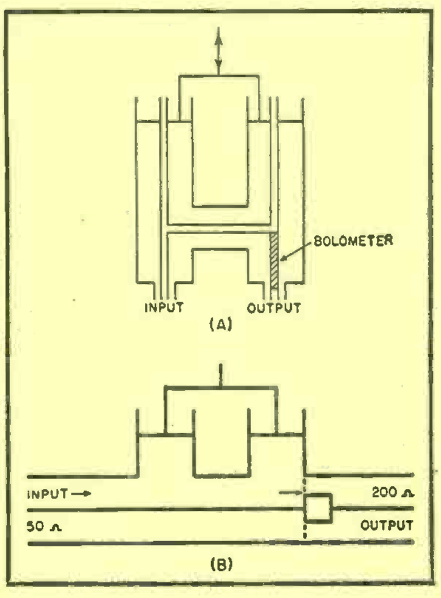


Fig. 9. Basic circuit of a self-balancing bridge power meter.

Fig. 10. Cross-section (A) and equivalent schematic (B) of a tunable bolometer mount.



Power Measurement

Power measurement, rather than voltage, is of much greater interest at microwave frequencies. There are two basic approaches to the measurement of power. In one case the power is measured directly at microwaves, while in the other the microwave energy is modulated by a low frequency signal and measurement is actually made of the modulation, after the microwave energy is detected and bypassed. This latter method is particularly useful in standing-wave measurements where it is possible to apply any convenient signal to the slotted line. Of course, in checking the output of microwave equipment where convenient modulation cannot be applied, microwave energy must be measured directly.

Microwave power is measured by one of three equipment methods, namely, crystal detectors in which power is measured directly; calorimeters in which power is converted to thermal energy and this energy measured; and bolometers in which power variation is converted, via thermal energy, into a varying resistance, and this variation is measured.

The crystal detector, shown in Fig. 5, is the simplest and least accurate method of measurement. The r.f. power is rectified by the crystal and used to charge up condenser C which also acts as an r.f. bypass. Two designs are possible, one for peak power measurement and the other for average power measurement. For peak power measurement the RC constant of the circuit is such that the condenser will charge to the peak of the applied voltage and will discharge only slightly during the remainder of the cycle as shown in Fig. 5B. For average power measurements the RC constant is made such that the video or modulation voltage will appear across C. This output is then fed to a meter which measures average voltage. For example, if the r.f. is pulsed at 1000 times per second, the peak power design will provide an essentially constant output equal to the peak of the pulse, while an average current design would have a series of pulses at the condenser output. This type of power indicator is calibrated with a signal generator whose power output can be varied and is matched into the crystal detector.

Sufficient power must be extracted from the device under measurement to actuate the meter over an appreciable portion of its range. This is a serious disadvantage of this method since, in the slotted line for example, the more power absorbed by the probe, the greater the error in standing-wave ratio measured. As a consequence, the circuit shown in Fig. 5 is used only to provide a relative indication of power output in a microwave transmitter (thereby indicating proper operation) or in some standing-wave equipment which is not required to be very accurate.

The sensitivity of this method can be increased and the SWR error decreased by modulating the microwave signal and employing an a.c. amplifier following the crystal detector, as shown in Fig. 6, tuned to the modulating frequency. The amplitude of the modulating signal obtained at the crystal detector output will be proportional to the amount of r.f. power pickup. By providing sufficient amplification it is possible to effect a highly sensitive and accurate measurement of power with a very small probe G_p.

Calorimeters

Another method of measuring power involves conversion of microwave energy into thermal (caloric) energy and measuring the latter. This can be done by feeding the microwave power into a water load matched to the output of the generator. The temperature rise of the water will be a function of the power absorbed and thereby provides an indication of output power.

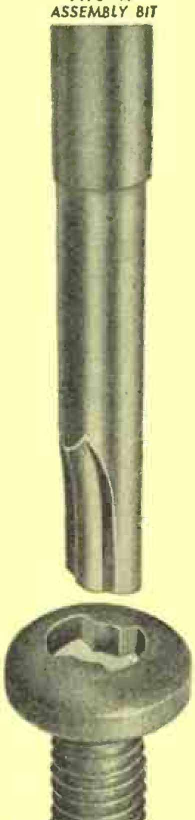
A typical coaxial line calorimeter that employs this principle is shown in Fig. 8. This instrument consists of a coaxial line into which r.f. power is fed at its input and is terminated into a water load. The water is contained within a section of the coaxial line with inlet and outlet connections permitting a continuous flow of water throughout this section of line. The temperature of the inlet and outlet streams is measured as well as the rate of flow, and from this data it is possible to calculate the absorbed power.

Due to the high dielectric constant of water, a mismatch is produced at the junction of the air- and water-filled sections. This mismatch can be eliminated through the use of a dielectric transformer placed between the two sections. This transformer, which also

(*Continued on page 26A*)

Time and Cost Saving Features

TYPE "A" ASSEMBLY BIT



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5. ***What Other Driver*** can begin to approach the durability record of the rugged Type "A" Bit . . . 214,000 screws driven non-stop?
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NEWS BRIEFS

AUDIO SYMPOSIUM

One of the main features of the IRE West Coast Convention held recently in Long Beach, California, was an Audio

Symposium led by John Hilliard, Chief Engineer, *Altec Lansing Corp.*, which featured a discussion of contemporary problems in television audio.

Bryan Cole (seated at right) of KFI-TV illustrated the principal problems in television audio such as: microphone placement, acoustics of sets and studio, reduction of noise in studio, etc. Dr. J. G. Frayne (left), Chief Engineer of *Westrix Corp.*, led the discussion on magnetic recording and stated that magnetic recording in the movie industry is here to stay.

Fred Albin, Supervisor of Video Recording of *ABC*, headed the discussion on sound on film problems, and E. B. Harrison of *Altec Lansing Corp.*, discussed the engineering specifications for high fidelity audio transformers.

TO BUILD ELECTROSTATIC ACCELERATOR

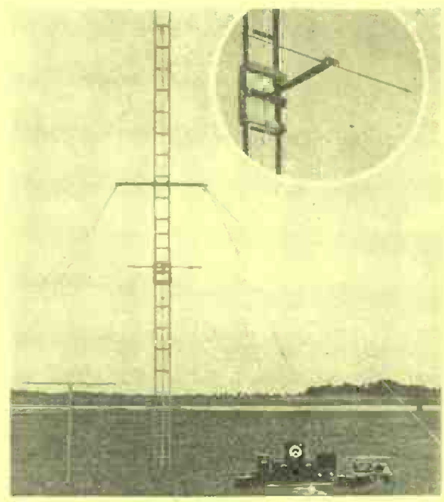
Northwestern University recently announced that it will build a 4½ million volt electrostatic accelerator for nuclear research. Dr. Russell A. Fisher, acting chairman of the Physics Department, said construction of the 28-ton atom smashing equipment will begin shortly, but it will be at least two years before the work is completed.

The instrument, a Van de Graaf type ion accelerator, will be installed in a structure to be built just south of the Northwestern Technological Institute. The lower part of the building probably will be underground so that the earth will serve as a shield for protection against the powerful rays produced by the generator. Additional protection will be provided by concrete walls and ceiling at least two feet thick.

The apparatus will be designed and constructed under supervision of Dr. Edward N. Strait, Jr., assistant professor in the Physics Department, who formerly worked with Professor R. J. Van de Graaf at MIT, and Dr. James H. Roberts, another nuclear physicist and assistant professor of physics. Consulting with them will be Dr. Paul E. Klopsteg, Director of Research in the N.U. Tech. Institute.

CALIBRATION SERVICE

A calibration service for field-intensity meters at all radio frequencies of broadcast and commercial importance up to 300 megacycles is now offered by



the National Bureau of Standards.

Of special interest are the new standards and methods which have been developed at the Bureau for calibrating field-intensity meters in the v.h.f. region from 30 to 300 megacycles. Two distinct experimental methods are used in the Bureau's field-intensity standardization work: the standard-antenna method for frequencies greater than 30 megacycles, and the standard-field method for lower frequencies.

In calibrating a commercial v.h.f. field-intensity meter by the standard-antenna method, the field strength at some arbitrary distance from a special v.h.f. transmitter is determined by a standard receiving antenna employing a crystal voltmeter. The antenna of the commercial set is substituted at the same position. The field strength, height of the antenna above ground, and the meter readings obtained with the two antennas enable one to compute the antenna coefficient that must be applied to the commercial instrument to relate field intensity to its meter readings.

H.F. MEASUREMENTS CONFERENCE

The second High Frequency Measurements Conference sponsored jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the National Bureau of Standards will be held in Washington, D. C. on January 10 to 12 in celebration of the semicentennial of NBS.

The Conference will be a forum at which leading engineers will exchange information on progress made since the previous Conference held in 1949. The Conference program will include about 25 technical papers, an evening demonstration, a luncheon, and conducted inspection tours of selected institutions.

The technical sessions will be held in the auditorium of the Department of the Interior. Conference Headquarters will be at the Hotel Statler. The Conference is under the general direction of Prof. Ernst Weber of the Microwave Research Institute of the Polytechnic Institute of Brooklyn. Dr. Harold Lyons of NBS is Chairman of the Local Arrangements Committee, and Dr. Frank Gaffney of the *Polytechnic Research and Development Company* is Chairman of the Technical Program Committee.

METEOROLOGICAL BATTERY

A battery capable of powering meteorological equipment such as radiosonde to heights of 30 miles into the stratosphere has been developed by the Signal Corps Engineering Laboratories at Fort Monmouth, N. J. According to Signal Corps engineers, this battery is the result of years of work to find a compact, lightweight battery that could meet the desired standards of easy activation, long storage life, good low temperature operation, low weight, low cost, and high service.

GERMANIUM PHOTOCELLS

George D. O'Neill, head of the Solid State Section of *Sylvania Electric Products Inc.*, presented a paper at the recent National Electronics Conference in Chicago describing a device consisting of a tiny piece of germanium placed in contact with a pointed wire for use as a light-actuated valve to control the flow of an electric current.

Such a device, called a germanium photocell, is smaller in diameter than a match stick and less than ½" long, requiring only a single pair of connecting wires.

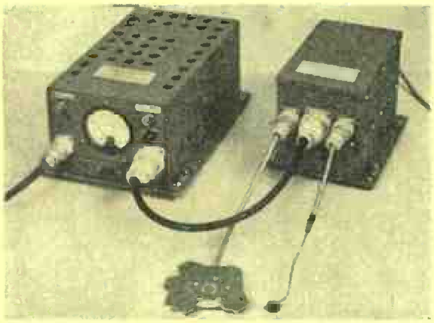
According to Mr. O'Neill, germanium

(*Continued on page* 31A)

NEW PRODUCTS

PRESSURE MEASURING SYSTEM

Elimination of the tubing connections in the new flush-mounted pressure cells announced by *Sierra Electronic Corp.*,



1110 County Rd., San Carlos, California, eliminates phase and amplitude errors arising from flexible-tube connection of pressure cells used in dynamic measurement. Cells mount directly in the surfaces upon which the measured pressures impinge.

Several styles are offered to fit various applications, including wedge-shaped types small enough to be used within ½" of an airfoil trailing edge. Units are listed with these sensitivities: 0 to ± 2.5 psi, 0 to ± 5 psi, and 0 to ± 10 psi.

SCALER

The *Atomic Instrument Co.*, 84 Massachusetts Ave., Boston 39, Mass., is now in production on its new 1010 Scaler, described as the first of a series of "building block" units.

While the standard Model 1010 is furnished optionally with a scale-of-100 or scale-of-256, added scaling assemblies to make either a scale-of-1000 or a scale-of-4096 may be specified. Other custom modifications include: scaling factor selector switch (10-100 or 4-16-64-256); precision calibrated 50 to 100 volt discriminator on front panel; electrical reset register; omission of manual reset register; omission of regulated high voltage power supply; etc.

A complete description of the 1010 Scaler may be obtained by writing the company.

OSCILLOGRAPH

Consolidated Engineering Corp., 620 No. Lake Ave., Pasadena 4, California, is now offering a small, low-cost recording oscillograph. Designated Type 5-116, the instrument is similar to the larger oscillographs manufactured by *Consolidated* but over-all dimensions have been appreciably reduced, and its weight cut by a factor of almost 50 per-cent.

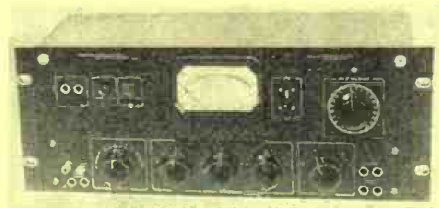
A new record transport system, recently adopted by *Consolidated* for their standard recording oscillographs, is also included in the 5-116. In this system neither sprocket teeth nor a pressure roller is required to provide positive record engagement, thus removing the major sources of record-drive malfunction, and at the same time reducing the power required to drive the recording

medium. Source of power for the record transport system is an exceptionally powerful governor-controlled motor directly connected through gearing to the record drive roll in the magazine.

The 5-116 is available in 9- or 14-trace block capacity for either 24-28 volt d. c. or 115-volt, 60-cycle a. c. drive.

TRANSMISSION MEASURING SET

A transmission measuring set which eliminates lengthy calculations and intricate setups for checking audio gain or loss, measurement of matching and bridging devices, complex circuit readings, and mismatch loss and frequency



response has been announced by the *RCA* Engineering Products Department.

The new equipment, *RCA* Type BI-11A, consists of a volume indicator meter, input and output attenuators, impedance matching system, and jacks for convenient connection. A meter multiplier, geared to the load-impedance shaft, provides an automatic correction for changes in load impedance. Convenient switches facilitate connection of the volume indicator to the input of the attenuator system, or to jacks for external connection. An output impedance switch allows matching to 600, 250, 150, 16, 8, or 4-ohm circuits.

Illustrated literature and specifications on the equipment are available on written request to the Broadcast Equipment Section of *RCA* in Camden, New Jersey.

SURVEY METER

Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago, Illinois, now has available a survey meter for checking all types of radiation found in clinics, hospitals, and laboratories.

Model 2581 is a battery powered, non-discriminating rate meter, and is an

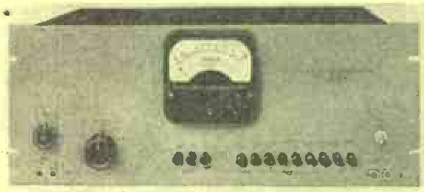
improved version of the wartime "Zeuto." The detecting ionization chamber is covered with a rubber hydrochloride film on the underside of the instrument and is capable of detecting 25 k.e.v. beta particles and 2 m.e.v. alpha particles as well as gamma and x-radiation. This film is easily replaced and is protected by a removable wire grille.

The operating life of Model 2581 is at least 200 hours, and the batteries may be easily replaced by a minor disassembling of the instrument.

DISTORTION AND NOISE METER

The Daven Company of Newark, New Jersey, announces the availability of its Type 35-A Distortion and Noise Meter with two amplifier gain controls provided; one an accurate step type covering the range +40 to −60 in steps of 10 db., the other a continuously variable control covering the range ±10 db.

The indicating meter covers the range 0 to −15 db., the range of 35-A is +40 to −60 db. full scale meter reading or +40 to −75 db. utilizing the meter scale. The range of noise and distortion



that can be measured depends upon the level of the source being investigated. At a level of −15 dbm. the limit is 60 db. below or 0.1% distortion. A pair of output jacks is provided for connecting an external scope in place of the output meter.

MASS SPECTROMETER TUBE

Available from the *General Electric Company*, Schenectady, N. Y., is an ion resonance mass spectrometer tube to aid scientists in the analysis of chemical compounds, especially gases. High-precision measurements can be made by the new tube in a number of special analysis problems.

In the ion resonance tube, when in operation, electrons from the filament

(*Continued on page* 29A)

Personals

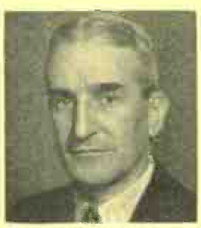
C. A. HAINES, formerly general manager of the Photoflash Division of *Sylvania Electric Products Inc.*, is now general manager of operations for the Radio Tube Div. and the Television Picture Tube Div. Mr. Haines joined the factory engineering staff of *Sylvania* in 1929 and served as superintendent of their Salem radio tube plant and as general manufacturing manager of proximity fuse tube operations during World War II.

JOHN H. HOWARD, a consultant in the field of electronic control systems, has joined the staff of the Research Division of the *Burroughs Adding Machine Company* in Philadelphia. Following service with the U.S. Navy, Mr. Howard was appointed Director of Development at *Engineering Research Associates* and was later associated with the *Sperry Gyroscope Company.* He is a member of the AIEE and the Institute of Radio Engineers.

DR. R. G. E. HUTTER, head of the electronics research section of the Physics Laboratory, *Sylvania Electric Products Inc.*, has been appointed adjunct professor at the Brooklyn Polytechnic Institute where he will conduct classes in electron tube theory and electron optics. Dr. Hutter, a native of Berlin, Germany, served several years as a research physicist in the *Telefunken* transmitter laboratories and has been associated with *Sylvania* since 1944.

PHILIPS B. PATTON has been named Manager of the Sales Engineering Department of *Lenkurt Electric Co., Inc.*, San Carlos, California. Before joining the company as field engineer, Mr. Patton was chief of FCC's Radio Telephone-Telegraph Section, Common Carrier branch; flight radio officer with *Pan American World Airways;* a field engineer and technical coordinator with *Farnsworth Mobile Radio;* and was associated with *Western Union Telegraph Co.*

BENJAMIN SAMPSON has been appointed General Sales Manager of the *K. H. Huppert Company*, Chicago. Mr. Sampson was formerly District Sales Manager of the Stewart Div. of the *Sunbeam Corp.*, and recently Manager of the Industrial Furnace and Oven Div. of the *Claud S. Gordon Company.* Plans are under way to expand the Industrial Furnace Div. to meet the demand of their special applications on industrial furnaces, ovens, and ceramic kilns.



DR. LAURISTON S. TAYLOR, Chief of the Radiation Physics Laboratory of the National Bureau of Standards, delivered the Sylvanus Thompson Memorial Lecture before the meeting of the British Institute of Radiology recently. The first American scientist to receive this honor since the lectures were begun in 1916, Dr. Taylor is an internationally known authority on x-rays and has contributed extensively to scientific journals in the field of radiology.

Microwave Measurements

(*Continued from page* 20A)

acts to keep water within its section, has an effective length of a quarter of a wavelength and a dielectric constant such that it acts as a quarter-wave transformer. It should be noted that in this setup matching is effected at one frequency only, with no provision for tuning to other frequencies.

Water calorimeters are useful only for measuring fairly large powers. Their operation is sluggish and heat losses are such as to prohibit their use for power smaller than a few watts. For larger powers, however, water loads may serve as very reliable power standards.

For the measurement of radio-frequency power in the range from 1 microwatt to several milliwatts, bolometer type instruments are usually used. The bolometer employs the characteristics of some conductors whose resistance varies as a function of power absorbed. This variation in resistance can be measured by bridge circuits and indicates the magnitude of power flow.

Bolometer elements, such as the thermistor, are manufactured by a number of companies and are usually contained within glass enclosures. As in other instruments described in this article an important problem in this equipment is effecting a match between generator and bolometer element. Matching at one frequency is relatively simple, but over a range of frequencies becomes more complex.

Fig. 10 shows a tunable mount which matches a 50-ohm line to a 200-ohm bolometer from 1000 to 4000 megacycles. This circuit uses a double stub tuner and employs the bolometer as the center conductor of the output connector. The r.f. power is fed across the input and the output operates into a bridge circuit.

Many types of bridge circuits can be used to determine bolometer resistance. It should be noted that if the bolometer element is allowed to vary in resistance appreciably, due to the absorption of r.f. power, the match between generator and this element may be affected. A circuit which overcomes this problem is shown in simplified block diagram form in Fig. 9. This circuit consists of a self-balancing bridge, with a bolometer as one of its arms, and a audio voltmeter. A high-gain amplifier is connected across the bridge as a detector and the output of this amplifier is fed back as a driving source for the bridge. This circuit will oscillate to maintain the bridge balanced and the design is such that bridge balance occurs when bolometer resistance is 200 ohms. The amplitude of oscillation is, therefore, such as to obtain a 200-ohm bolometer resistance. The frequency of the oscillator is determined by the bridge circuit and is a convenient audio frequency.

When r.f. power is applied through the bolometer element its resistance tends to increase and, to maintain bridge balance, the amplitude of the oscillator decreases so that the power flowing through this element remains the same. The reduction of audio power is equal to r.f. power, and hence an audio voltmeter (zero set for r.f. power) can be calibrated in terms of r.f. power. It should be noted that in this system the bolometer element has a 200 ohm impedance at all times and hence the proper matching is assured. An accuracy within 5 per-cent can be effected with this circuit.

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(*To be continued*)

Potted Circuits

(*Continued from page* 8A)

to eight per-cent in the setting process. However, the great bulk of this shrinkage takes place at an early gel stage, when the material is still quite soft, and no undue pressures are therefore exerted on the components embedded.

On the other hand, these materials have a greater coefficient of thermal expansion than most of the metals and glass usually enclosed in them. No difficulty is experienced at higher than normal temperature operation from this effect. When low temperature operation is to be experienced—temperatures below about minus 30 degrees Centigrade—special treatment of the circuit to be embedded is required. Equipment has been successfully operated at temperatures as low as minus 85 degrees C.

Silicone plastics, such as *Dow-Corning* Silastic 181, remain flexible at extreme temperatures and make suitable cushions when placed between the circuit and the plastic which surrounds it. The Silastic is dispersed in a solvent so that the circuit to be protected can be dipped in it. Several dips are required, with treatment in an oven after each dip to drive off the volatile material and vulcanize the Silastic.

Unless the Silastic is vulcanized, trouble may be experienced. Under the heat of operation of the tubes embedded in the plastic, it will undergo the vulcanization process, liberating certain materials. This results in the development of a pressure within the casting which may result in fissures.

The photographs accompanying this article show some of the applications to which the casting resin has been put at the Navy Electronics Laboratory. A large number of cylindrical subassemblies one inch in diameter and two to two and one-half inches long have been made. These contain single stages or at most two stages, such as multivibrators, oscillators, amplifiers, modulators, etc., as complete units.

It will be noted that no chassis as such has been used in any of these units. Leads are necessarily short and as a result the circuits are normally sufficiently self-supporting to get them embedded in the plastic before something happens. Most of those illustrated use a seven or a nine pin miniature base in order to plug into the corresponding socket. However, any type of connection means may be used which is desirable for the application in mind. Circuits are wired in a jig which holds the plug pins in position and the components built up by point-to-point wiring.

Also illustrated is a superheterodyne receiver containing six tubes and cast as a unit. This particular receiver covers the standard broadcast band and was built as a "propaganda" unit to prove to some skeptics that the things would continue to operate after being potted. It is not intended as a representative design, either electrically or mechanically, for military applications. It has, nevertheless, created considerable interest. The speaker and power supply are enclosed in the base into which the receiver plugs. The power supply uses a selenium rectifier which is also potted for protection.

The formulation and processing of NEL-177 Casting Resin are fully covered by a patent disclosure in the name of Mr. Edward Rolle, NEL chemist, who is chiefly responsible for the development of the materials and processes involved. The details of these may be obtained for use by firms legitimately involved in production for Government use which requires the use of such compounds.

Others who contributed to the program are: Messrs. J. C. McAdam, A. T. Steinkamp and J. R. Potthoff, who did the bulk of the circuit work; Mr. R. J. Violette, who developed the molds and did a large amount of the actual casting; Mr. A. H. Attebery, whose assistance in selection and procurement of suitable components was extremely valuable; and last but not least, Mr. E. B. Robinson, whose foresight started the whole program. -®-

TECHNICAL BOOKS

"**SURVEY OF MODERN ELECTRONICS**" by Paul G. Andres, Associate Prof. Electrical Engineering, Illinois Institute of Technology. Published by *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York 16, N. Y. 522 pages. $5.75.

This is a textbook for a short course in electronics based on lectures and classroom notes from a course given to mechanical, chemical, and industrial engineering students to familiarize them with the basic principles of construction, operation, and application of electron tubes.

It explains the fundamentals of electronics and provides a summary of applications. The material is treated in a descriptive manner rather than mathematical, and the description of nearly every tube is followed by one or more practical applications. Final chapters review applications of electronics in instrumentation, communication, control, and heating, and offer practice in reading circuit diagrams.

General references in the appendix and specific references and problems at the end of each chapter are given for additional study. Data, circuits, and illustrations are also included.

"**ANTENNAS**" by John D. Kraus, Prof. Electrical Engineering, The Ohio State University. Published by *The McGraw-Hill Book Co.*, 330 West 42nd St., New York 18, N. Y. 553 pages. $8.00.

Here is a clear, systematic treatment of basic antenna theory and its applications to a great number of antenna systems, compiled from lectures given in recent years by the author in a course on antennas at Ohio State.

The text presents a unified treatment of antennas from the electromagnetic theory point of view with stress upon those aspects which are of engineering importance. The principles given are basic and are applied to antennas for all frequency ranges. Some of the material is published here for the first time, particularly portions of the treatment on point sources and on helical antennas. Recent advances in the field are described, and problem sets are included at the end of each chapter. The rationalized mks system is employed and a complete table of units in this system is included in the Appendix.

Although primarily written to serve as a textbook, it is hoped that practicing engineers and scientists will find it a valuable reference book.

Miniaturization

(*Continued from page* **11A**)

terioration were also promised.

Next, the general problem of insulation was considered. The hotter a transformer is run, the smaller can be its size. However, the usual organic material used to insulate wire, and the insulating tapes used for start, interlayer and finish wraps, will carbonize if they are pushed beyond their safe high temperature limits.

Thus, an inorganic insulated wire and an inorganic paper for the insulating tape were chosen. The former is a wire coated with a ceramic material. The latter is composed of asbestos with a binder, and is available in sheet or tape form, in a variety of widths, and in thicknesses down to 0.003". Its ability to withstand heat without disintegration is unusual. A few thousandths of asbestos paper is sufficient to stop the passage of the direct flame of a blow torch. Finally, as an impregnant, a silicone varnish was picked for its inorganic composition and relative ease of production use.

It was found that interlayer insulation in many instances was unnecessary. Where possible, random winding was used—that is—machine-winding without interlayer insulation. This meant, of course, that the potential between the two adjacent layers was the difference between the potential of the first turn of the first layer and the last turn of the next layer. This potential is usually a matter of only a few volts and, if the coil is properly impregnated, sufficient insulation appears to exist. Inter-winding insulation of asbestos paper was always provided.

When impregnation was first considered, a material was sought which would act as impregnant, seal and outer shell. However, no such material was found which could qualify, as available impregnants were not true hermetic seals. Furthermore, it was calculated that if a dipped seal was used, the weight of the seal would be greater than the weight of a conventional brass can.

The use of a silicone varnish as an impregnant consists of first driving off the moisture in the coil and then subjecting it to a series of impregnation and bake cycles. The impregnant fills in the spaces between the wires, seals the coil and allows maximum heat transfer.

Military requirements usually call for hermetically sealed transformers and chokes. As previously stated, this is normally done by using a solder-sealed brass or copper can in which the transformer is mounted and held in place by an impregnant fill or compound commonly known as "gunk".

Our survey started with the knowledge that the specific gravity of copper is 8.91 as compared with 2.7 for aluminum. Heretofore, aluminum could not be used for cans because of the difficulty of solder-sealing. Iron or zinc with 7.85 and 7.1 specific gravities respectively showed little weight advantage. Magnesium, with a 1.8 specific gravity, could not be obtained in comparable wall thicknesses. It appeared that aluminum was the desired material if some process could be evolved for solder-sealing it.

Aluminum-plating techniques were developed whereby the fabricated can parts could be plated with copper or nickel. This resulted in a can which could be soldered readily, yet gave a 70% reduction in weight.

Early in the development of the plated aluminum, some discussion arose over the possibility of electrolysis developing between the base aluminum and the copper plating (due to their removed position in the electromotive series). However, extended tests indicate that, when the developed plating process is followed, this condition is not existent in practice. Plated strips of aluminum have been subjected to 500 hours of salt-spray without deleterious effects.

The use of a compound or "gunk," which anchors the transformer in the can and conducts heat from the transformer to the can, has been the standard practice for some years. However, the weight of the compound often approached the weight of the transformer and can. By using an alternative method, we accomplished the same result at a saving in weight and cost.

This we did by mounting the transformer with special aluminum braces, evacuating the can, re-filling the can with a non-explosive, non-inflammable gas and sealing off the can against leakage.

For transformer terminals, the small glass bead type was used. They withstand applied voltages and exhibit no leakage between can and terminal stem so long as the glass bead does not become cracked in assembly.

As a final illustration of what has been done in transformer miniaturization with newer materials and techniques, Fig. 5 illustrates a 400-cycle 115-volt excitation transformer which delivers 4.2 watts at 24.25 volts into a resistive load with an efficiency of 73.9%. It can deliver 7.06 watts into a resistive load with an efficiency of 62%. Yet, this hermetically-sealed transformer measures 1¼" x ¾" x ⅞" and weighs only *one ounce*! Compare this with a previous comparable design which occupies approximately 900% more space and weighs approximately 10 times as much.

The use of subminiature tubes (as shown in the assembly illustrated in Fig. 1) allows the designer to utilize better the space available. Newer and more compact condensers save much additional weight and space. The failure of electrolytic condensers to hold capacity at low ambient temperatures (such as -55 degrees C.) results in the forced use of paper and mica types. Thus, a 30% to 50% saving in weight and size of paper condensers used in a power supply filter circuit can mean an appreciable saving in total size and weight of the complete electronic system.

The Scotch saying, "Many a mickle makes a muckle" aptly describes the process of miniaturization. A fraction of an ounce saved and multiplied many times means pounds saved in the final electronic equipment. However, this process can not be accomplished over night. It is a slow, painstaking inching forward requiring the best of laboratory equipment and personnel working as a team to advance the cause of science and to provide our military with the very best in operational equipment —modern as tomorrow.

Millivolt Chopper

(*Continued from page* 14A)

modulator, while the supply was approximately 12-25 volts. A *Sylvania* 1N42 Varistor was employed as the modulator. The carrier voltage was supplied through an isolation transformer so as to not introduce capacitively unbalanced line frequency signals into the oscilloscope.

The output of the electronic chopper may be connected into an oscilloscope or amplifier. In the typical circuits illustrated, input into a schematic tube is shown. Tube biasing was not shown, as this may depend on a number of variables. No biasing at all may be required with a high mu tube with low plate potential; while fixed bias, where bias is required, will give higher gain than cathode bias due to elimination of negative regeneration from the cathode circuit. The total amplifier gain required will depend on the operating conditions of input signal available and output signal required.

The amplified d.c. signal may be read or indicated four ways. Visual observation of an oscilloscope, a.c. output of the amplifier measured, or the a.c. output rectified into d.c., any residual (or hash) signal balanced out and the differential read on a d.c. meter. The fourth method and possibly one of the best is the use of an automatic potentiometer circuit. Here the amplified signal is used to turn a potentiometer arm and balance out the d.c. input signal. The potentiometer arm position is then read in terms of d.c. input (the voltage across the potentiometer is standardized) and any amplifier or chopper gain variation affects the accuracy of reading only to a small percentage of the total accuracy.

The *Dumont* 274 oscilloscope used by the author in these experiments was not a standard instrument. Its gain had been increased by the addition of a cascade 6J7 and it compared in gain with the *Dumont* 208B and other higher priced instruments. With full gain and some unbalance carrier appearing on the screen, the output signal level was sufficient to cause about a one- to two-inch variation in trace. The chopper efficiency was not established, but was 50% or lower; therefore the input signal did not exceed 25 millivolts.

REFERENCES

1. *Freedman, Samuel, "D. C. Amplifier of Improved Stability"*. RADIO-ELECTRONIC ENGINEERING. *April*, 1950.

New Products

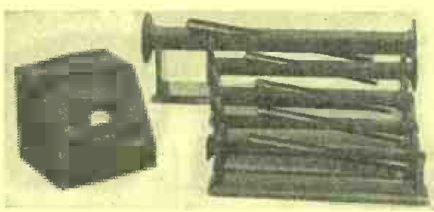
(*Continued from page* 25A)

are accelerated and form ions which are in turn accelerated in a space where crossed magnetic and r. f. electric fields are maintained. In these crossed fields, ions describe spiral paths. Those ions with the proper mass to resonate with the crossed fields will gain energy and describe larger and larger orbits until they reach the collector and are measured.

Approximately 150 volts d.c. and r.f. voltages of about 1 volt at frequencies up to 5 megacycles are employed. The filament utilizes 5 amperes at 15 watts.

NOISE GENERATORS

A series of random noise generators designed to produce a known output noise in the frequency range of 2600 to



12,400 mc. has been announced by *The Kay Electric Co.*, Maple Ave., Pine Brook, N. J.

Designated Microwave Mega-Nodes, they are a group of five separate noise sources, each utilizing a standard commercial fluorescent lamp in a JAN size wave guide, each mounted on a hardwood stand. A separate cabinet houses the power supply for the noise sources.

The following wave guide sizes are available: RG48/U, RG49/U, RG50/U, RG51/U, and RG52/U. Noise output is 15.84 db. above thermal noise at a wave guide temperature of 32° C.

Radio-Electronic Engineering·1950
Index to Volumes 14 & 15

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News Briefs

(*Continued from page* 23A)

photocells are of three types: the photoresistance cell, able to produce electric signals at least as great as 25 volts when a light shining on the cell is interrupted or modulated; the photoconductance cell, having a large current response for operating a relay directly in applications such as alarms and door openers; and the photovoltaic cell, similar to a tiny battery but having the peculiar property of supplying a voltage in proportion to the amount of light shining on the germanium.

3-Probe Method

(*Continued from page* 9A)

$$\frac{E_1}{E_3} = -j\frac{Z_R}{Z_o};\ \frac{E_2}{E_3} = \frac{1}{\sqrt{2}}\left(1 - j\frac{Z_R}{Z_o}\right) \qquad (5)$$

Substituting for Z_R/Z_o its value $(R/Z_o) + j(X/Z_o)$, these are:

$$\frac{R}{Z_o} + j\frac{X}{Z_o} = j\frac{E_1}{E_3} \qquad (6)$$

$$\frac{R}{Z_o} + j\left(\frac{X}{Z_o} + 1\right) = j\sqrt{2}\frac{E_2}{E_3} \qquad (7)$$

It is seen that these two equations, when the moduli are squared,

$$\left(\frac{R}{Z_o}\right)^2 + \left(\frac{X}{Z_o}\right)^2 = \left(\frac{E_1}{E_3}\right)^2 \qquad (8)$$

$$\left(\frac{R}{Z_o}\right)^2 + \left(\frac{X}{Z_o} - [-1]\right)^2 = \left(\sqrt{2}\frac{E_2}{E_3}\right)^2 \qquad (9)$$

define two circle families; a family of circles centered at (0, 0) with radii of E_1/E_3, and a family of circles centered at (0,-1) with radii of $\sqrt{2}(E_2/E_3)$. These are plotted in Fig. 1. The intersection of any two of these circles defines normalized impedance uniquely, and additionally, if so desired, the voltage standing-wave ratio.

For practical use, however, a chart in a form other than this is to be preferred. The present map extends to infinity in three directions. These infinite boundaries can be collapsed into a single point if the coordinates are distorted according to the bilinear transformation:

$$\frac{W}{Z_o} = \frac{1 + Z/Z_o}{1 - Z/Z_o} \qquad (10)$$

This particular complex-plane transformation can be employed to produce either the Smith Chart ("Transmission Line Calculator," *Electronics*, January 1939; "An Improved Transmission Line Calculator," *Electronics*, January 1944, both written by Phillip H. Smith) or the Carter Chart ("Charts For Transmission-Line Measurements and Computation" by P. S. Carter, *RCA Review*, January 1939).

At the outset, the circle family defined by:

$$\left(\frac{R}{Z_o}\right)^2 + \left(\frac{X}{Z_o}\right)^2 = \left(\frac{E_1}{E_3}\right)^2,$$

$$\text{or } \left|\frac{Z_R}{Z_o}\right| = \left|\frac{E_1}{E_3}\right| \qquad (11)$$

is seen to be identical with the modulus of the Carter Chart, Z_R/Z_o, and so it can be transformed into the new W/Z_o by:

$$\left(\frac{R}{Z_o} - \frac{(E_1/E_3)^2 + 1}{(E_1/E_3)^2 - 1}\right)^2 + \left(\frac{X}{Z_o}\right)^2 = \left(\frac{2\,E_1/E_3}{(E_1/E_3)^2 - 1}\right)^2 \qquad (12)$$

It is difficult to so treat the other circle family. However, since these circles can easily be drawn graphically in the original Z/Z_o, and since the coordinates are transformed conformally in the Smith Chart, a point-for-point plot enables this latter family to be carried over to the new W/Z_o plane. These circle families are shown on P. 32A.

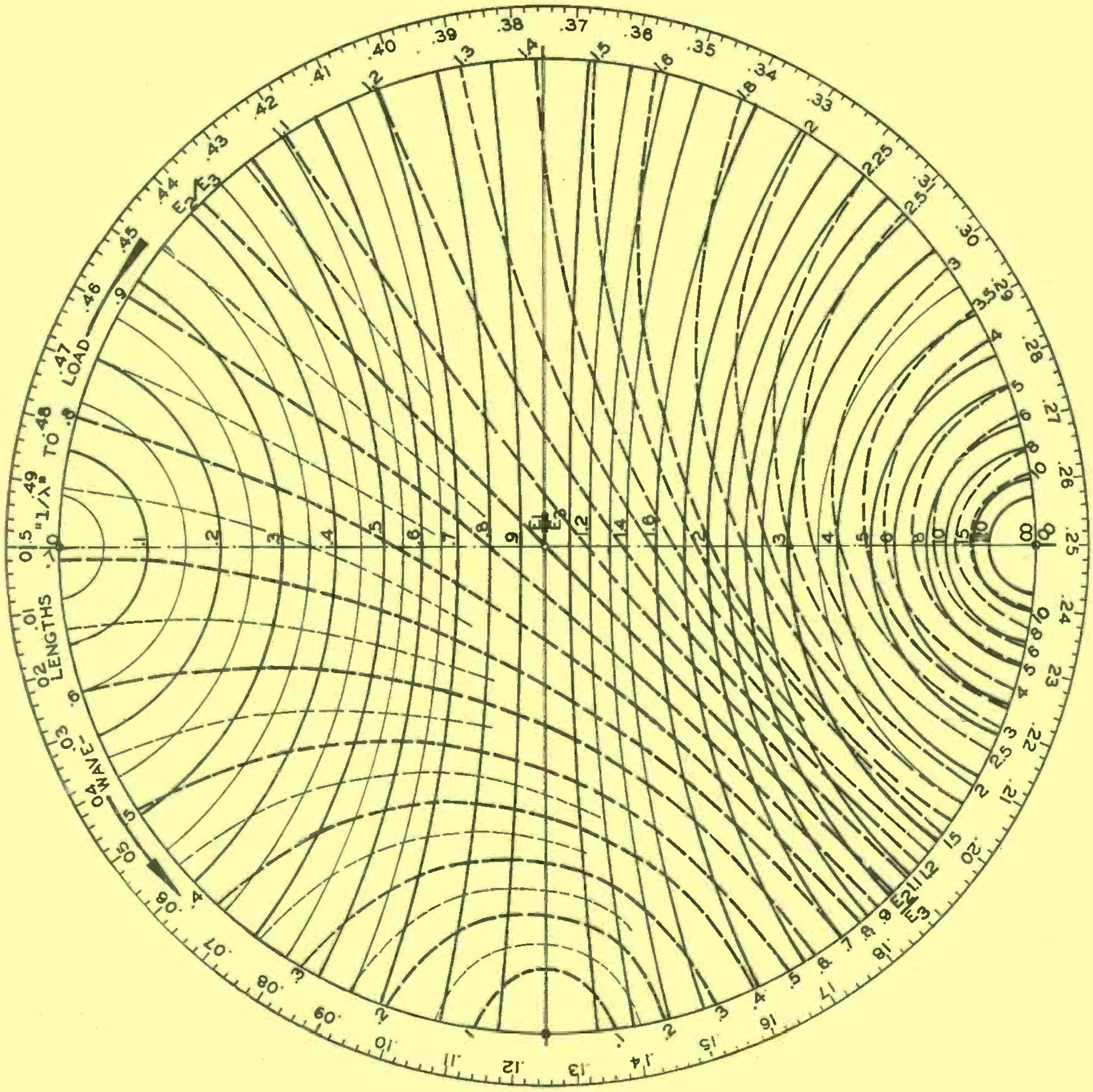
Aside from the drafting error in the construction of this map, P. 32A, an additional inaccuracy lies in the fact that, in some regions of this map, the intersecting circles are not orthogonal. Thus, in these regions, it is difficult to obtain a clear-cut "fix." As examples of this, it will be noted that the voltage ratios of .8 and .5 for E_1/E_3 and E_2/E_3, respectively, intersect nearly at right angles, and, so, a definite value of impedance can be obtained if this chart is used as an overlay for either the Smith- or the Carter-Chart, with which charts this one has a one-to-one interior correspondence. On the other hand, ratios of 1.3 and 1.6 for E_1/E_3 and E_2/E_3, respectively, intersect at such an acute angle that any chosen impedance value would be rather doubtful. This fault of interpretation is not caused by the transformation, since the transformation is conformal, but lies, rather, in the setup of the original chart, Fig. 1.

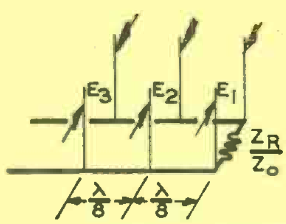
However, this new map has several advantages. In common with both the Smith- and Carter-Charts, the entire right-hand half of the infinite plane is contained within the bounding circle, which contains all impedance values within the range $(0 < R/Z_o < \infty)$, $(-\infty < X/Z_o < \infty)$. Again, in common with these charts, the circles of constant VSWR are concentric with the center of the chart. In this connection, the arm shown in the figure may be pivoted at the center, or a circle family in contrasting color may be drawn using the chart center and a radius equal to E_1/E_3 equal to 1.1, 1.2, 1.3, 1.4, ... Thus, ratios of 1.4 and .7 for E_1/E_3 and E_2/E_3, respectively, indicate a VSWR of 2.6.

3-PROBE IMPEDANCE MEASUREMENT CHART

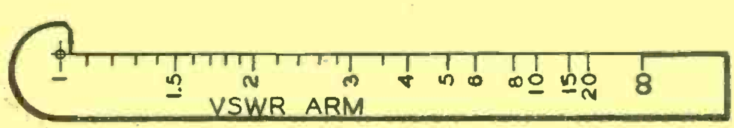
A chart for determining load impedance from voltage readings taken from three fixed probes spaced 1/8 wavelength apart.

(*See page 9A*)





LAYOUT DIAGRAM



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commands the world's airwaves!

In every price range, Hallicrafters offers precision instruments—to serve you better, and giving you more value for your investment than any other set.

Model SX-62 World's finest receiver for the all-wave listener. Outperforms any broadcast receiver on any frequency—continuous coverage from 540 kc to 109 Mc in six bands. Crystal calibration oscillator built in. Six position selectivity with crystal filter. Two stages r-f, three stages i-f amplification. 10-watt push-pull high fidelity output. Phonograph jack. 14 tubes plus regulator and rectifier..............$289.50

Model SX-71 Value-packed with features specifically asked for by the Hams. Extra sensitivity, selectivity, and stability; double super-heterodyne, plus built-in Narrow Band FM. One r-f, two conversion, and three i-f stages. Range 538 kc to 35 Mc, 46-55 Mc. Extra wide dials for Main and Bandspread Tuning. Sensitivity, Volume, BFO Pitch, Selectivity, and Crystal Phasing controls.; AVC, BFO, Rec./Standby, ANL, Tone, and Phono-Rec. switches. Phonograph input jack. 500, 3.2-ohm output......$199.50

Model S-77 New version of an old favorite. Temperature compensated oscillator; tuned r-f stage, two i-f stages for better selectivity. Covers 540 kc to 43 Mc in four bands. Sensitivity, volume, three-position Tone, BFO Pitch, controls; AVC, BFO, Rec./Standby, and Noise Limiter Switches. Built-in PM speaker. External power, remote control connections. 7 tubes plus rect.
S-77..............................$99.95

Model S-38B Pulls in broadcast stations in weak signal areas where ordinary sets fail. Also offers world-wide reception for the short-wave listener and the new amateur. Covers Broadcast Band and three short-wave bands 540 kc to 32 Mc. Separate Fine Tuning control. BFO, Rec./Standby, Speaker/Phones switches. Built-in PM speaker. Four tubes plus rectifier. For 115 V. AC or DC........................$49.50

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You can put your confidence in—

GENERAL ELECTRIC

fb1-JA9

Within the INDUSTRY

P. B. REED, a veteran of more than 20 years in the electronic equipment and servicing fields, has been named head of the *RCA Service Company's* new Government Service Division.

Mr. Reed, who was formerly a representative of the *RCA Victor Division* in Washington, D. C., has been given the title of vice-president in charge of the Government Service Division for the *RCA Service Company.* The new division will undertake an expansion program involving technical personnel and facilities to keep pace with increased requirements of the military services. Included in the expansion program are elaborate and centralized repair facilities and a technical publications section.

He has been associated with *RCA* since 1930 and has held various posts with the company.

* * *

CORNELL-DUBILIER ELECTRIC CORPORATION and its subsidiary, the **RADIART CORPORATION,** has purchased the **U. S. DEVICES CORP.** of South Plainfield, New Jersey. The new owners will continue the manufacture and merchandising of the "Tele-Rotor" line . . . **R. M. KARET ASSOCIATES, INC.** has changed its corporate name to **JKM INCORPORATED.** The new name is formed from the initials of the principals, Oden Jester, Bob Karet, and John Margolin . . . John C. Merman, operator of an engineering firm and a TV service firm in Philadelphia, and four other television service contractors in the Philadelphia area have recently formed an electronics manufacturing firm under the name of **ELECTRONIC CONTRACTORS, INC.** General offices of the new company are at 1508 Sansom Street in Philadelphia.

* * *

JEROME J. KAHN, president of the 1951 Radio Parts Distributors Show, has named a fifteen-man manufacturer-distributor advisory committee to consult with and advise the Show management and committees making preparations for the annual all-industry sponsored Show to be held in Chicago next May.

Herbert C. Clough of *Belden Mfg. Co.* was named chairman of the committee. Serving with him are: W. O. Schoning, *Lukko Sales;* W. D. Jenkins, *Radio Supply Co.;* L. W. Hatry, *Hatry & Young;* W. A. Wilson, *Hughes-Peters, Inc.;* George Barbey, *George D. Barbey Co.;* Lew Bonn, *Lew Bonn Co.;* H. L. Dalis, *H. L. Dalis Co.;* Sam Poncher, *Newark Electric Co.;* Charles Golenpaul, *Aerovox Corp.;* Milton Deutschmann, *Radio Shack Corp.;* Walter W. Jablon, *Espey Mfg. Co.;* John Stern, *Radio Electric Service Co.;* Les Thayer, *Belden Mfg. Co.;* and Robert C. Sprague, *Sprague Electric Co.*

Last year's recommendations by a similar committee resulted in a highly successful program for the Show and it is anticipated that the new committee will be called upon shortly to make similar recommendations for the 1951 session.

* * *

ROBERT PAXTON, manager of manufacturing policy for the *General Electric Company,* has been elected a vice-president of the company by the board of directors . . . **SEYMOUR D. NEWMAN** has been appointed national sales manager of *Ansley Radio and Television, Inc.* . . . **LYNN C. HOLMES,** who has been associate director of research at *Stromberg-Carlson Company* since April 1950, has been named director of research for the company, succeeding **BENJAMIN OLNEY** who retired recently . . . **MARIO A. GARDNER** has been promoted to the post of vice-president in charge of purchases for *Air King Products Company, Inc.* . . . **TYRELL G. ROGERS** has been appointed executive assistant to **LEONARD F. CRAMER,** executive vice-president and director of the *Allen B. Du Mont Laboratories, Inc.* . . . *Olin Industries, Inc.* recently named **ROBERT H. EVANS** as executive assistant to the president and the executive committee . . . The newly-created post of vice-president in charge of engineering for *Starrett Television Corp.* is being filled by **EDMOND SHERMAN,** until recently chief engineer for the firm . . . **CAPTAIN STEADMAN TELLER, USN,** has been appointed Navy Secretary of the Research and Development Board, Department of Defense, succeeding **REAR ADMIRAL ARLEIGH A. BURKE** who has been recalled to sea duty in the Far Eastern theater of operations.

* * *

CLARENCE E. LINDSTROM who has been associated with *Philco Corporation* for 18 years, has been named western sales manager of the company with headquarters in San Francisco.

He replaces Cliff S. Bettinger who recently retired after 19 years in the post. Mr. Lindstrom joined the company in 1932 and served as controller of *Philco Distributors,*

take it from EXPERTS

renew with N.U.

premium quality tubes

PAT REID SAYS:

Salesmanager, United Radio Supply, Inc.
Portland and Eugene, Oregon

"Our 379 servicemen and dealers tell us N. U. tubes are best, because their own experience has proved N. U. tubes are reliable, uniform, and above all are properly designed for interchangeability. What's more, costly call-backs are minimized by N. U.'s proven quality control. That's why we've featured N. U. tubes for 15 years. They mean good business for all of us.

- RADIO AND TELEVISION RECEIVING TUBES
- VIDEOTRON TELEVISION PICTURE TUBES
- PANEL LAMPS
- TRANSMITTING AND SPECIAL PURPOSE TUBES

NATIONAL UNION RADIO CORP.

Main Office: 350 Scotland Rd., Orange, N. J.
Research Division: Orange, N. J. • *Plants:* Newark, N. J.—Hatboro, Pa.

Inc. of Chicago for several years before becoming sales manager of this branch of the company's wholesale organization. During the war he was active in special work connected with the company's large-scale production of radar and ordnance.

* * *

J. B. SHIMER has been appointed to the newly-created post of Factories Manager of the Industrial and Electronic Division plants of *American Structural Products Company.*

The increased demand for the company's *Kimble* all-glass rectangular television bulbs has been cited as the reason for creating the new post. Mr. Shimer, who recently served as plant manager for the company's Columbus, Ohio facility now assumes supervision over the Columbus and Toledo factories as well as certain forming operations at the Chicago Heights plant. For the present he will continue to make his headquarters in Columbus, Ohio.

Mr. Shimer has been associated with *Owens-Illinois Glass Company,* the parent company, since 1946 when he joined the *Libbey Glass Division* as manager of Factory A. Prior to that he was connected with other firms in the production of electronic equipment.

* * *

THE LAPOINTE-PLASCOMOLD CORPORATION, manufacturers of "Vee-D-X" television antennas and accessories, has recently purchased a new plant in Windsor Locks, Conn. The increased size of the new factory will permit the company to double its present production . . . **THE TECHNICAL MATERIEL CORPORATION'S** new mailing address is P. O. Box 142, Mamaroneck, New York . . . **TELEFEX** has moved its office and laboratory facilities to 5746 Sunset Boulevard in Hollywood, California . . . **AMERICAN ELECTRONEERING CORP.,** Los Angeles manufacturer of test equipment, has moved to new and larger quarters at 5025 West Jefferson Boulevard in that city . . . **TELEVISION TECHNICIANS INC.** is now occupying new quarters at 516 South Cicero Avenue, Chicago 44, Illinois . . . **SONOTONE CORPORATION** is currently producing miniature electron vacuum tubes for radio and television receivers in its new Elmsford, New York plant . . . The *RCA* Victor Division of **RADIO CORPORATION OF AMERICA** is establishing a new plant in Cincinnati, Ohio for the manufacture of miniature-type electron receiving tubes. The plant is expected to be in production by the autumn of 1951 . . . A new plant for the production of plastic and plastic-metal components for the radio, television, and lighting industries is now under construction at Warren, Pa. for the Parts Division of **SYLVANIA**

(*Continued on page* 152)

Raytheon Backs its Products with a

COMPLETE FIELD SERVICE PROGRAM!

WE AIN'T TELLIN' YOU NOTHIN' when we say that the major headache of the television business today is installation and service of TV sets.

But we *are* telling you something when we say that Raytheon backs its television dealers and servicemen with a *complete field service program!*

Seven factory-paid service representatives are in the field 12 months of the year, making scheduled calls in every TV community. These service experts call regularly on distributor service departments and, in conjunction with them, schedule regular servicemen's educational meetings.

At these meetings, they explain new techniques and simplified methods of servicing . . . they franchise Raytheon service agents and supply them with the latest bulletin releases from the factory on new servicing techniques.

In addition to all this, the factory maintains a regular direct-by-mail program going to distributors for their franchised Raytheon service agents only, keeping them completely informed at all times.

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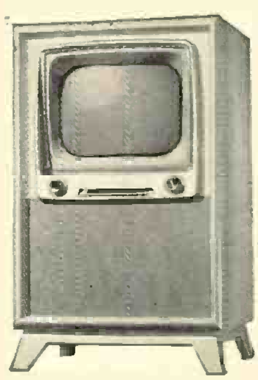

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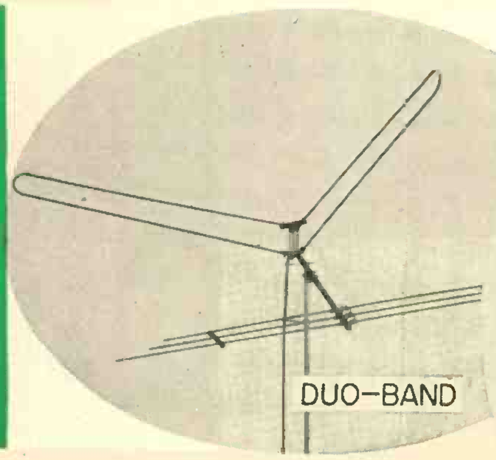
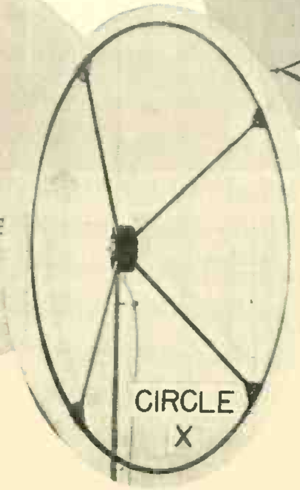
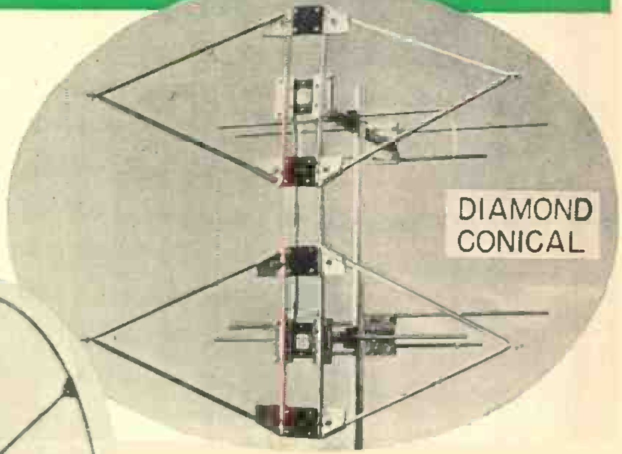






By ALAN SMOLEN

THE picture obtained on a television screen can never be better than that allowed by the signal supplied at the antenna and, as most technicians know, given a strong, noise- and ghost-free signal any set can be adjusted to provide good reception. Unfortunately, many manufacturers' claims to the contrary, there is no single type of antenna that provides the best signal for all or even a large majority of locations and channels. Every installation has its individual requirements and the antenna chosen should be the type that best meets these requirements. For this reason there are scores of antenna types now available on the market and each one can be considered the "best" for a given set of installation conditions. It is the purpose of this article to review the characteristics of the most popular antennas and indicate where and why they should be employed.

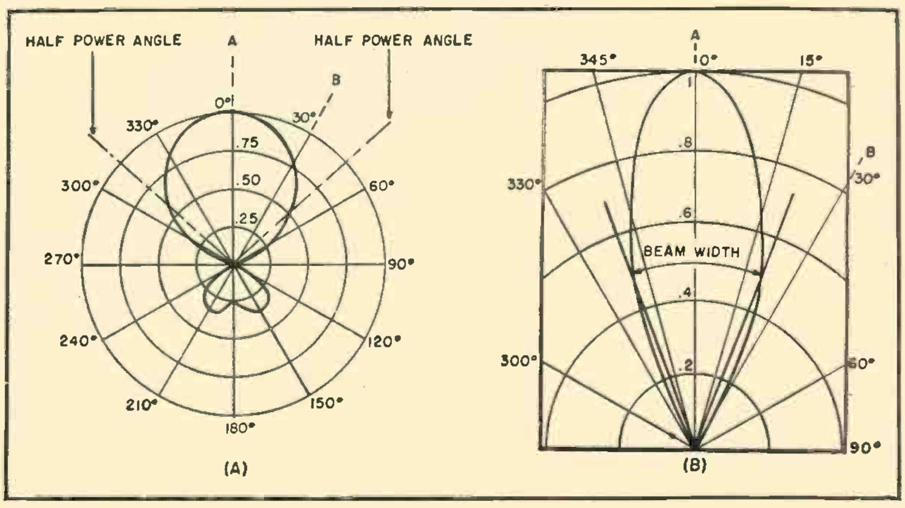
One of the most common descriptions of an antenna today is that it is "high gain." It is extremely important that the installer understand what this term "high gain" means because in some locations it may result in a very strong signal while in others it may provide a weak signal or none at all. The reason for this can be understood by briefly reviewing the significance of the radiation patterns.

Two typical radiation patterns are shown in Fig. 1. The radiation pattern indicates the relative signal strength that can be expected from a given direction. In both patterns shown in Fig. 1 maximum signal is obtained in the *A* direction or 0 degrees. At an angle of 15 degrees however the antenna of Fig. 1A picks up about 95 per-cent of the maximum signal while that of Fig. 1B picks up about 62 per-cent. At an angle of 30 degrees the percentages would be 85 for 1A and 0 for 1B. The beamwidth of these patterns is defined as the angle between half power directions as shown in Fig. 1.

In order to determine the power gain of an antenna as a function of direction the "nominal" gain given by the manufacturer (usually in db.) must be reduced by the percentage factor indicated on the radiation pattern converted to db. Table 1 is a percentage-to-db. conversion chart. Note the inclusion of voltage ratios for conversion from power to voltage and vice versa. Thus the gain of an antenna in a direction corresponding to 85 per-cent maximum signal on the radiation pattern would be equal to the nominal gain (in db.) minus approximately 0.7 db.

The smaller the beamwidth angle

Fig. 1. (A) Radiation pattern of folded dipole with reflector, and (B) pattern of a yagi.



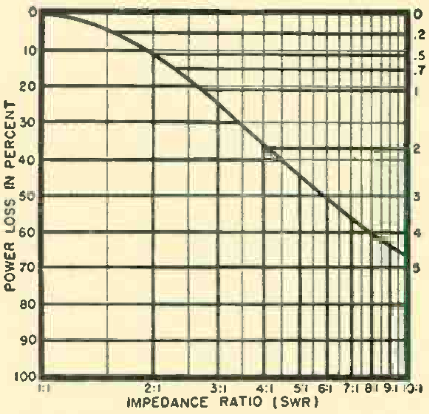


Fig. 2. Power loss which occurs due to mismatch from antenna to receiver. Note that impedance ratio is equal to the v.s.w.r.

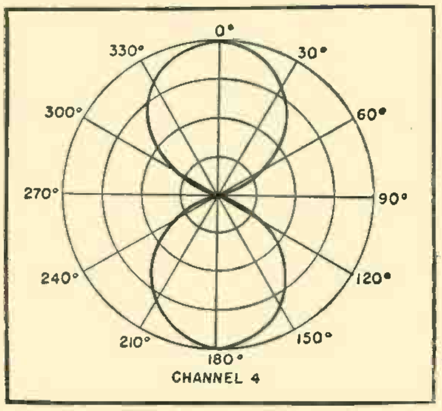


Fig. 3. Typical bidirectional radiation pattern (folded dipole without a reflector).

(sharper radiation pattern) the higher the gain of the antenna. The pattern shown in Fig. 1A (folded dipole with reflector) corresponds to a power gain of 2.5 db. (with respect to a dipole), while the gain of the antenna whose pattern is shown in Fig. 1B (yagi) is about 9 db. If the transmitter is located in direction *A* the yagi would pick up 6.5 db. more signal than the folded dipole. However, if the signal originates at point *B*, the dipole will pick up a signal equivalent to a gain of 1.8 db. (2.5 — 0.7) while the yagi will not pick up any signal at all. This illustrates a very important point, *i.e.,* that a high gain antenna is "high gain" for a given direction only and may be "low gain" for other directions.

Assume that these two antennas are available at an installation where there is only one broadcast transmitter operating from direction *A*. If the installation is in a very strong signal area with no ghosts or interfering signals, the author would be inclined to choose the dipole, provided an adequate signal can be obtained with its use. The high gain antenna, because of its directivity, has the disadvantage that it must be secured very firmly. Otherwise a strong wind will turn the antenna thereby losing the signal completely. The direction of the dipole, on the other hand, is not very critical and a simple mechanical installation is possible. Furthermore, should a transmitter be placed in direction *B* in the future it may not be necessary to erect another antenna to cover this station.

The high gain antenna would be used in weak signal areas and in areas where a ghost or interfering signal exists in the null points of the yagi pattern, such as point *B*. In this latter case it is obvious that the yagi would not pick up the ghost or interfering signal at all, while the dipole would. This principle of using the radiation pattern of an antenna to minimize ghosts and interfering signals is overlooked by many installers, though it can prove to be very effective.

In areas where there are a number of transmitting stations the same general considerations would prevail over a wider area. Other factors, such as favoring weak stations over strong signal ones, must be introduced and frequently some compromise must be made between maximum signal strength, presence of ghosts in picture, and number of stations received.

At multi-station installations it is desirable to employ one antenna to cover all channels. In such an installation it is important to investigate the effect of different frequencies on the radiation pattern, power gain, and mismatch losses—particularly when high and low band frequencies are involved. For some antennas the radiation pattern for the low frequency band is completely different than the pattern for the high frequency band and may even vary from channel to channel.

The variation of power gain and impedance mismatch with frequency are usually considered separately though some manufacturers include mismatch effects in their published data on power gain. In this latter case, however, a statement to the effect that gain is measured into a 300 ohm impedance is prominently indicated. Unless this statement appears, the power gain-versus-frequency curves given assume that the antenna is suitably matched. Gain may also be expressed in terms of voltages. Use Table 1 to convert voltage gain to power gain and vice versa.

The losses due to mismatch between antenna and receiver must be subtracted from the calculated antenna power gain to determine the over-all system gain. It is well known that for maximum power transfer the impedance of the antenna must be equal to the receiver input impedance—usually 300 ohms. When the impedances are not the same, some power is lost. Fig. 2 plots the power loss in percentage and db. for various impedance mismatch ratios (also expressed as v.s.w.r.—voltage standing wave ratio). As in the case of power gain, the antenna impedance—and hence mismatch losses—will vary with frequency and therefore must be checked. Throughout this article proper matching between lead-in and receiver will be assumed.

With these facts in mind it is possible to intelligently analyze the published characteristics of television antennas and indicate their application. In this article we are concerned with antennas readily available on the market. Antennas will be discussed in accordance with the following application categories; strong signal areas, medium signal areas, and weak signal areas. It should be noted that the line of demarcation between these classifications is not very rigid and weak signal antennas can frequently find application in medium signal areas and vice versa.

Table 1. Conversion table. Power or voltage ratios may be converted to db. and vice versa.

LOSS		DB.	GAIN	
Power Ratio	Voltage Ratio		Power Ratio	Voltage Ratio
1.000	1.000	0	1.000	1.000
.977	.988	.1	1.023	1.011
.955	.977	.2	1.047	1.023
.891	.944	.5	1.122	1.059
.794	.891	1.0	1.259	1.122
.631	.794	2.0	1.585	1.259
.501	.708	3.0	1.995	1.413
.398	.631	4.0	2.512	1.585
.316	.562	5.0	3.162	1.778
.215	.501	6.0	3.981	1.995
.199	.447	7.0	5.012	2.239
.158	.398	8.0	6.310	2.512
.126	.355	9.0	7.943	2.818
.1	.316	10.0	10.000	3.162
.01	.100	20.0	100.0	10.0
.001	.0316	30.0	1000.0	31.62

Strong Signal Areas

Strong signal areas are defined as those areas where the power gain of the antenna is not a very important factor and where serious ghosts or interference are not encountered. In these cases the most inexpensive antenna which also results in a relatively simple, non-critical installation should be employed. Antennas which fall into this category are; (A) dipole, (B) dipole with reflector, (C) folded dipole, (D) folded dipole with reflector, and (E) high and low band folded dipole and reflector. A typical radiation pattern is shown in Fig. 3.

(A) Dipole. The simplest and most inexpensive antenna is a dipole cut to a particular frequency. The imped-

ance of a dipole is 72 ohms and, as such, matches the few 72 ohm receivers manufactured. The response curve (gain-versus-frequency) of this antenna is quite sharp providing maximum gain at the specified frequency, and falling rapidly at different frequencies.

When this antenna is used to feed a 300 ohm receiver, the gain of the antenna is offset by the 4:1 mismatch. Fortunately, the impedance of the antenna increases off resonance so that the loss in gain is balanced by a decrease in mismatch loss. The result is an over-all system gain that does not vary radically over either the low or high frequency band. Hence the dipole is a narrow-band antenna when used to feed a 72 ohm receiver and broadband antenna for 300 ohm receivers. It should be noted that this applies over the high or low band but not over both bands simultaneously with one antenna.

The radiation pattern of this antenna is very broad. The antenna is bi-directional and will receive signals equally well from 0 and 180 degrees. This will be advantageous if there are stations in both directions and undesirable if a ghost originates from one of these points.

(B) Dipole and reflector. The back lobe of the dipole radiation pattern can be reduced through the use of a reflector. The reflector will also reduce the impedance of the dipole. This results in an increased mismatch so that even though the reflector increases the antenna gain, the over-all system gain may not be increased.

(C) Folded dipole. The folded dipole is, in effect, two dipoles in parallel, thereby increasing the effective cross-section of the antenna. The impedance of this antenna is approximately 300 ohms and it provides a good match for 300 ohm receivers. The gain of this antenna is slightly greater than that of the dipole because of the improved matching obtained. The impedance of this antenna does not vary to an appreciable degree over either the high or low band. Its radiation pattern is virtually the same as that of the dipole.

(D) Folded dipole with reflector. A reflector can be added to the folded dipole to obtain greater power gain and reduce the back lobe to 50 percent of its value without a reflector. This antenna is sometimes used in medium signal areas because it does provide a power gain of approximately 3 db.

(E) High and low band folded dipole (and reflector when necessary). Both the dipole and folded dipole can be used over either the high or low bands but not over both with one antenna. When it is necessary to cover both bands two individual antennas connected together must be used. The most important factor in these antennas is the necessity for isolating the low band unit from the high band antenna. The feed system between the two antennas is also very important and it should not be changed from the manufacturers' specifications.

Antenna Type	Av. Power Gain (in db.)	Front-to-Back Ratio (approx.)	Av. V.S.W.R.	Beam Width (in deg.)	Impedance	Broadband	Remarks
A. STRONG SIGNAL AREAS							
Dipole	0	1:1		90	72	No	
Dipole	—1	1:1	3	90	300	No	Broadband only when mismatched to 300 ohm line
Folded Dipole	—0.5	1:1	2.5	90	300	Lo or Hi band	
Folded Dipole (with reflector)	2.5	2:1	3.5	90	300	Lo or Hi band	
Folded Dipoles (with reflectors low and high band)	Lo 3 Hi 4	4:1	3.5	Lo 90 Hi 80	300	Yes	High band directivity affected by orientation of low band antenna
B. MEDIUM SIGNAL AREAS							
2-Bay Low Band Folded Dipoles (with reflectors)	6	2:1	2	80	300	Lo band	
2-Bay High Band Folded Dipoles (with reflectors)	6	3.5:1	1.5	80	300	Hi band	
2-Bay Low and High Band Folded Dipoles (with reflectors)	Lo 6 Hi 9.5	Lo 2:1 Hi 3.5:1	2	Lo 80 Hi 100	300	Yes	
Winged Dipole	Lo 4 Hi 5	5:1		Lo 60 Hi 40	300	Yes	Wings available for conversion of standard dipole
Reversible Beam	4	15:1		70	300	Yes	Beam may be reversed by switch
Duo-Band	3	5:1		Lo 80 Hi 40	72 or 300	Yes	
In-Line	Lo 2 Hi 4	6:1		Lo 90 Hi 70	300	Yes	
2-Bay In-Line	Lo 3 Hi 6	6:1		Lo 80 Hi 40	300	Yes	
Conical (with conical reflector)	Lo 1.5 Hi 5.5	4:1	1.5	Lo 90 Hi 50	300	Yes	
2-Bay Conical (with reflector)	7.5	4:1		Lo 50 Hi 35	300	Yes	
2-Bay Diamond Conical	3	5:1	1.5	Lo 80 Hi 40	300	Yes	Good mechanical construction. Beamwidth 65° on Channel 13
Circle-X	3	Lo 1:1 Hi 2:1		Lo 120 Hi 80	Approx. 150	Yes	78" in diam.
C. WEAK SIGNAL AREAS							
4-Bay Conical	10			Lo 45 Hi 30	150	Yes	Excellent when all stations are in one direction
Twin-Driven Yagi	9	20:1		30	300	No	One channel or two adjacent channels only
Square Corner Reflector	9	100:1		25	300	No	Cut for single high-band channels only

Table 2. Characteristics of some of the most popular types of television antennas.

By the addition of reflectors on both folded dipoles an antenna with greater gain is obtained which may be used in medium signal areas. Most antennas of this type permit individual siting of the two antennas. However, the orientation of the two antennas is not completely independent. The low frequency antenna pattern is not seriously affected by the orientation of the high band dipole, but the high frequency pattern may be shifted by as much as 90 degrees because of the position of the low band unit.

One way to reduce this possible shift in the high frequency lobe is to employ two transmission lines, one for each antenna. By using a double-pole, double-throw switch mounted on the receiver, the appropriate antenna can be selected for the channel desired. A better method of avoiding this shift is to use two masts, separated by several feet, to minimize interaction.

Medium Signal Areas

In this category fall antennas which have power gains of better than 3 db. but whose radiation patterns are not so sharp as to exclude large areas. These antennas are generally of the "all channel" type and are employed where many channels are to be received over a relatively wide angle

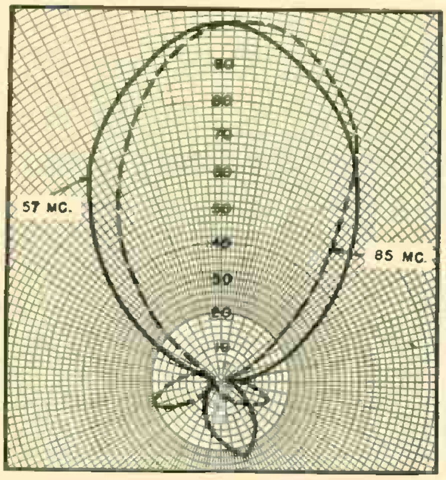


Fig. 4. Power gain patterns, at Channels 2 and 6, of a two-bay diamond array.

(45 degrees). The antennas to be described are; (A) winged dipole, (B) reversible beam antenna, (C) duo-band antenna, (D) in-line antenna, (E) conical antenna, (F) diamond conical antenna, and (G) Circle-X antenna. A typical radiation pattern is shown in Fig. 4.

(A) Winged Dipole. The winged dipole acts as a conventional dipole and reflector at low band frequencies. Over the high band, a single lobe is obtained by the use of wings attached to the driven element. These wings act as a wave trap and make the driven element a half wave dipole on the high band. A high frequency reflector is added in order to increase the gain and obtain a unidirectional pattern.

(B) Reversible Beam Antenna. There are installations where it is desirable to receive stations that are located in opposite directions, *i.e.,* 0 and 180 degrees. If the antenna is allowed to pick up signal from both directions simultaneously there may be co-channel interference. Thus, an antenna is required which is unidirectional but whose direction can be switched in opposite directions. In this way it will be possible to pick up stations in both directions without co-channel interference.

The reversible beam antenna shown in Fig. 5 acts in this manner. The two antennas in the horizontal plane are connected together by a transmission line one-half wavelength long. This transmission line is joined at the center by the receiver lead-in. The two dipoles in the vertical plane are similarly connected together with a second receiver lead-in. The two lead-ins must be of the same length and are connected to a diplexer in the receiver. The diplexer connects the transmission lines together so that the voltages from the two antennas add for maximum gain.

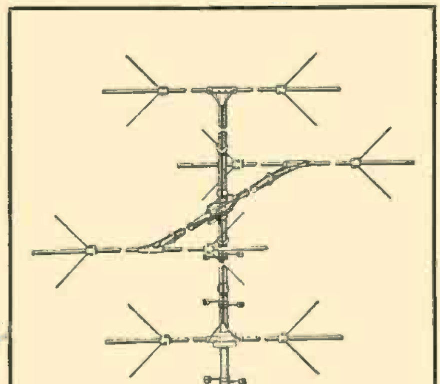
This antenna is highly unidirectional with front-to-back signal ratios ranging from 5:1 to 20:1 with a gain of approximately 4 db. over the entire band. The direction of reception can be varied by 180 degrees by making the horizontal lead-in one-quarter wave longer than the dipole lead-in. This quarter wave line is inserted in or out of the horizontal line by a switch. In this way it is possible to get good reception from either of two directions by flipping a switch. This antenna has proved very useful in locations between Philadelphia and New York and between Philadelphia and Baltimore-Washington.

(C) Duo-band Antenna. The duo-band antenna is another all-channel unit that utilizes two principles to achieve directivity and broadband characteristics. The first is the use of a folded dipole which is a broadband antenna. However, the low frequency folded dipole will have a multi-lobe pattern at the high frequencies, which is not desirable because lobes are off center. To focus the multi-lobe pattern, the folded dipole is tilted forward. This also results in a single forward lobe for the high frequency stations. To obtain directivity and a good front-to-back ratio, a series of three reflectors is used. This is necessary because a single reflector is effective only over a narrow band of frequencies. Use of three reflectors extends the effectiveness over a wider range.

(D) In-Line Antenna. This antenna consists of a high and low band folded dipole in line with a single low frequency reflector. On the low band the antenna makes use of the conventional folded dipole and reflector. On the high band, the low frequency folded dipole acts as a reflector for the high frequency dipole over the high band. Thus a unidirectional pattern is obtained over the entire TV band.

(E) Conical Antenna. The X elements of a conical antenna represent the corner lines of an actual cone. The true conical antenna has a very broadband characteristic impedance but it is not practical because it would be very heavy, have high wind resistance and, as such, involves an expensive installation. By proper choice of angle between elements and forward angle, a good approximation of the true conical can be obtained.

Fig. 5. A typical reversible beam antenna.



A single conical antenna without reflector has a front-to-back ratio of approximately 2:1. If a conical reflector is used, the gain and front-to-back ratio is increased. These effects will be more pronounced at the higher frequencies. This type of antenna would lend itself to applications where more gain or sharper pattern is required at the high band. Stacking of a conical antenna will further increase the gain over the entire band. This also sharpens the pattern. This antenna is not suitable where all stations are not in one general direction unless an antenna rotator is used.

(F) Diamond Conical. Another form of conical antenna is known as the diamond antenna. The mechanical structure of this antenna is somewhat superior to other types because its weight is concentrated at the center where it is supported. There are no free ends that will vibrate and possibly fracture.

It is interesting to note that the radiation pattern of this antenna broadens at the high end of the band. This pattern might prove helpful in an area like New York where all stations originate from a relatively small angle except for the highest channels.

(G) Circle-X. This antenna is a recent addition to the variety now available commercially. The antenna may be visualized as a conical antenna with its ends joined and tilted forward. It is made of 1½ inch tubing which aids in attaining broadband characteristics. The *Circle-X* has a gain of approximately 3 db. over the entire band.

Weak or Fringe Areas

It is always possible to increase the gain of any of the antennas described by stacking them. However, stacked arrays are very cumbersome and can introduce undesirable effects unless proper spacing is obtained. In weak signal or fringe areas it is desirable to use high gain antennas with relatively simple structures. These antennas are characterized by the fact that they are generally effective for one channel only, and an individual antenna may be required for each channel. These antennas are very often used as an adjunct to an all-channel antenna to pick up the one channel that the all-channel unit is incapable of receiving properly. Two antennas will be discussed in this category; the (A) yagi antenna; and (B) the square corner reflector.

(A) Yagi Antenna. Two types of yagis are available. One, a single driven element, consists of a folded dipole with one reflector and two directors. The second type, twin driven, consists of a folded dipole with director and a folded dipole with reflector. The units are connected so that the two voltages combine to give higher

(*Continued on page* 169)

Clever Idea PROMOTES DEALERS' SALES

How one progressive Memphis distributor uses his ultra-modern facilities to promote retail sales.

WHEN *Shobe, Inc.* of Memphis, Tenn. recently opened the doors of its new and ultra-modern headquarters a new page was written in the story of distributor-dealer relations.

While many distributors might feel that since their contact with the buying public is very slight it isn't necessary to provide elaborate showrooms, *Shobe's* expresses a different philosophy.

The interior of this new super-appliance mart features a series of ultra-modern movable partitions which can be easily shifted to provide 52 different arrangements for attractive displays.

One of the outstanding features of this new showroom is the fact that it is used, in effect, as dealers' showrooms. *Shobe's* has put into effect a system whereby each week an outstanding dealer is selected as the "dealer of the week."

This dealer is then invited to furnish his own sales personnel to work the *Shobe* displays and make sales there to all visitors to the wholesaler. The chosen dealer is also featured in the *Shobe* advertising that week, including mentions on the local *Philco* TV show.

This cooperation between the distributor and the dealers has proven to be extremely popular since it gives the dealers an opportunity to show a complete line of merchandise under very favorable selling conditions. Furthermore, it is an ideal arrangement for both dealer and distributor in terms of sales training, because it gives the *Shobe* salesmen a chance to help the dealer to develop the best possible selling techniques. —30—

Part of the display area at Shobe's. Note how movable partitions and drapes are used to divide room into selling areas.

A well-stocked parts department is one reason why this distributor has increased his sales 1700% in the past 5 years.

PLANNING INTEGRATED SIGNAL COMMUNICATIONS

By BRIG. GEN.
WESLEY T. GUEST, USA
Chief, Signal Plans & Operations Div.
Office of the Chief Signal Officer

Born in Silver Creek, N. Y. in 1900. Entered Regular Army in 1921. Received MS in communications engineering from Yale in 1929. Commander of Aircraft Radio Repair section (San Antonio) in 1937. Became chief of Communication Liaison Div. in Office of Chief Signal Officer in 1939 and in 1942 was named assistant director of the Plans and Operations Div. He went overseas in 1942 as director of Communications Div., of Communications Zone Hq. in European Theater. Returned to U. S. in 1944 to become chief of Plans and Operations Div. Named director of that division in the Southwest Pacific Theater in 1945. He became chief of the Army Communications Service Division in the office of Chief Signal Officer in 1947.

A Signal Corps achievement—planning and operating an earth-girdling electronic communications network geared to the speed and mobility of modern warfare.

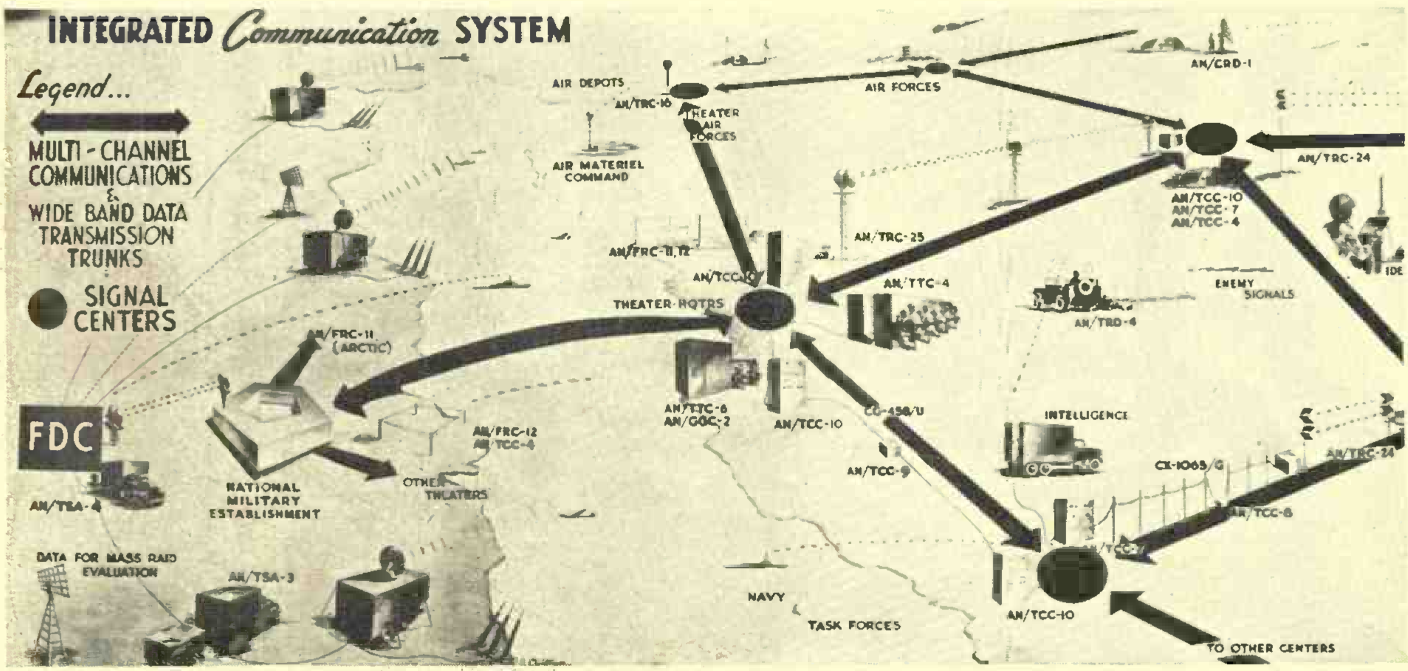
COMMUNICATIONS, the means of coordinating the fighting team, are, in fact, an indispensable element in *creating* a team from separate and often widely dispersed forces. No amount of force can be effective in repelling an enemy unless there are brains and nerves to direct it. Communications are the nerves of fighting power.

Communications do not just grow; they are planned. In the Army, the planning is the responsibility of the Signal Corps. That planning is largely guided by a concept which we call "integrated communications." The planning, engineering, and operation involve the development of equipment that will fill the tactical requirements of the integrated communications system.

It is well to remember that as technical developments have made warfare more complex, communications have grown more complex to keep pace. When the Signal Corps was created during the Civil War as the only branch of its kind in a modern army, wig-wag flags were quite new and modern and the magnetic telegraph was just appearing. Today, military communications are geared to the speed of light by earth-girdling electronic systems.

That is the extent to which communications can be integrated. Integration is required by the speed and mobility of modern war. Delay can be fatal. The relaying of information takes time and causes delay, unless it is accomplished swiftly through the integrated system.

This thinking, it may be noted in passing, closely parallels that of the major civil communications systems. In private affairs it is necessary for efficient service. In military affairs it is a vital necessity for survival.



In each of the last two wars, the Signal Corps was confronted with an emergency situation in the development, procurement, distribution, installation, operation, and maintenance of a military communication system. In the First World War, the situation was relatively simple. There was only one theater of operations and that in a friendly country where communications had been established by both the British and French Forces after several years of military operations. The American Forces engaged in the First World War were relatively small compared with those of the Allies and, consequently, the organizational structure was relatively simple. In that war, Air Force communications were negligible, radar was not employed, communications for amphibious and airborne landings were not required, and major reliance was on wire and cable.

The problem during the Second World War was far more serious than it was in the first. Not one theater of operations had to be served, but many. The increased geographical coverage and the accelerated speed at which operations unfolded created difficulties never before experienced by any signal organization, either commercial or military. The need for a *system* concept—for integration—became immediately apparent.

Let us consider the organizational aspects of the Signal Corps System Concept. We feel that the best type of organization for a communications system is one that is established on a *commodity basis*. By that we mean one organization that is responsible for all aspects of the "commodity of communications," including research and development, training, procurement and distribution of signal supplies, and plans and operations—all under the control and direction of one man, the Chief Signal Officer. This is true of the Signal Corps today, and administration of the Army's farflung communications activities is centered in the Office of the Chief Signal Officer.

The reason the Chief Signal Officer must have his finger on all activities of the Corps is that those activities are closely interrelated. For instance, training must be geared to delivery of equipment, both the newly developed equipment and the old. Likewise, research and development are closely related to procurement.

Signal Corps personnel install, operate, and maintain communications from the Department of the Army to the Theater of Operations; and from the Theater Headquarters down to the regiments. Regiments and lower units to which no organic Signal Corps personnel are assigned, are responsible for their own communications, for tactical reasons that will be explored presently. However, the Signal Corps is responsible for providing signal equipment and supplies for use between and within all tactical and service echelons. Thus, it may be said that the Signal Corps exercises supervision over signal communications literally from the Pentagon to the foxhole.

This over-all system may be considered to be composed of three networks: the *global network*, the *theater network*, and the *tactical network*.

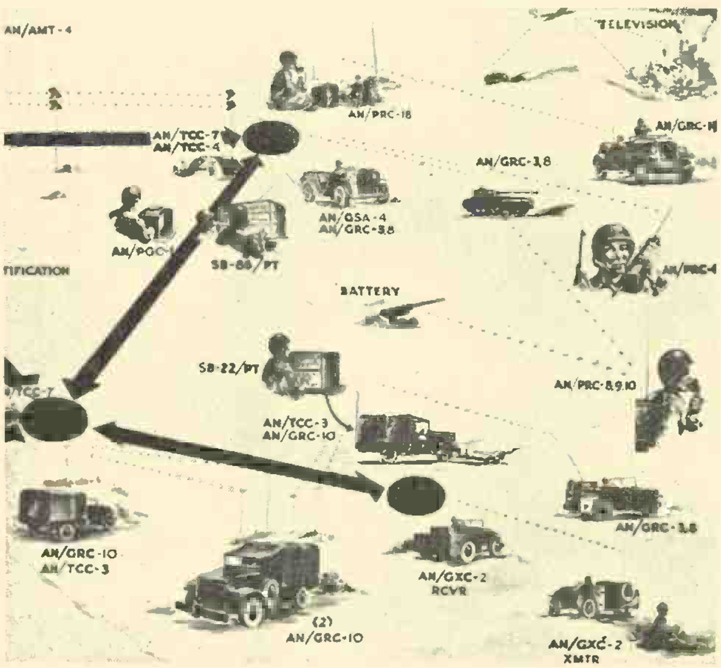
The *global network* is used for establishing communications circuits:

1. Between the Pentagon and the Theaters of Operations, occupation zones, bases, etc.;

2. Within the Theater where wire or radio relay circuits are not feasible, as in the case of a large ocean area;

3. Within the Theaters as the first established circuits, until supplemented by wire (*Continued on page* 113)

The Signal Corps is responsible for maintaining many different types of communications both in war and peace. In the top photograph Corpsmen are shown at their job of keeping transmission lines and antenna towers in good condition. The antenna is a beam, 250 feet high and supports five two-element v.h.f. antennas. By means of these antennas, this station transmits signals from all over the world to the Signal Center in the Pentagon. In the bottom photograph another aspect of Signal Corps communications is shown as Corpsmen adjust military telephone wires.



The over-all concept of the integrated communication system.

ENGINEERING THE INTEGRATED COMMUNICATIONS SYSTEM

By Col. EDWIN R. PETZING
Chief, Engineering & Technical Div.
Office of the Chief Signal Officer

Born in Illinois in 1896. Attended University of Illinois 1914-17. Entered Officers' training in 1917. Went overseas in 1918 and from 1919 to the outbreak of second World War attended various Army training schools and held diversified commands. Served as Signal Officer for 9th Army Corps in Panama at beginning of World War II and subsequently saw service in the Caribbean Defense Command and in the China-Burma-India theater. He served as signal officer for the 6th Army in 1946-47. He became Chief of the Engineering and Technical Division in the Office of Chief Signal Officer in September 1947, a post he still holds.

Top-flight engineers, military and civilian, work as a team to produce the world's finest communications equipment for our Armed Forces.

THE integrated communications system planning discussed on page 36 of this issue resulted, shortly after World War II, in concrete requirements for the individual items of equipment necessary to form the global, theater, and combat communications networks.

To bring the integrated concept into being, the Signal Corps established at its Signal Corps Engineering Laboratories in Fort Monmouth, New Jersey, a major program of research and development designed to furnish the fighting forces with the best and most efficient military communications equipment in the world, integrated into a system providing the maximum speed and flexibility needed for future warfare. System-wise, the development plans have taken into consideration the increasing complexity of warfare; the increasing need for inter-arm and inter-service communications; and the wider bands needed for larger numbers of communications channels or for newer forms of communications.

Equipment-wise, the plans have emphasized the requirement that all communications equipment for our modern army be light, rugged, and operable in hot, cold, dry, or rainy weather. Logistics-wise, due consideration has been given to engineering for mass production, maximum use of common components and subassemblies, and application of the "building block" principle.

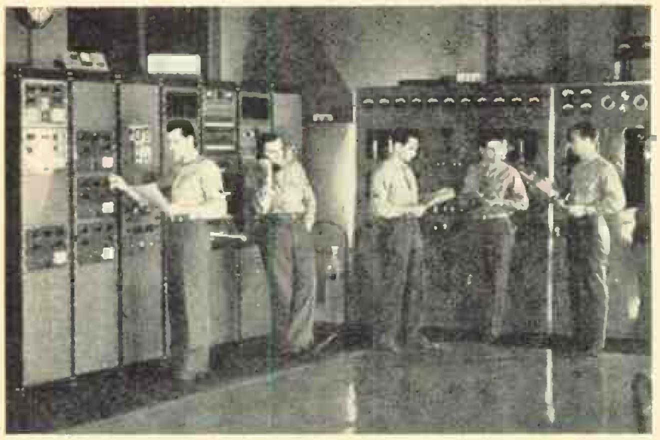
Successful accomplishment of a plan as ambitious as that outlined above would require many times the facilities and manpower available to the Signal Corps in its own laboratories. But, by means of contracts with industry and educational institutions, the best communications brains and the best facilities in the country have been obtained to aid the Signal Corps in translating the many equipment requirements into the tangible hardware needed to form the system.

Military development in peacetime must, of necessity, be geared to limited budgets and limited manpower and, consequently, is spread out over a considerable time period. However, emphasis on communications developments has resulted in many equipments of the integrated system being completed and placed in production. Most of the remainder are advanced to a point where production will be started this fiscal year.

The chart shown on page 36 illustrates the general concept of the integrated communications system and depicts the general use of the various types of equipment in the system. The following discussion of the individual equipments will cover the main developments in radio and wire illustrated on the chart.

One of the main communications requirements of lower

Army Communications Center in Pentagon, shows patchboard and coordinating and receiving consoles. Teletype loop jacks are provided at patchboard to connect spare receiving equipment to incoming circuits in case of trouble. Board is also used with associated printer equipment (left) in order to communicate directly with distant station to correct discrepancies in messages. Console in foreground is used as a coordinating point between traffic terminating section and radio control section (not shown). Console's operator decides whether a circuit is operable or requires action by some other section to correct troubles. Receiving consoles in background are where messages are received in tape form and, if necessary, are transferred to relaying equipment for further transmission.



Main control board in the transmitter room of the Army Communications Center. In the foreground at left are shown the 72" racks which are equipped with Press Wireless radio teletype shifters. These units are used as exciters to each transmitter and the output is fed through a coaxial antenna system to the oscillator of the transmitter. Center foreground is the main control panel which is the nerve center between the transmitting station and message center. The 15 kw. transmitter used for transmissions on overseas circuits is in right front.

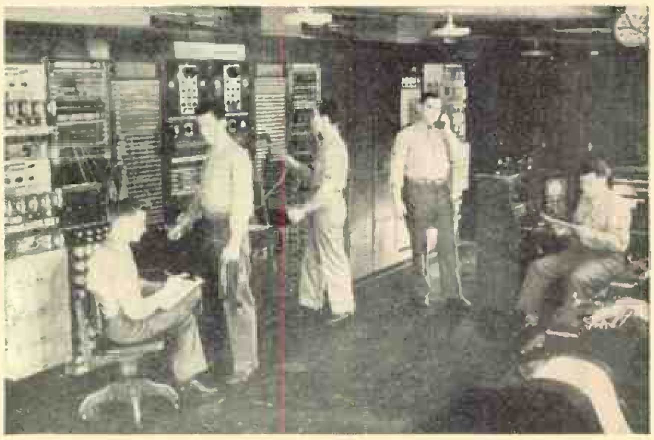
echelon combat commanders has long been a series of hand-held, back-pack, and vehicular radios designed to give efficient command communications and at the same time provide channels for use between Infantry, Armor, and Artillery. World War II equipment was not adequate for the job; handie-talkie sets were amplitude modulated; walkie-talkies were FM, and vehicular sets using FM were provided only for Armor and Artillery.

The postwar sets, on which development has now been completed and production started, provide many advantages. For example, the handie-talkie, a 1- to 3-mile set, is now FM and can communicate with other appropriate sets in the group. While it is about the same size as its AM predecessor, it represents significant progress in miniaturization in that a 14-tube FM circuit has been packaged in the same space formerly required for a 5-tube AM set. The walkie-talkie, a 3- to 5-mile set, has been designed in three frequency bands to match the bands of the vehicular sets of the Armor, Artillery, and Infantry with overlaps to allow communication between them. While power output has been slightly increased, size and weight have been reduced by one-half. Particularly important to the man in the front line is the 50 per-cent reduction in thickness which makes the set much less conspicuous when carried on the back. The vehicular sets, composed of three basic assemblies to cover separate frequency bands with overlaps, provide 10- to 20-mile FM voice communications for the Infantry, Armor, and Artillery. In addition to the basic transceiver, a separate short range transceiver is provided which will communicate with the handie-talkie, one of the walkie-talkies, one of the basic transceivers and all of the other short range transceivers in this vehicular group. To obtain added range and flexibility, provisions are included for retransmission from the basic transceiver to the short range transceiver and *vice versa*. In addition, where 20- to 40-mile FM voice ranges are needed, a back-to-back type relay set is provided. It is interesting to note that the use of crystal saver sets in the vehicular series has resulted in a requirement of 11 to 21 crystals per set *versus* a comparable requirement of 80 to 120 in the World War II series.

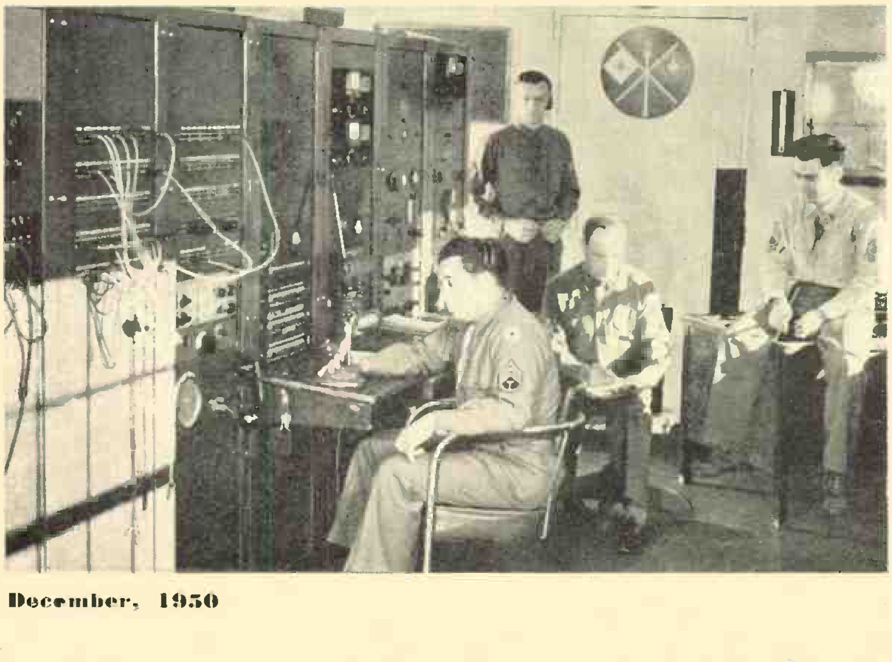
Radio Relay

Experience with the limited number of equipments available toward the end of the past war indicated that radio relay was a most promising means of communications as a substitute for and augmentation of wire systems, and that it was ideal for radio-wire integration. In general, World War II equipment was not used below division headquarters level and when used in rear areas did not provide an adequate number of channels per set. Consequently, the development program has been directed toward providing three types of relay systems: forward area, intermediate area, and rear area.

With three relays, ranges up to 50 miles are possible on the forward area relay system. The transmission accommodates a relatively broadband signal and, with carrier equipment discussed later in this article, will give four voice channels, each of which can, in turn, provide up to eight teleprinter channels. Since use down to regimental level is contemplated, (*Continued on page* 143)



Since the transmitter and receiver sites are widely separated, a centralized control point is used. All radio circuits are coordinated and associated and the transmitted and received signals carried through the radio control switchboard to the terminating equipment used in sending and receiving the message traffic. The radio control operators carry out their coordinating work with distant stations both overseas and domestic by voice or teletype printers.



Radio control panels where all signals can be checked, switched, and measured. The panel on the left is for radio frequency patching, sometimes called switching. The next two panels are "audio" patching panels and the emergency two-way PM communications position to the Communications Center. The trick chief's duties are monitoring and keeping all circuits and two-way communications normal before reception at the center.

A TV Contrast Generator And GAMMA CHECKER

Over-all view of test instrument. It can also be used to check linearity and the slope of the amplitude response of the video amplifiers.

By
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Hazeltine Electronics Corp.
Little Neck, N. Y.

A new TV test instrument. It produces a series of uniformly graded steps in contrast range for determining gamma of a TV system.

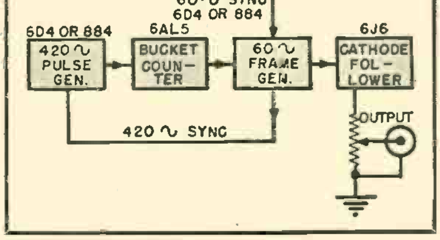
IN TELEVISION systems, like photographic systems, the range of intensity between the light and dark portions of the picture plays an important part in its realistic viewing. The extent of this range from highlights to shadows is called the "contrast." Middle tones or shades in this range give the viewer a significant amount of information and make the difference between a photograph and a line drawing or a silhouette. Nuances of light and shadow often can contribute resolution to a picture by suggestion. In coarse detail areas of a picture, a contrast range of as much as 50:1 can be obtained in a television picture, while in fine-detail portions this contrast range is often not greater than 2:1. Evidence of the latter condition is apparent when looking at a standard television resolution chart on a receiver having inadequate bandwidth. The resolution of the wedges tapers off into a uniform gray as the resolving limits of the system are reached.

If a television system or a receiver is incorrectly adjusted so that the picture shows blanching in the light grays and deepening of the dark grays, the resulting picture is said to be too "contrasty." On the other hand, if a picture looks washed out, such as would be caused by a high general level of brightness with a small amount of contrast, the picture is said to be "flat." The correspondence of original tones to their reproduction contrast range is called "gamma." A picture which has the highlights relatively brighter and the dim regions relatively darker than the original is said to have a gamma greater than 1 and has more contrast than the original scene. This is typical in the motion picture industry where the tendency is to accentuate the highlights and depress the shadows. This is why some motion pictures reproduce so poorly when sent over a television system. Pictures having a gamma less than 1 generally result with the use of present cameras and amplifiers in television systems. Since a television system should be designed to have a gamma of unity, it is generally necessary to put a gamma corrector somewhere in the television system.

Even if a television system had a unity gamma up to the picture tube, it would still be necessary to install a gamma corrector. This is because of the non-linearity of the picture tube, which requires more voltage for changes in brightness at low levels than for the same changes at high levels. Also, many pictures may be improved by compressing the ratios in the white and expanding them in the dark regions.

The generator about to be described provides a means for observing the gamma of a television system by furnishing a series of uniformly graded steps in contrast range. The number of these steps may be varied. This electrically generated staircase is highly accurate, with uniform steps, so that the equipment may be used to check linearity and the slope of the amplitude response of video amplifiers. By the use of a simple suitable modulator and carrier source, the generator may be employed to measure the over-all r.f., i.f., and video responses of a TV system.

Fig. 1. Block diagram of test instrument.



Description of Circuit

A block diagram of the instrument is shown in Fig. 1. Essentially what is done is to make pulses, have these pulses charge a condenser, and then transfer this charge to another condenser. The voltage on the second condenser is periodically discharged while the pulses continue to charge the small condenser which, in turn, recharges the larger unit. Referring to the schematic in Fig. 2, the 884 or 6D4 tube, V_1, is the pulse generator, which is adjusted to run at approximately 420 cycles. The bias and plate voltages of V_1 and the values of R_3, R_4 and C_2 determine the frequency. At the plate of V_1, a 420-cycle saw-tooth exists, but is not used. Instead, the pulses at the cathode caused by the breakdown of the gas tube charge condenser C_3. This charge is transferred by means of the 6AL5 bucket counter circuit to C_4. The bucket circuit consists of a double-diode tube, one diode of which allows a positive pulse to pass and then cuts off as soon as the charging pulse falls. In order not to keep C_1 charged indefinitely, the other diode of the 6AL5 is connected to reset or restore the voltage level initially appearing across C_1. Unless some means were used to prevent C_4 from charging up to the amplitude of the original pulse, (at which time the sequence of events outlined previously would stop), a gas tube V_3 is connected across C_4 to discharge it periodically. This discharge of C_4 is conveniently arranged to be at the field rate, which in television systems is 60 cycles.

At the same time, a small pulse derived from the cathode of V_3 is fed by C_5 back to the grid circuit of V_1 so that the 420-cycle staircase rate may be maintained. The output across C_4 is then fed through C_6 to V_4, a cathode follower and isolating tube which allows the staircase voltage to be used without disturbing the generator making the staircase. Should an opposite-polarity staircase wave be desired, 2000 to 3000 ohms may be inserted in the plate circuit of the cathode follower and the output taken from the joined plates. This resistor would be inserted between the bypass condenser C_7 and the plates of the tubes. In addition to the positive power supply, there is a negative regulated supply derived from a separate rectifier and regulator tube.

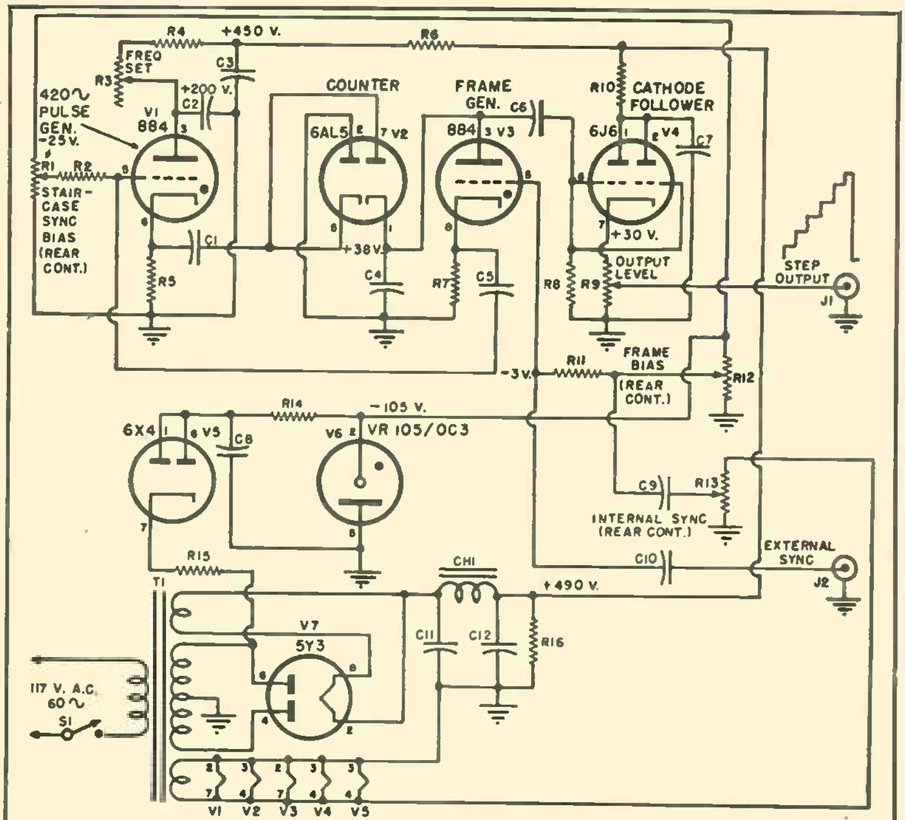
The staircase output delivered at J_1 is shown in Fig. 3.

The voltage obtained at the output of the filter circuit is practically the open circuit voltage, due to the low current drain of this unit.

It was not necessary to use a transformer of 70 ma. rating, but this was the smallest stock size with the required high voltage winding.

Adjustments

The use of an oscilloscope is especially helpful in setting up the generator initially. (If none is available, a television set may be used as a final check.) With a scope, the following is the sequence of adjustments. The vertical plates of the scope are connected to the cathode of V_1. The scope horizontal sweep is synchronized to 60 cycles, and the bias on the grid of V_1 and the frequency control in the plate of V_1 are adjusted until approximately 7 pulses appear on the scope. The input connections of the scope are then connected to the grid of V_4 and the 60-cycle sync is adjusted so that V_3 conducts every 60th of a second. It may be necessary to adjust the bias on V_3 for this to happen. It might be that instead of 7 fixed steps appearing on the staircase, the stairs are jittery and tend to slide back and forth, or the stairs tend to be moving up or down like an escalator. The motion of the stairs may be stopped by readjusting the bias and frequency controls of V_1. If there is a tilt in the bottom two steps of the staircase, the 60-cycle sync that is injected in V_3 should be reduced and the bias of V_3 and V_1, together with the frequency control of V_1 should be readjusted until there is no evidence



R_1, R_3, R_{12}—500,000 ohm pot.
R_2, R_{11}—27,000 ohm, 1/2 w. res.
R_4—51,000 ohm, 1 w. res.
R_5—3600 ohm, 1/2 w. res.
R_6—4700 ohm, 1 w. res.
R_7—300 ohm, 1/2 w. res.
R_8—1 megohm, 1/2 w. res.
R_9—5000 ohm pot.
R_{10}—27,000 ohm, 2 w. res.
R_{13}—500 ohm pot.
R_{14}—20,000 ohm 2 w. res.
R_{15}—50 ohm, 1/2 w. res.
R_{16}—82,000 ohm, 2 w. res.
C_1, C_5—.005 μfd., 400 v. cond.
C_2—.001 μfd., 400 v. cond.
C_3, C_{12}—16 μfd., 450 v. elec. cond.
C_4—.25 μfd., 400 v. cond.
C_6—.5 μfd., 400 v. cond.
C_7—30 μfd., 450 v. elec. cond.
C_8—8 μfd., 450 v. elec. cond.
C_9—.1 μfd., 400 v. cond.
C_{10}—.01 μfd., 400 v. cond.
C_{11}—6 μfd., 600 v. elec. cond.
T_1—Power trans. 350-0-350 v. @ 70 ma.; 5 v. @ 3 amps.; 6.3 v. @ 2.5 amps. (Stancor P-6011 or equivalent)
CH_1—Filter choke, 12 hy. @ 80 ma. (Thordarson 20C53 or equivalent)
J_1, J_2—Jack
S_1—S.p.s.t. sw.
V_1, V_3—884 or 6D4 tube
V_2—6AL5 tube
V_4—6J6 tube
V_5—6X4 tube
V_6—VR105 or 0B2 tube
V_7—5Y3 tube

Fig. 2. Schematic diagram of gamma checker. If an oscilloscope is not available any TV set can be used to make final adjustments on this test instrument.

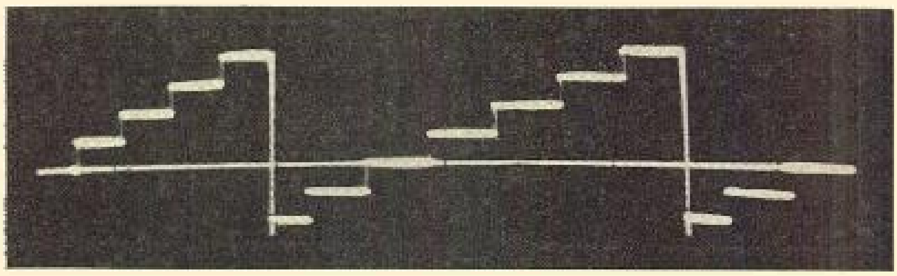
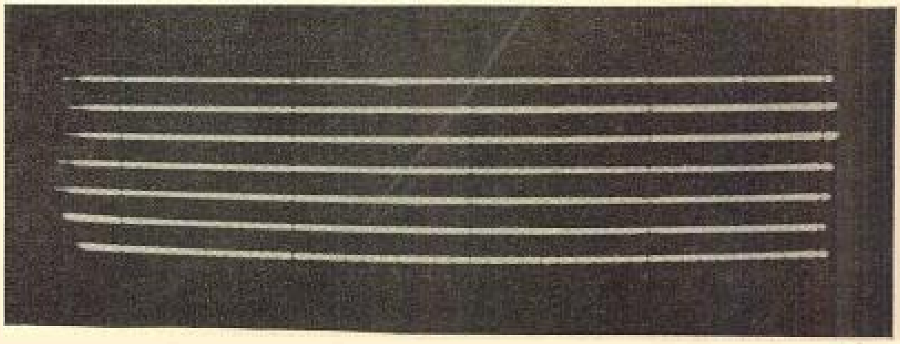


Fig. 3. Staircase output delivered at terminal J_1, shown in the schematic diagram.

Fig. 4. Scope pattern obtained when checking generator for both amplitude linearity and tilt in the stairs. This is the desired pattern. See text for the explanation.



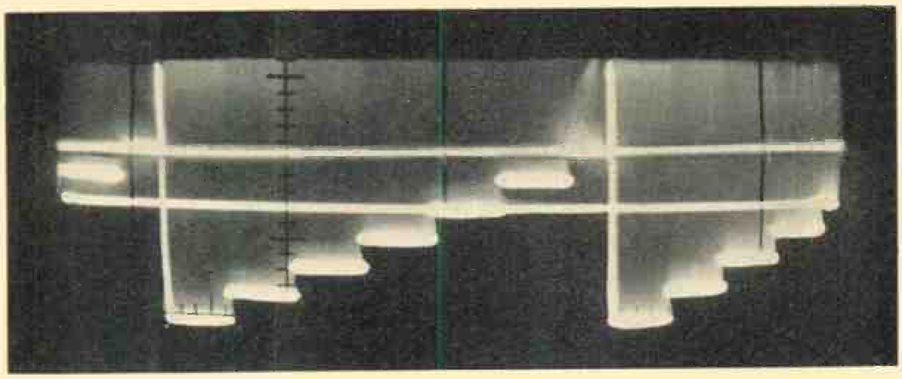


Fig. 5. The oscilloscope pattern obtained when non-standard blanking is used.

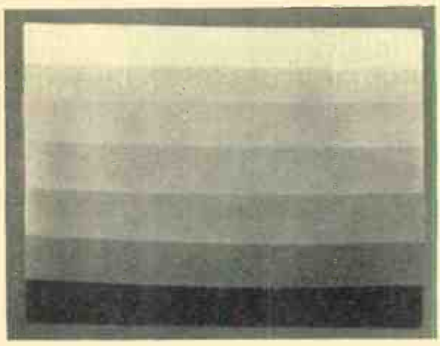


Fig. 6. Kinescope picture of Fig. 5.

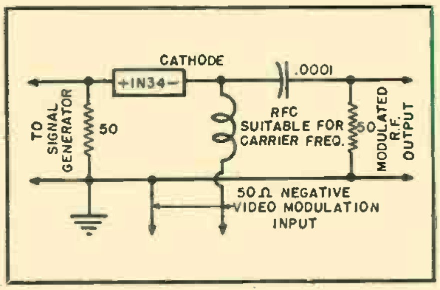


Fig. 7. Diagram of a simple modulator. The output of this modulator can be used to check over-all receiver response.

of any tilt in the first few steps. Generally, the smaller the 60-cycle sync voltage, the more uniform the steps. Of course, 60-cycle sync derived from the separated sync from an RTMA standard picture may be used for external synchronization of V_3 by application at J_2. In this case the internal 60-cycle injection is reduced to zero at R_{13}. An easy way of checking the staircase signal generator for both amplitude linearity and tilt in the stairs is by connecting the scope to the output of the generator and running the horizontal sweep of the scope 10 to 20 times faster than 60 cycles. This will result in the picture shown in Fig. 4. Any non-linearity in the steps will show up as an unevenness in the spacing between lines. Any tilt in the stairs will show up as a widening of the lines.

Uses

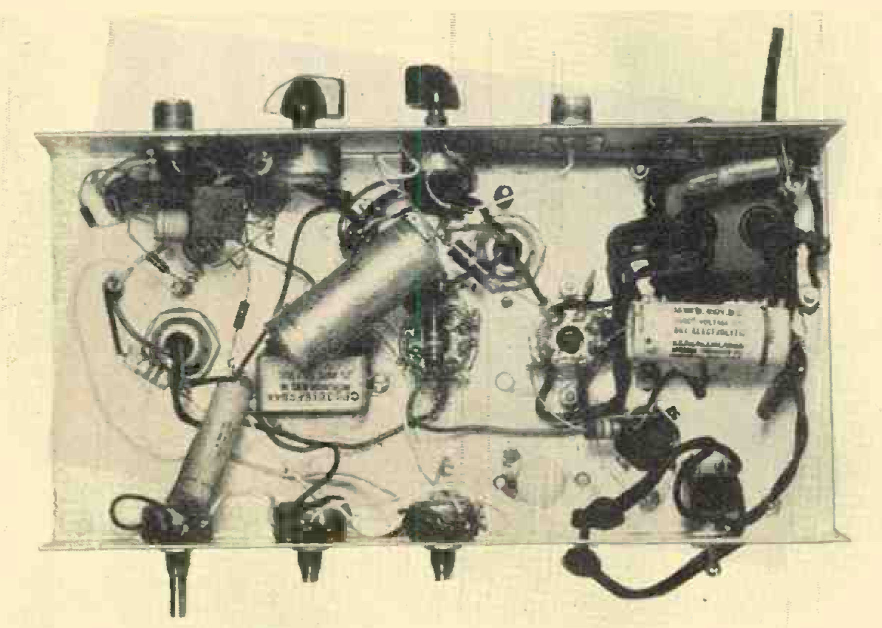
The staircase waveform produced by this generator may be fed into the video amplifier of a television set and should produce a picture similar to that shown in Fig. 3 when viewed with an oscilloscope. A scope applied stage-by-stage in turn along a video amplifier would show whether the responses of the stages are linear. Crowding of the stairs at the bottom or the top would indicate that the video amplifier is either being overloaded or operating on an improper portion of its curve of grid voltage versus plate current. Whether or not the blacks or whites will be compressed depends upon whether the video stage in question is poled black-positive or black-negative. Any tilt in the staircase waveform as observed on the oscilloscope indicates poor low-frequency response. By connecting either the composite blanking output from a standard television generator or the combined horizontal and vertical sync pulses obtained from a television set, blanking may be added to the basic staircase signal. This may be obtained by separating the grids of the cathode follower and feeding one of the grids the composite blanking voltage. The oscilloscope picture with the non-standard blanking used will then appear as shown in Fig. 5 and the kinescope picture as in Fig. 6. The apparent white edge at each grey tone is an optical illusion. The pictured steps may be checked for tilt by masking each step from its neighbor with a piece of paper. Of course blanking is not necessary, but the return traces of the horizontal and vertical lines will otherwise be seen.

This composite staircase signal with blanking is useful in checking automatic black level and the action of d.c. restorers, which are supposed to restore at the black level. Proper operation of the d.c. restorer or automatic black level circuits will be indicated by the black level remaining unchanged as varying levels of the signals shown in Fig. 5 are fed into the system. If it is desired, this signal may be fed into the simple modulator shown in Fig. 7. The output of the modulator may be used for checking the over-all response of a receiver.

As mentioned earlier, motion pictures do not always reproduce well on a television receiver. Using the gamma checker, video amplifiers may be adjusted for non-linear amplitude output by either using diodes, crystals, or several pentode amplifiers in parallel, each tube having different grid voltage-plate current characteristics. It is possible to have a sharp cut-off tube amplify by itself, then a medium cut-off tube is added to it, and then finally a remote cut-off tube is added to the other two tubes. The output of such a gamma corrector amplifier, when fed by the gamma checker, will show larger steps in the staircase at either end or in the middle. By manipulating the controls, any desired result can be obtained; control over the over-all gamma curve of the television system at the receiving end makes it possible to optimize the television picture reproduction for any given set of conditions.

It is easily seen that this relatively simple and inexpensive generator may also be quite useful for checking the performance of other portions of a television system. —30—

Fig. 8. Under chassis view of the completed television gamma test instrument.



New AUDIO DEVELOPMENTS

Three new speaker types. Each speaker has its own individual sound and the final selection of any one should be based on comparative listening tests.

By

JACK SIMON

Manager, Sound Studio, Terminal Radio Corp.

A discussion of some of the latest improvements in styli, pickups, equalizers, preamps, amplifiers, etc.

OBSCURED by the widespread interest in television, the many developments recently effected in the audio art have been all but lost in the shuffle. In fact, because of the paucity of publicity on this subject, many otherwise well-informed men are of the opinion that there is "nothing new in audio." Nothing can be farther from the truth for, during the past year, the quality of sound reproduction has been increased to such a degree as to delight even the most discriminating.

This fact can best be illustrated by recalling a recent experience. A well-known symphony orchestra conductor came into the *Terminal* sound studio to replace a pickup arm for a very expensive set that he had purchased several years ago. To demonstrate the operation of the pickup arm I "piped" one of his records through our best amplifying and loudspeaker system.

The conductor was completely carried away by the recording to the extent of actually "conducting" an imaginary orchestra towards its end. He attributed his reaction to the fact that the quality of the sound was far better than any he had previously heard. Of course he was tremendously interested in "how I did it" and the explanation I gave him parallels, to some degree, the ensuing article.

The most important advance in audio is entirely intangible and extremely hard to explain. It seems that in addition to developing equipment which must meet rigid frequency response and distortion characteristics, a "plus" factor must be introduced into the design which recognizes that the human ear is the final judge of the "quality" of reproduction.

At the present time, we do not know exactly what this "plus" factor is. Many theories have been advanced and a considerable amount of research is presently being conducted to track it down. This much is known—two units may seem to have exactly the same electrical characteristics and yet one will sound better than the other.

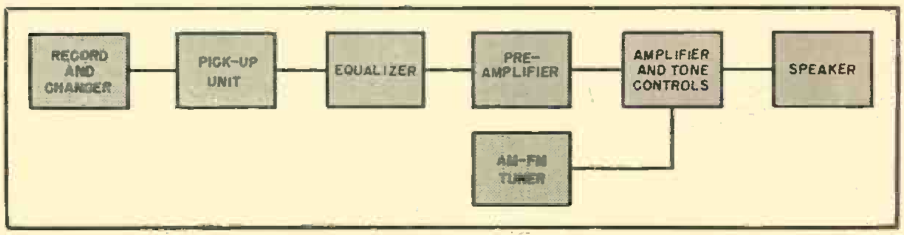
In essence this is analogous to two piano players. One plays every note exactly as it should be played and his music is flat, while the other may actually strike a wrong chord occasionally, and yet his music has "feeling" and consequently greatness.

The biggest improvement made in audio within the past few years is in the introduction of "feeling" into the sound equipment. This improvement can be traced to the work of a number of engineers who are also topflight musicians. These men did not check the operation of their equipment on the oscilloscope alone. Instead, after obtaining the best possible oscillogram, they proceeded to pass the unit through its most severe test—their own ears. Final adjustments were made on the basis of best *sound*.

Because final adjustments were made to suit an individual ear, some systems will sound better than others to certain people. Each human ear has its likes and dislikes and consequently "bass" and "treble" controls are provided in better amplifiers to permit the listener to alter the audio until it sounds most pleasing to his ear. For this reason, "high quality" audio is, in the last analysis, primarily a function of the listener's music appreciation.

Of course there are also tangible improvements. It should be remembered that any audio system is no better than its weakest elements. There is no point in designing an amplifier of outstanding characteristics unless you have the record, pickup unit, and speaker that will match these characteristics. The impetus for the present intensified activity in audio is the development of the long playing record which, partly because of competitive necessity, is of far better quality. Starting with better records, it was then necessary to improve the audio reproduction systems to derive the full benefit of the higher quality. Fig. 1 is the block diagram of the units employed in an audio system. We shall

Fig. 1. Block diagram of the essential components in a high-fidelity sound system.



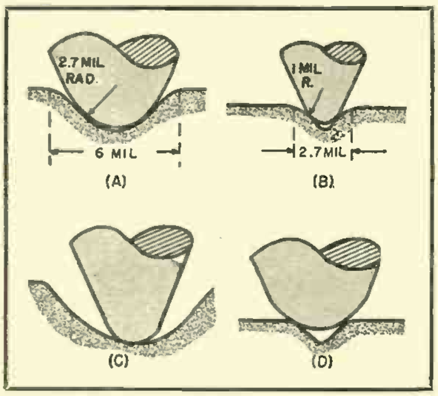


Fig. 2. (A) 78 r.p.m. groove, 2.7 mil radius stylus, (B) Microgroove, 1 mil radius stylus. (C) 1 mil stylus in a 78 r.p.m. groove. (D) A 2.7 mil radius stylus in microgroove.

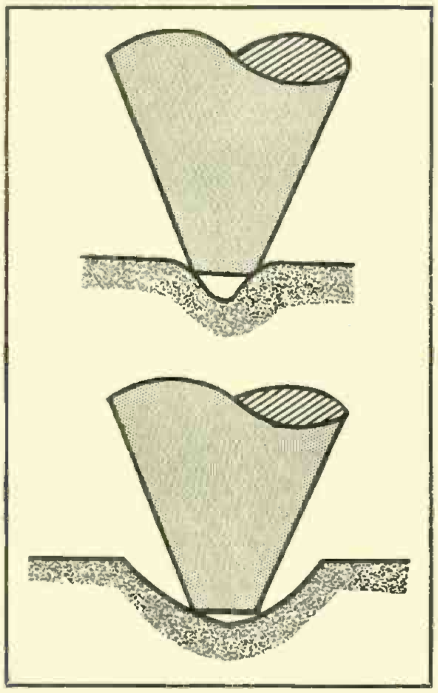


Fig. 3. Compromise stylus shape as it appears when resting in a microgroove (top) and a 78 r.p.m. groove (bottom).

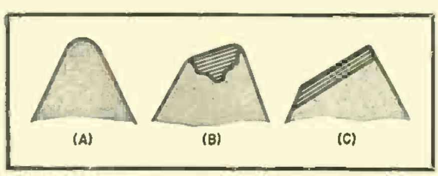


Fig. 4. Diagrams showing typical stylus wear. (A) A new stylus. (B) After 100 playings. (C) After being used 1000 times.

consider the improvements effected in each of these units individually.

Pickup Unit

The pickup unit is comprised of three elements, *i.e.,* the stylus (or needle) that contacts the record, the cartridge or crystal that converts the mechanical modulation to electrical energy, and the supporting pickup arm. Each one of these elements must meet rigid requirements.

The importance of the stylus in the audio system is often overlooked. To fully understand the functioning of this unit, a brief review of the relationship between phonograph grooves and needles is necessary. Fig. 2A shows a cross-section of a conventional 78 r.p.m. record into which a 2.7 mil tip radius needle is inserted. Fig. 2B shows a cross-section of a typical microgroove, or long playing, record with a 1 mil tip radius. In this case it can be noted that the tip radius must be considerably smaller to fit into the smaller groove. In each case the needle is made so that it is supported by the sidewalls, rather than the bottom of the groove, since in this manner it has a positive engagement with the groove and can be driven laterally without loss in motion. Under these conditions good reproduction is possible.

Consider what would happen if (a) a 1 mil stylus is used for 78 r.p.m. records, and (b) if a 2.7 mil needle is used for LP records. In this first case, as shown in Fig. 2C, the needle is not properly supported and cannot be driven laterally in a positive manner. When playing a modulated groove such a needle will "skate" from one sidewall to the other resulting in distortion and a characteristic swishing type of surface noise. When the needle is too big, 2.7 mil in microgroove, it hits the top of the sidewalls, as shown in Fig. 2D, and cannot follow the modulation accurately—again resulting in distortion.

A compromise stylus, shown in Fig. 3, has very recently been placed on the market. This stylus eliminates the necessity of using two different radii styli for conventional and LP records. With this stylus the effects mentioned above are minimized for either type record, as seen graphically in Fig. 3, but for high fidelity systems it is recommended that individual needles be used for each type of record.

From the above it is evident that the shape and size of the stylus is of utmost importance, particularly where the audio system must meet the requirements of highly appreciative ears. Consequently, a great deal of research and development has been expended during the past year in determining the optimum stylus dimensions for each type of record, and it is likely that improvements will continue to be effected in the future.

Another important characteristic of interest is the durability of the stylus. It should be noted that when a stylus touches the record groove only a small part of the surface area is in contact with the groove walls and the pressure per square inch may amount to several tons! Under this pressure the styli tend to wear, rapidly at first and then, as the contact area increases and pressure per square inch decreases, wear continues at a slower rate. This effect, shown in Fig. 4, changes the stylus shape and hence introduces distortion in the system.

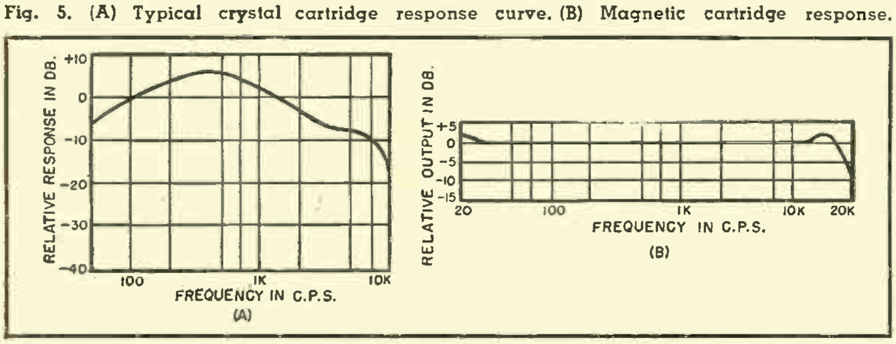
Frictional pressure not only affects the needle itself, but similarly cuts into the record so that it is modified and its quality deteriorated. Until recently it was believed that the use of a soft stylus material saves the record. However, it has been shown that softer material loads the record grooves with abrasive particles and hence modifies the groove characteristics. It is generally true that a stylus that wears poorly will, in time, affect the life of the record.

This problem has been particularly aggravated by the appearance of the microgroove because the narrower the groove the greater the frictional problem. For this reason a lighter vertical force is used though sufficient vertical force must be maintained to assure proper tracking. A light vertical weight is also required for best reproduction characteristics. However, despite the lighter vertical force, the stylus wear is far more rapid on microgroove than on standard groove. A rough estimate is about three times faster.

It is important to note that this deterioration of quality due to stylus wear occurs very gradually and therefore the listener does not readily notice the change. It is frequently not until the record is virtually ruined that the effect is noticed.

The degree of stylus wear is, of course, primarily a function of the type of material used. Steel wears very rapidly and is very rarely employed in high fidelity systems. Diamond styli have appeared recently and are by far the most durable and expensive type. Between these two extreme types, there are several materials, such as sapphire and osmium, which result in a fairly durable stylus at lower cost. The music lover who has collected a large number of records and plays them often will probably want to protect his investment by using a diamond stylus.

Fig. 5. (A) Typical crystal cartridge response curve. (B) Magnetic cartridge response.



Cartridge

There are two basic types of cartridges; namely the crystal and magnetic cartridge. The crystal, because of its relatively low cost and high output, has been widely used for many years. However, as indicated by the typical response curve given in Fig. 5A, this cartridge has a poor and very non-uniform response characteristic. A poor response can sometimes be corrected by means of an equalizer, but it is extremely difficult to compensate for a non-uniform characteristic.

Magnetic cartridges, as indicated in Fig. 5B, are characterized by a much better and more uniform response but, until recently, were very expensive. The constant demand for better quality has led to the development of several magnetic cartridges which combine good electrical properties with reasonable cost. Consequently today most high quality audio systems use magnetic cartridges. Because the output of the magnetic cartridge is relatively low, a preamplifier is required when they are used. The preamplifier used should either be made by the manufacturer of the cartridge or his recommended circuits employed.

For the discriminating listener, one cartridge should be used for LP records with separate cartridge for standard records. In this way, records are played under optimum conditions. In this case, as with the stylus, attempts are being made to develop a single compromise cartridge for both type records. However, these cartridges, while satisfactory for many listeners, will at best be only a compromise.

Pickup Arm

Again, for optimum results the pickup arm must be carefully designed to assure the right vertical force for the stylus. Several new arms are available that provide adjustment for counter-balancing for different cartridges, a tracking adjustment, and a leveling adjustment. These arms are amazing in their ability to maintain tracking even when the record is at angles as high as 60°.

These features may seem like gilding the lily but when quality results are expected attention must be paid to minute details, for it is in these details that the difference between good reproduction and truly high fidelity reproduction exists, and the ear can readily detect the difference.

Equalizers

With the advent of wide frequency range and uniform characteristic cartridges, true equalization became a practical reality. Equalizers are designed to compensate for the non-linear characteristics of the record and pickup unit. Previously the non-uniformity of the crystal cartridge made it impractical to effect compensation for the pickup unit and hence only partial equalization was possible.

To fully understand the need for equalizers it is necessary to briefly review the properties of records. Two methods of cutting lateral recordings are available; namely constant amplitude and constant velocity. In constant amplitude recordings, the lateral displacement of the cutting stylus remains constant at all frequencies for a given input voltage but the lineal velocity varies with frequency. In the constant velocity method, the lineal velocity of the cutting head is constant for all frequencies for a given input voltage but the amplitude changes.

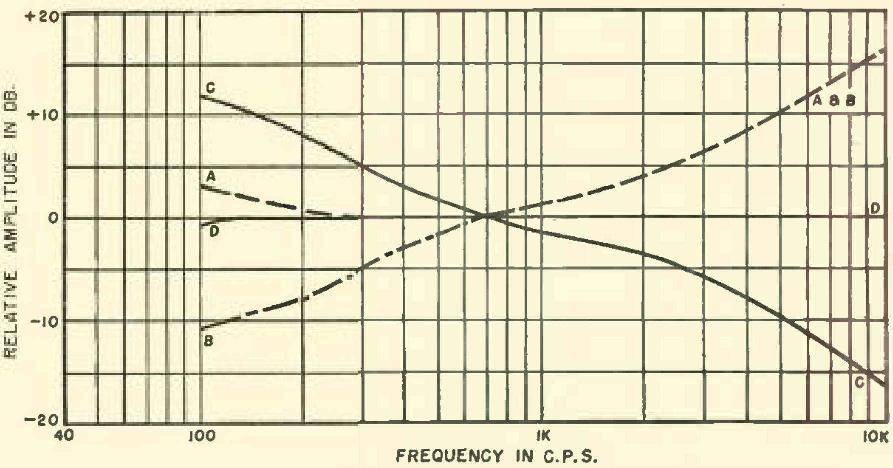


Fig. 6. (A) Recording characteristic. (B) Characteristics when played by a magnetic cartridge. (C) Equalizer characteristic. (D) Over-all characteristic (A + B + C).

Consequently in the constant velocity cuttings the amplitude increases at low frequencies and may cut into an adjacent groove, while in the constant amplitude recording the lineal velocity becomes so high at high frequencies that it is difficult to cut and impossible for the playback needle to track. As a compromise the recording companies use constant amplitude at low frequencies and constant velocity at high frequencies. In this manner they are able to use each system to advantage. The point of change from constant amplitude to constant velocity is called the crossover frequency and is usually 500 cycles in domestic recordings.

Since the recording companies employ both methods of cutting on a record neither a crystal pickup (which is amplitude sensitive) or a magnetic pickup (which is velocity sensitive) will produce a flat characteristic. Thus, an equalizer is necessary to compensate for loss in pickup gain. Furthermore, since different recording companies produce records with different response characteristics, modern equalizers have different circuits to cover records made by different companies.

When a magnetic cartridge is used it is not only possible to compensate for the record characteristics but also for the pickup unit. Furthermore, the frequency range of the equalizer has been extended to well beyond 10 kc. to take full advantage of the wider frequency range available.

An example of the equalizer action is shown in Fig. 6. In this figure a typical recording characteristic of a long playing record (A) is shown. Note the low frequency boost, the 500 cycle crossover, and the high frequency boost. The low frequency boost is provided to reduce the effects of hum and turntable rumble, while the high frequency boost is designed to minimize surface and stylus noise.

Fig. 6B shows the response characteristics of the LP record when picked up by a magnetic cartridge. As indicated by this curve, the low frequencies would be at a lower amplitude than they should be, while the high frequencies are over accentuated. Fig. 6C illustrates the equalizer curve that should be used with the recording. The output of the equalizer would then be the flat response shown in Fig. 6D.

Some manufacturers combine the

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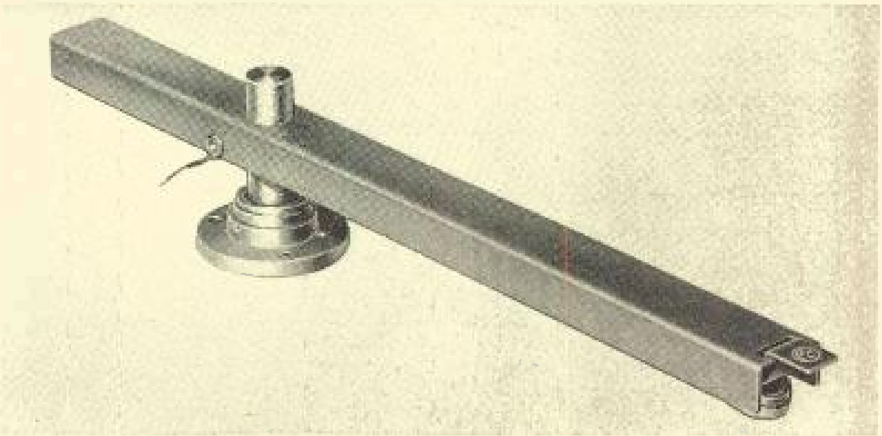
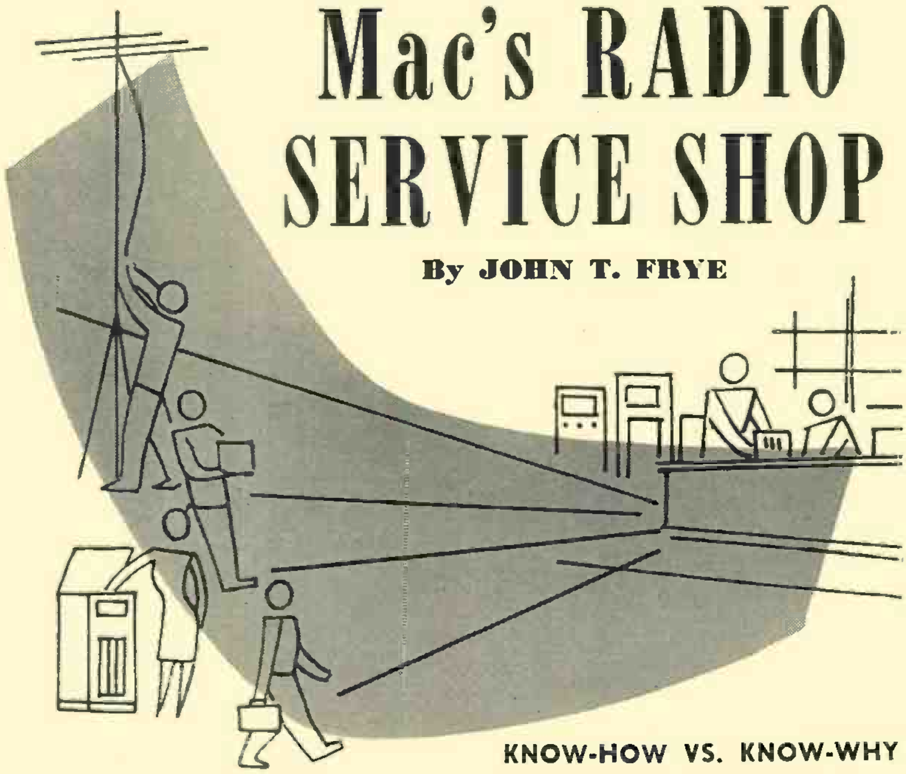
The new Pickering pickup arm designed to assure proper stylus pressure and tracking.





Mac's RADIO SERVICE SHOP

By JOHN T. FRYE

KNOW-HOW VS. KNOW-WHY

CHRISTMAS was still three weeks away, but the day itself was strictly off a Christmas card. A heavy snowfall the night before had given all the roofs a richly overstuffed look that was still further enhanced by glittering icicle fringes along the eaves. The brilliant sunshine cast purple shadows on the spotless snow.

All was warm and cozy inside Mac's Radio Service Shop. At the front of the store Miss Perkins was busy arranging, rearranging, and rearranging—after the immemorial way of women—the various small radios, toasters, mixers, electric razors, etc., that Mac always displayed on his shelves for the Christmas trade. In the service shop proper Mac and his assistant, Barney, were—after the immemorial way of men—loafing under the pretext that they deserved and needed a "break" from the hard work they had been doing.

"Whew!" Barney said as he sprawled at full length on the service bench. "I think we have repaired every radio in the county during these past two weeks, and I *know* that we have checked every TV set in town. If the people are not able to see and hear Santa, it is not our fault. Everyone certainly intends to make this an electronic Christmas."

"Which is quite all right with us," Mac said complacently. "Not to change the subject, though, what were you doing to John Reddinger's portable radio? All he complained about was low volume, but it looked to me as though you were giving it a major overhaul."

"I was changing one of the tubes so it would have more gain," Barney explained. "The dumb bunnies who designed that set must not have known their stuff. I don't see how it could have had much pep with the tube lineup they used. I yanked out a socket and put in another that let me use a tube with a higher amplification factor."

"And how is it now?" Mac asked with suspicious casualness.

"Well, to tell the truth, I was rather disappointed," Barney said. "I am sure it is better, but it still is no ball of fire."

"As I recall," Mac said with a frown, "that set always had excellent volume. Let's have a look at it."

Barney swung his long legs off the bench and slid the little chassis over to Mac. The owner of the shop prodded around inside it for a few minutes with a plastic rod, and suddenly the volume increased several times.

"Well I'll be darned!" Barney exclaimed. "What did you do then?"

"Just moved a coupling condenser so that the lead that was making a poor contact with the foil made a better contact," Mac replied. "Before, the condenser was acting like a condenser in series with a high resistance. What fooled you was the fact that it was not entirely open-circuited. They'll do that sometimes, and about the only change will be a big reduction in volume and a loss of bass response."

"Guess I had better change that tube back, huh?"

"Yes, I guess you had; and while you are doing it, let's have a little chat about gilding the lily."

"I'm a sucker for asking, but what do you mean?"

"I mean that I want you to think a long time before deciding to 'improve' on a radio or TV set. Changing the circuit should always be a last resort instead of a form of first aid."

"You are suggesting that perhaps the fellows who design these sets are maybe not so stupid after all?"

"That's the general idea," Mac said with a wry grin. "Most of those fellows have had many years of engineering schooling plus many more years of practical experience. Their designs are checked and rechecked by other radio engineers and production men before the assembly lines are started. Even after that the 'pilot run' shows up other defects, and many other improvements are made after production starts.

"Remember, too, that the fellow who sold the set must have liked it when he got it from the jobber, and the owner must have been pleased with its performance when he bought it. In view of all this, it seems a pretty far-fetched assumption to decide that the set was *never* any good just because it is not working so hot when we get our hands on it. It would seem only logical to try and restore the set to its original working condition before deciding that the circuit needs revamping."

"It is possible you have something there," Barney cautiously offered.

"Of course," Mac said, "if you are really a hot-shot service technician and feel obligated to prove it, you cannot be bothered with simply repairing a set. That is purely kid stuff. The thing to do is to tear it all apart and then put it back together again according to your own pet ideas. It may not work so well as before, but that does not matter. The important thing is that you have demonstrated your ability to take 'em apart and put 'em back together again."

"Okay, okay! Lay off the heavy sarcasm," Barney pleaded. "From now on I promise never to so much as replace a No. 44 pilot lamp with a No. 47 even in a transformer set. But aren't there some instances where changes are warranted?"

"Yes, there are a few such cases," Mac agreed. "During the war we were forced to make many circuit changes simply because we could not get the proper replacement parts; and it seems very likely that we shall be doing some of that again. Some shortages are already beginning to crop up as a result of the increase in military requirements, and more will probably follow.

"Then, too, there are cases where a set has to be altered so that it can be used in a manner or in a location different from what the manufacturer intended. A good example is the way in which we narrow the i.f. bandwidth of TV sets in this ultra-fringe area in order to get more gain. Strictly speaking, this does not 'improve' the receiver at all. It simply allows us to exchange picture detail, which we could not take advantage of, for much-more-important-to-us picture-stability and contrast. The manufacturer's alignment is the best for the signal level for which the set was designed, but our alignment is best for the

(*Continued on page* 142)

NAVAL COMMUNICATIONS

By REAR ADMIRAL JOHN R. REDMAN, USN

Director, Naval Communications

Born Reno, Nev. in 1898. Graduated from U. S. Naval Academy in 1918. Promoted to Lieutenant (jg) during World War I, advanced to rank of Captain in 1942, became a Rear Admiral in 1944. He took a post graduate course in radio engineering at Annapolis and subsequently served in various communications posts in many different theaters. From October 1942 until March 1945 he served as communications officer and assistant chief of staff for communications on the staff of Fleet Admiral Chester W. Nimitz. He commanded the USS Massachusetts until 1946 after which he assumed command of the Naval Receiving Station at Treasure Island. He became Deputy Commander and Chief of Staff to the Commander Western Sea Frontier in 1947 and later served as Deputy Commander Western Sea Frontier and Deputy Commander Pacific Reserve Fleet. In July 1949 he reported to the Chief of Naval Operations for duty as Director, Naval Communications, a post that he continues to hold at the present. He has been decorated 9 times.

Fifty years ago Marconi installed the first wireless equipment on Navy ships. Today, utilizing all forms of communications, naval forces, whether on land, sea, or in the air, are united as a single fighting unit.

ON A GRAY morning in 1803, Commodore Edward Preble set sail with a "task force" of wooden ships to instill respect for the infant United States in the pirates of the Barbary Coast. Preble's communications consisted of a strip of bunting, a megaphone, and a bull voice. Naval Communications have come a long way since those pioneer days.

Early progress was primarily in the extension and perfection of visual communications systems. By 1875, the Navy was experimenting with electricity for signaling. There was much excitement the following year when signals were read at a distance of 6 miles by means of an electromagnetic device. The flash lamp, perfected in 1878, permitted signals to be read at the unheard-of distance of nearly 17 miles! Communicators of the day hailed the event with enthusiasm. But it was the advent of "wireless" that gave Naval Communications its real impetus.

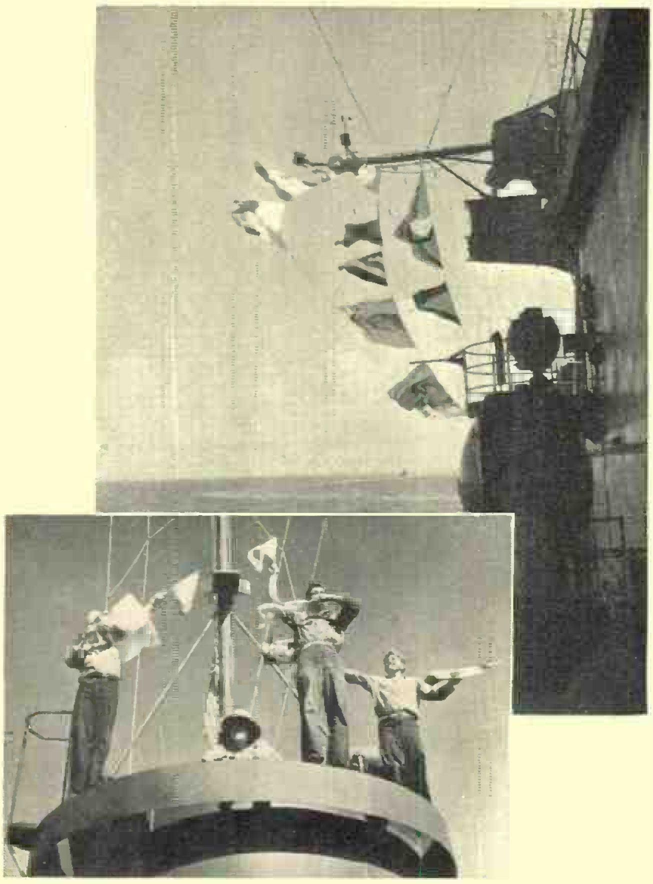
With the Nineteenth Century approaching its close, Guglielmo Marconi startled the world by his experiments with wireless. He was invited to experiment under Navy supervision. As early as 1900 the young inventor and his assistants were installing the "Marconi device" aboard several vessels. In 1901 the Navy made its first wireless installation on a battleship. A year later the first Naval wireless test stations on shore were established at Annapolis, Maryland and Washington, D. C. During 1903, five different systems of wireless were under test in the United States. By the end of that year, the Navy's tests had progressed to the extent that seven ships and five shore stations were fully equipped with wireless apparatus and operators were furnished for service use. Wireless had shed its swaddling clothes and was growing rapidly.

The Navy now demanded that the new equipment be installed on all its fighting ships. Meanwhile, developments ashore kept pace with those at sea. Six experimental stations were built. A special training school was established at the Brooklyn Navy Yard. Wireless—or radio, as it came to be called—was in the Navy to stay. From then on, advance followed advance, keeping pace with technological progress, lessons learned from operational experience, and the needs of the Navy.

The present-day Naval Communication Service would stagger the imagination of communicators of the early 1900's. All known forms of communication are employed. Today's naval vessels are floating communications centers—from the tiny torpedo boat with as few as seven radio circuits to the mighty carrier with more than a hundred. The extensive, yet flexible circuits of the Naval Communication Service keep the fleet units of a seven-seas Navy in constant communication with each other and with the Naval Shore Establishment. Through careful planning, an organization has been built up that can get in touch with any ship in the fleet almost instantly. With the facilities now available, a ship out of sight is never a ship out of mind. No longer does the control of communications by shore stations extend only as far as the eye can see through a telescope. Today, distance does not limit communications, for messages can be sent around the world.

The Naval Communication Service (NCS) has three watchwords—"Reliability, Security, and Speed." The performance of each element of the myriad services and devices which make up the over-all NCS is weighed in terms of those three factors. As the name implies, Naval Communications is a "Service." Its mission is to provide

A Navy radioman operates teletype equipment. These units are now being used extensively by the Navy. A private network of such teletype stations links far-flung stations and ships.



Visual signals are still widely used in the Navy. (Top) Flaghoist signals for maneuvering and (Bottom) semaphore signals.

and maintain reliable and secure communications, based on war requirements, adequate to meet the needs of the Operating Forces, the Navy Department, and the Naval Shore Establishment, primarily to serve command and secondarily to facilitate administration.

In considering command, a parallel is found in the game of football. The quarterback on a football team is, in effect, the "officer in command." When he directs a play, he is exercising a function of command, and each signal he calls is a command communication. The information he passes on is the most important his team can receive, for it determines just which course of action will be taken against the opposition. Naval Command, playing a role similar to that of the quarterback, controls the movements of the operating forces. Command cannot function smoothly without reliable and rapid means of sending and receiving information—and no Naval operation can be successful without the smooth functioning of Command. Thus it is that the first duty of the Naval Communication Service is to serve Command.

All Navy dispatches do not relate directly to combat, even in wartime. Most communications deal with activities that support the fleet. It is a big task to equip and train all the personnel in the Navy and to provide for them such vital needs as ammunition, transportation, food, clothing, hospitals, and supply depots. In moving the countless messages that must be handled to carry on the work of supporting the fighting forces, Naval Communications facilitates Administration.

To maintain the objectives of "Reliability, Security, and Speed," flexibility is a necessity. In the development of Naval Communications, it has been found that no one method of passing information can adequately serve all purposes at all times. Scientific progress has added immeasurably to the effectiveness of communications, but it has not eliminated the utility, under certain conditions, of some of the earliest methods of signaling. The systems of communications employed today in Naval Communications embrace many new, some old, methods. They run the gamut from hand semaphore to the advanced radiotele-

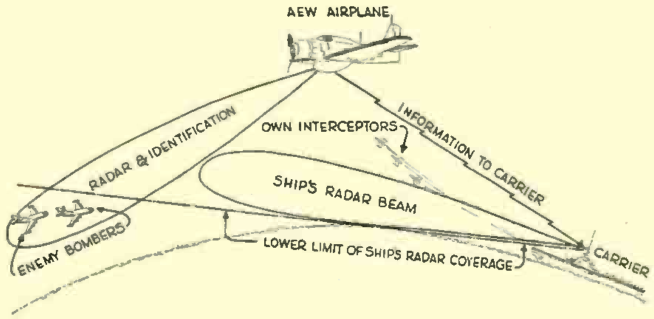


Diagram of how a plane, carrying "airborne early warning" radar equipment, is used to relay this information over the horizon.

type, and include visual communications, sound, wire systems, radiotelegraph, radiotelephone, facsimile—radiophoto, television, and even messengers.

Messenger communication, as the name implies, provides delivery by hand from the communication office of the originator to that of the addressee. The courier who carried news of victory from Marathon to Athens was a forerunner of today's messenger. When other methods, especially radio channels, are overloaded, messengers do much to relieve the congestion. Like messenger service, mail is an important alternate method for easing the transmission load on wire and radio circuits. It should be noted that the Navy Postal Service is an integral part of the Naval Communication Service. Naval Communications has responsibility for the establishment and operation of Navy post offices, both afloat and ashore.

Visual Communications

The transmission of intelligence by visual methods is ancient in origin. Yet, today visual communication still holds its own along with more modern systems. The three principal types of visual signaling—flaghoist, semaphore, and flashing light—meet the rigid demands of good naval communications.

Flaghoist signaling, because it can be used to reach a complete group of ships rapidly and simultaneously, is about the most efficient type of visual short-range communications. Almost all flaghoists are coded signals. To communicate by flaghoist, the originator selects the combination of flags that will convey his particular message. The flags are then attached to the halyard which carries them to a yardarm to form a display—a complete flaghoist message. The receiving station reads the meaning and takes appropriate action. More than 60 flags and pennants

WAVES in mock-up control tower during familiarization course which is given at the "Airman School"

A Navy signalman uses one of the Service's signal searchlights to maintain communications during "radio silence."

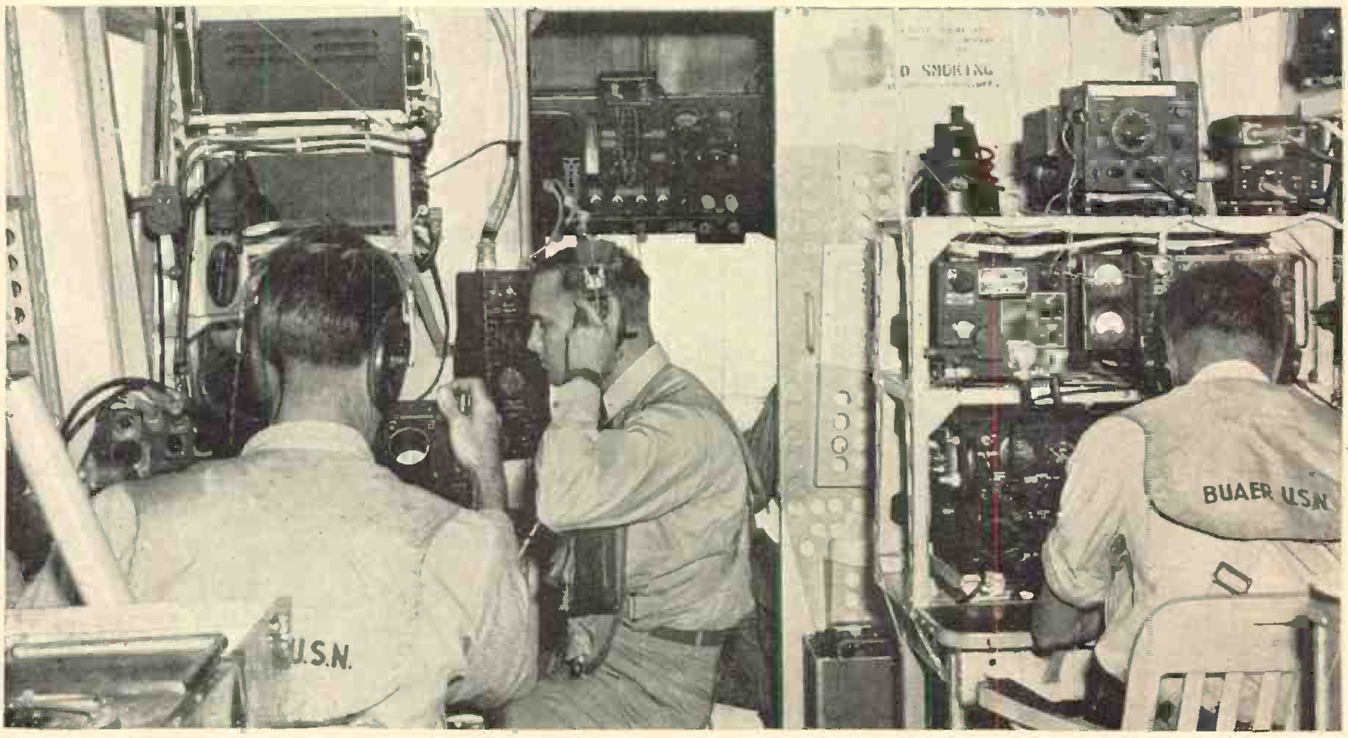
A different form of searchlight which utilizes an infrared filter and a specially-designed infrared viewer.

go into action at one time or another. It is an inspiring sight, to any observer, to see a large convoy of ships traveling in close formation, maneuvering in unison to displays of multi-colored flags.

Semaphore is another fast, short-range form of signaling. It requires the most simple equipment of standard visual methods, just two flags attached to staffs. Being restricted to short-distance communication, Semaphore is more secure than either radio or light, since there is less chance of interception.

The third principal visual signaling method is flashing light. It is a visual telegraphic system using International Morse Code, the same code used by radiotelegraph operators. The signalman sends and receives dot-and-dash characters as short or long flashes of light. There are two systems of flashing light, directional and non-directional. In directional signaling, the light is aimed at the ship or station to which the message is being sent. Searchlights, blinker tube, or a multi-purpose signal lamp are used for this purpose. Non-directional signaling is accomplished by yardarm blinkers. These are (*Continued on page* 120)

Radar, magnetic airborne detection, and sono-buoy listening devices make up the electronic "nerve center" of anti-submarine blimp.



TECHNICAL ASPECTS OF NAVAL COMMUNICATIONS

By CAPTAIN J. A. MORRISON, USN

Head, Equipment Engineering Section
Division of Naval Communications

Graduated U. S. Naval Academy in 1926, completed post-graduate course in electronic engineering in 1935. Officer-in-Charge of U. S. Navy Radio Materiel School at Anacostia, D. C. from 1938-49. During war served as Communication Officer attached to British Combined Operations Staff, attached to Allied Forces' Headquarters (North African Campaign), served on USS Yorktown, and became Communication Officer, U. S. Naval Forces (Europe). Except for two years in San Juan, Puerto Rico, he has headed the Equipment Engineering Section of the Division of Naval Communications since 1945.

A "behind-the-scenes" review of the problems involved in coordinating the U. S. Navy's vast research, procurement, and installation programs.

THE Naval Communication Service is provided for by the Navy Communication System (shore stations) and shipboard radio facilities. The shipboard facilities provide communication channels between ships, fleet, and task force commanders. Ship-shore and air-ground circuits are part of the entire service. The primary, major, and minor relay stations of the Naval Communication System employing wire and radio systems both automatic and manual, handle the Navy's point-to-point traffic and fleet broadcasts. To maintain this service, both shore station and ship require the very latest and most modern type of communication equipment.

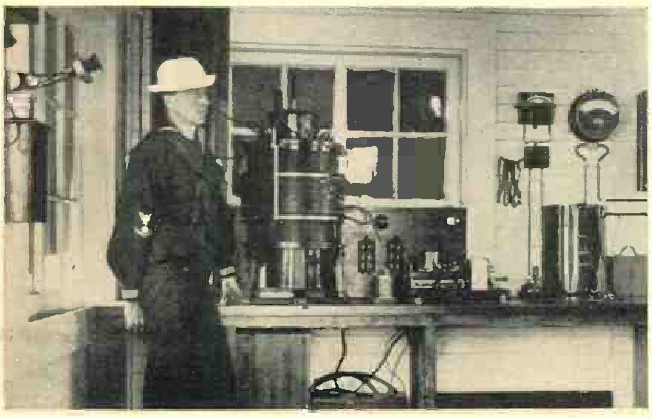
To accomplish progressive improvement in fleet communications, the Office of Chief of Naval Operations' staff includes trained electronic officers who are thoroughly familiar with ship and shore communication systems. These officers hold membership in various Joint and Combined Electronic groups, Electronic Committees of the National Research and Development Board, the Munitions Board, the International Telegraph Union, and many other civil and military electronic organizations. Careful attention is paid to system-wise engineering to insure that communications can be maintained with the U. S. Army and the Air Force units, certain foreign military and commercial systems, as well as with domestic U. S. commercial systems.

Technical reports from the civil and military research laboratories are carefully reviewed in order that new methods or techniques that have military application may be considered and adopted, if improvement to naval communications is indicated.

As technological advances in design of new weapons are made, either by unfriendly nations or by the United States, tactics or counter tactics are developed in our operational planning sections to take advantage of, or overcome them.

This ever-changing struggle presents naval communi-

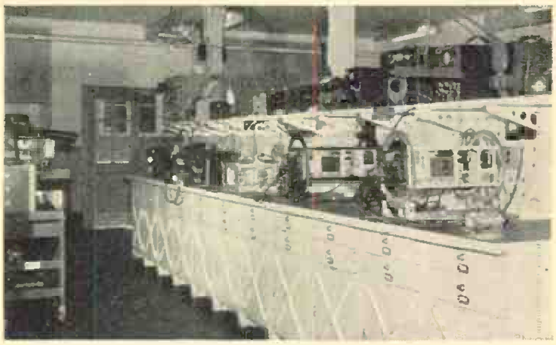
Interior of an operating building at U. S. Naval Radio Station, Mare Island, California in 1904. Note "dated" equipment.



Monitoring equipment, installed at Navy Radio in Washington, D. C., makes a record of all transmissions over the system.

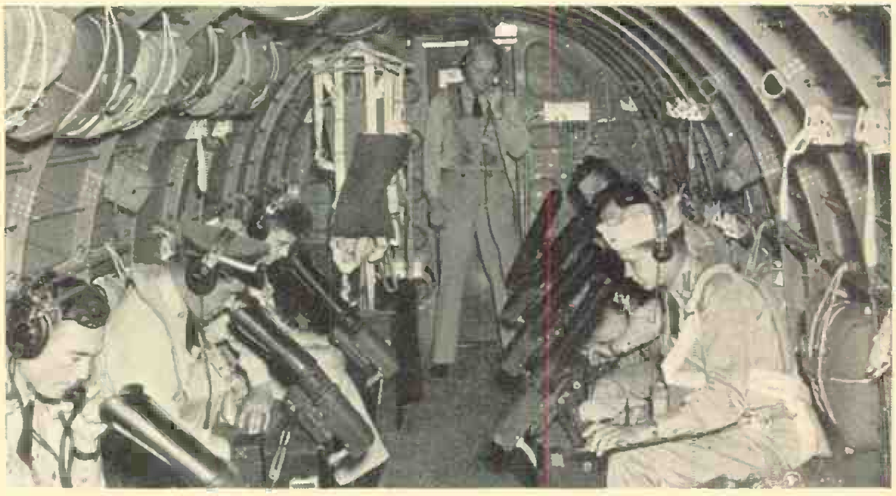
cation equipment and system engineers with the task of not only satisfying current requirements, but at the same time solving the problem of arranging research, development, procurement, and installation programs to insure that equipment and systems, sometimes of comparative radically changed characteristics, will be available should war come suddenly. As far as the Navy is concerned, when it is realized that from writing the specifications to the completion of the installation in all ships of the fleet of just one piece of communication equipment, may take as long as four years, even under wartime production schedules, the job of keeping fleet communication systems fitted with equipment of advanced design can be appreciated.

To insure that the best equipment available is purchased, a considerably complicated process must be followed. A government purchase involving the taxpayers' money must be justified as thoroughly as practicable, and all manufacturers must, under the law, be given opportunity to obtain the contract. The primary requisite for a justification is known as an operational requirement. Operational requirements originate in the Office of the Chief of Naval Operations, and are based upon fleet doctrine, fleet tactics, and ship developments. Since shore stations exist fundamentally to support the fleet, an operational requirement for shore communication equipment generally stems from a fleet requirement.

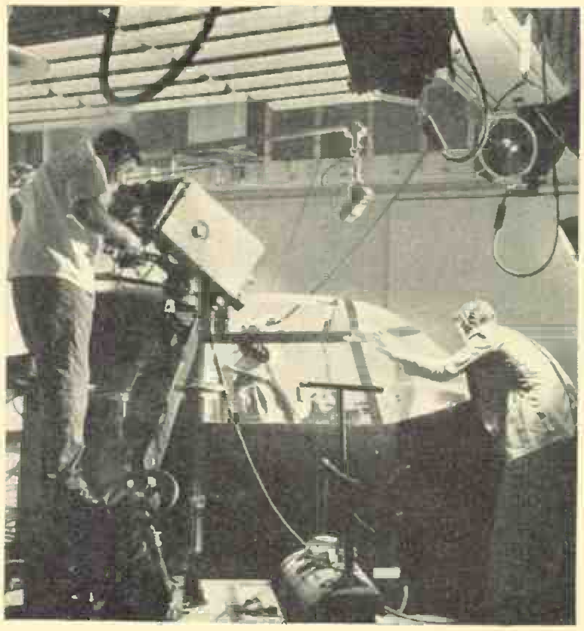


A Navy workshop setup for testing and repairing aviation communication and other electronic equipment.

This protective helmet for pilots is literally "wired for sound." It contains a built-in headset and an adjustable microphone unit.



Navy communication and radar training on board an R4D electronics flying classroom.



A television camera peers into the cockpit of a mock-up Navy bomber as the "pilot" and "co-pilot" demonstrate a simplified control system. By means of microwave or coaxial cable relays the demonstration can be witnessed by personnel at remote naval stations or units of the fleet. The Navy is experimenting with mass training by television at Sands Point, Long Island.

These operational requirements are studied in the Naval Communication Division of the Navy Department, and from these studies are determined the allowances of equipments per ship and shore station that will fulfill them. The equipments required are listed by frequency range, distance coverage necessary, and the type of emission desired. In the case of ships, the requirements are listed in a Tentative Type Allowance, one being prepared for each type of Navy ship. The Bureau of Ships proceeds to fill this allowance with equipment available. If the equipment available will not meet the specified requirement, or cannot be economically modified, then new equipment must be developed and procured.

The first step in the development of new equipment is to write a set of military characteristics. These characteristics are written in broad terms to cover fully the operational requirement. After the preparation in the Office of the Chief of Naval Operations, the characteristics are submitted to the Joint Communications Electronics Committee of the Joint Chiefs of Staff, which is composed of representatives of the Army, Navy, and Air Force. The characteristics are studied for possible joint interest, and yield information as to whether equipment already exists, or is planned, that will fill the requirements. Technical and operational sections of the three Services study the characteristics and determine whether or not there is a joint interest in the proposed development.

After approval of the Joint Committee, the characteristics are forwarded to the Bureau of Ships. As the next step, the Bureau of Ships, using the military characteristics as a guide, writes a set of technical specifications. Here, in the interest of (*Continued on page* 94)

Building the "WILLIAMSON" AMPLIFIER

By HERBERT I. KEROES
Acro Products Co.

Fig. 1. Two views of the audio amplifier. The power supply is built on the same chassis as the amplifier.

High quality performance is obtained from this American version of a British design.

THE Williamson amplifier circuit* originated in England by D. T. N. Williamson has attracted world-wide attention from high fidelity enthusiasts because of the almost perfect quality of the reproduced output. There are many features in the amplifier that make it an attractive construction project for the builder. The circuit is simple, free from critical adjustments, and may be built economically of top quality parts at a cost of less than \$50. Within its power rating of 10 watts at less than 1% intermodulation, the amplifier proves to be ideal for home and small auditorium installations.

The performance of the amplifier, based on listening tests, can best be described as containing the elusive "presence effect," a quality inherent in low distortion equipment with the flat frequency response and low phase shift that enables speech and musical transients to be correctly reproduced. The bass response is solid and free from harmonic distortion. Highs are clean and crisp with none of the shrillness so often experienced with other amplifiers.

Since a number of the components specified in the original amplifier are of English manufacture, considerable effort was made to choose substitute parts that would permit the same high degree of performance attributed to its prototype.

The circuit diagram of the amplifier is shown in Fig. 2. The circuit contains four resistance-coupled stages and is operated with 20 decibels of voltage feedback taken from the secondary of the output transformer and carried around the complete amplifier. Medium mu triode tubes are used throughout and are biased to operate with minimum distortion. A noteworthy feature of the amplifier lies in the selection of the type of output tube. This is a power tetrode which is connected in the circuit to function as a medium mu power triode. The driving voltage required is much smaller than that taken by the more conventional 2A3 or 6B4 type of output tube, and the driver operates with considerably lower distortion.

The first two stages of the amplifier are somewhat unusual. The first stage, which is a voltage amplifier, is directly coupled to the second, a cathodyne inverter. This method of coupling is made possible by the high operating potential on the inverter cathode. The two stages are self balancing and bias themselves to a low distortion operating point.

The heart of the amplifier is the output transformer. This device must provide response that extends well beyond the limits of the audio band in order to limit phase shift to the requisite degree in the feedback circuit. It is the degree of success with which this is achieved that makes for fidelity in musical transient reproduction. The original specifications of the output transformer call for response which is down not more than 3 db. at 3 c.p.s. and at 60 kc. An American counterpart, the Acrosound TO-290, faithfully copies the performance of the original and is used in the circuit here described.

The type 7N7 tube has been selected for use in the voltage amplifier stages because of its shielded construction, low internal capacity, and symmetrical base layout that permits direct point-to-point wiring. The output tubes are the type 807, the characteristics of which are similar to the KT-66 British type used in the original. The plate resistance, however, is about 20% greater for the 807, and this requires a corresponding increase in the plate-to-plate match of the output transformer in order to obtain the same low figures of distortion in the output. The plate-to-plate impedance of the transformer is, therefore, 12,000 ohms instead of the 10,000 ohms specified for the original. Another excel-

* Wireless World: April, May 1947, August 1949.

lent output tube which may be used is the *Western Electric* type 350A. This tube has greater power capabilities than the 807 and will provide up to 25% more output.

One deviation has been permitted in the circuit and is based on the operating characteristics of the 807. An electrolytic condenser has been added across the cathode biasing resistor arrangement of the output stage and has been found to be of material advantage in further reducing distortion at high output levels.

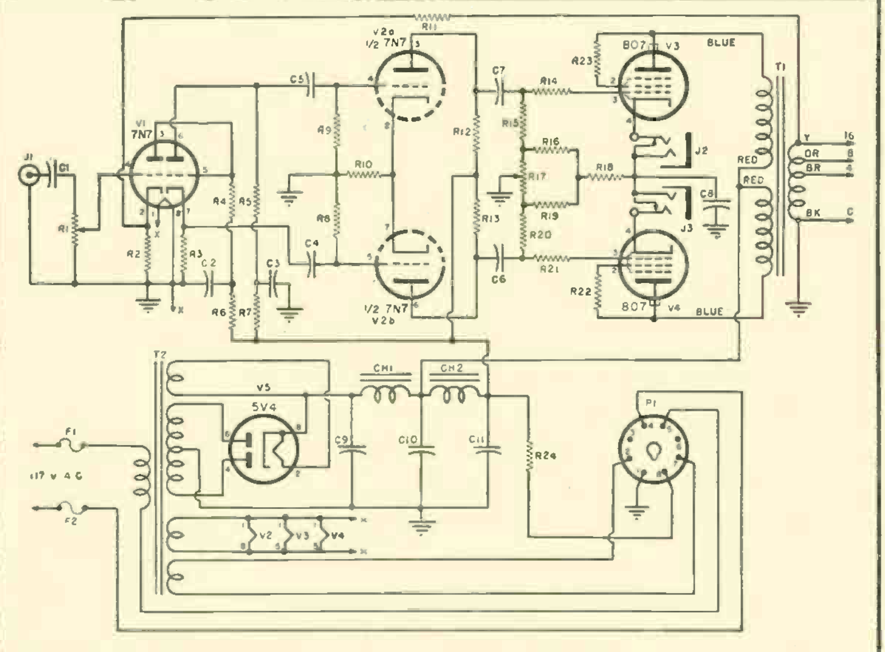
Construction

The amplifier is constructed on a single 10 x 14 x 3 inch chassis. Considerable care has been taken in the layout to permit direct point-to-point wiring in all signal circuits and to avoid extraneous couplings which may introduce instability into the feedback loop. In the construction of the amplifier a ground bus is not used since no improvement will be effected through its use provided several precautions are observed. Ground returns should be made closely adjacent to the stage affected. This may be easily done by using sockets with ground lugs projecting from the mounting ring. It is also desirable, but not essential, to solder one mounting tab of each electrolytic condenser to the mounting plate and one point on the plate to the chassis. The filaments are wired by running a separate two-conductor pair to each stage. When wired in this manner only one pair of leads carrying the stage current enters into proximity with the stage, and the hum field is reduced. The filament lines do not necessarily have to be twisted. It is desirable that they be cabled or taped compactly together. The filament wiring is grounded at one point only; at the first stage, as indicated.

After the amplifier is wired and checked, it may be turned on and connected to a speaker load. If any motorboating is experienced the two plate leads connected to the output transformer should be interchanged. The plate currents may then be balanced, after which no further adjustments will be required. The amplifier will be driven to full output by about two volts r.m.s. Although a volume control has been included on the amplifier chassis to permit setting the level when the unit is used with a variety of inputs, for most installations it will not be required, and may be replaced by a resistor of equivalent value. A power take-off plug has been provided to facilitate external control from a separate preamplifier chassis.

A suggested preamplifier circuit is shown in Fig. 3. It incorporates tone controls and compensating controls for the various recording characteristics and is designed for use with reluctance cartridge input. Crystal cartridges can, however, be operated into the tuner input channel. Constructional details are not given and are

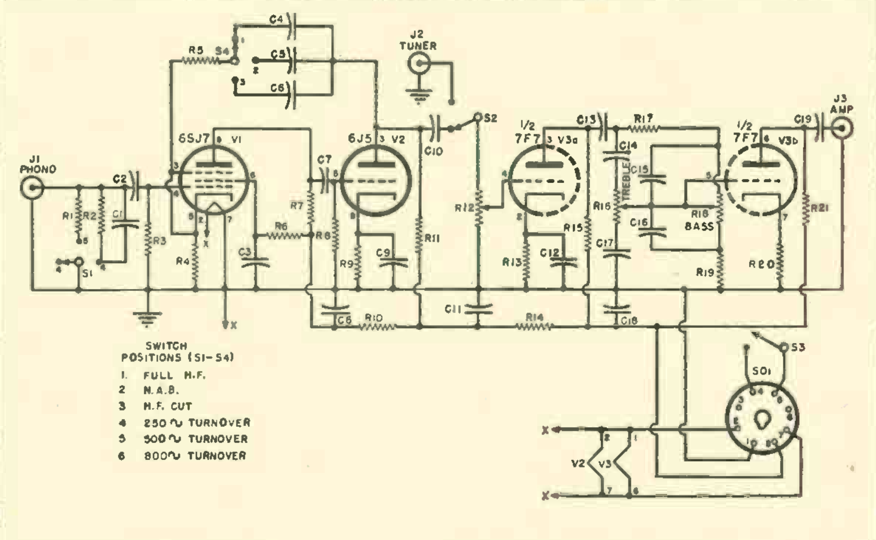
(*Continued on page* 76)



R_1—1 megohm vol. control
R_2—470 ohm, ½ w. res.
R_3, R_5—22,000 ohm, ½ w. res. (matched pair ± 1%)
R_4—47,000 ohm, 1 w. res.
R_6—33,000 ohm, ½ w. res.
R_7—22,000 ohm, ½ w. res.
R_8, R_9—470,000 ohm, ½ w. res.
R_{10}—560 ohm, ½ w. res.
R_{11}, R_{24}—4700 ohm, ½ w. res.
R_{12}, R_{13}—47,000 ohm, 2 w. res. (matched pair ± 1%)
R_{14}, R_{21}—1000 ohm, ½ w. res.
R_{15}, R_{20}—100,000 ohm, ½ w. res.
R_{16}, R_{19}, R_{22}, R_{23}—100 ohm, ½ w. res.
R_{17}—100 ohm, 2 w. wirewound pot.
R_{18}—300 ohm, 10 w. res.
C_1, C_4, C_5—.05 μfd., 600 v. cond.
C_2, C_3—10/10 μfd., 450 v. elec. cond.
C_6, C_7—.25 μfd., 600 v. cond.
C_8—500 μfd., 50 v. elec. cond.
C_9—4 μfd., 600 v. cond.
C_{10}, C_{11}—20 μfd., 450 v. elec. cond.
T_1—Output trans. 12,000 ohm plate-to-plate, to 4, 8, 16 ohms (Acrosound TO-290)
T_2—Power trans. 425-0-425 v. @ 130 ma.; 6.3 v. @ 3.5 amp.; 6.3 v. @ 3.5 amp.; 5 v. @ 3 amp. (Acrosound TP-310, Stancor P-4004, or equiv.)
CH_1—4 hy., 150 ma. filter choke
CH_2—4 hy., 50 ma. filter choke
J_1—Input jack
F_1, F_2—Fused line plug
P_1—Octal plug
V_1, V_2—7N7 tube
V_3, V_4—807 tube
V_5—5V4 tube

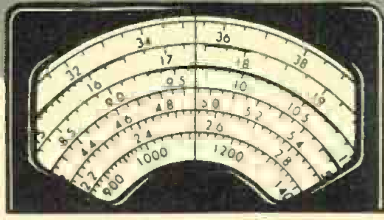
Fig. 2. Complete circuit diagram of the American version of the "Williamson" amplifier.

Fig. 3. Suggested preamplifier incorporating tone controls and equalizing networks.



R_1—15,000 ohm, ½ w. res.
R_2, R_{10}, R_{14}—10,000 ohm, ½ w. res.
R_3—10 megohm, ½ w. res.
R_4—560 ohm, ½ w. res.
R_5—27,000 ohm, ½ w. res.
R_6—1.2 megohm, ½ w. res.
R_7—270,000 ohm, ½ w. res.
R_8—470,000 ohm, ½ w. res.
R_9, R_{13}, R_{20}—1100 ohm, ½ w. res.
R_{11}—47,000 ohm, ½ w. res.
R_{12}—1 megohm pot.
R_{15}, R_{21}—22,000 ohm, ½ w. res.
R_{16}, R_{18}—3 megohm pot.
R_{17}—300,000 ohm, ½ w. res.
R_{19}—30,000 ohm, ½ w. res.
C_1, C_{17}—.002 μfd., 400 v. cond.
C_2, C_5, C_{16}—.01 μfd., 400 v. cond.
C_3—.5 μfd., 400 v. cond.
C_4—.02 μfd., 400 v. cond.
C_6—.007 μfd., 400 v. cond.
C_7, C_{10}, C_{19}—.05 μfd., 400 v. cond.
C_8, C_{11}, C_{18}—20 μfd., 450 v. elec. cond.
C_9, C_{12}—20 μfd., 25 v. elec. cond.
C_{13}—.03 μfd., 400 v. cond.
C_{14}—500 μμfd. mica cond.
C_{15}—.001 μfd., 400 v. cond.
J_1, J_2, J_3—Open circuit jack
S_1, S_4—S.p. 3-pos. rotary sw.
S_2, S_3—S.p.s.t. sw.
SO_1—8-prong socket

International SHORT-WAVE



***Compiled by* KENNETH R. BOORD**

WE ARE pleased this month to dedicate the *ISW DEPARTMENT* to radio in Denmark. Direct from Paul Berg, chief of the press department, The Danish State Radio, Copenhagen, comes this interesting information:

The first radio broadcast in Denmark was made October 29, 1922. It was an experiment in which a ship's installation was used as a transmitter while the receiving apparatus was placed in a lecture hall in Copenhagen. In 1923, a transmitter was built for broadcasting. At the same time, a military transmitter was used for broadcasting purposes. The programs of these two stations were organized by two competitive listeners' organizations. Money for artists' fees and for administration was provided by private contributions. But both listeners and the State claimed a more satisfactory organization of the broadcasts.

In March 1925, Parliament agreed that as an experiment the Telegraph Administration should handle the broadcasts for a year. So on April 1, 1925, the State took over broadcasting. A Radio Council—composed of 38 members—was appointed to supervise broadcasting during the year's experiment and an annual fee was imposed on listeners amounting to 10 Kr. for a crystal receiving set and 15 Kr. for a tube receiving set. On March 31, 1926, listeners numbered 28,140. On March 13, 1926, Parliament adopted an Act of Broadcasting which set forth that the Broadcasting Service should remain a State function.

For 15 years, the Danish State Radio was controlled by the Ministry of Public Works, but on August 8, 1940, it was placed under the Ministry of Education—except for its technical service.

The Radio Council now consists of 16 members, 11 of whom are appointed by the Minister of Education; two direct; one member must be a radio technical expert, upon nomination by the Minister of Public Works; one upon nomination by the Association of Newspaper Editors; one upon nomination by the Association of Journalists, and six upon nomination by the Listeners' Associations; the remaining five members are appointed by the five great political parties of the country as their representatives. From these members, the Minister appoints the president and vice-president of the Radio Council; the vice-president is a technical radio expert.

The Radio Council is responsible to the Minister of Education for the management of the Danish State Radio and of the Radio Fund (license fees) in accordance with a budget approved by the Minister. It lays down the general principles of the radio programs and is responsible for their being of a versatile, cultural, and educational nature. *Advertising by radio is strictly forbidden.*

Stations currently listed are Kalundborg, 245 kc., 60 kw.; Kalundborg, 1061 kc., 5 kw.; Copenhagen, 1430 kc., 30 kw.; Copenhagen, 1484 kc., 2 kw.; s.w. transmitter using OZU, 7.260, OZF, 9.520, and OZH, 15.165, 50 kw.; FM transmitters on 42.0 (800 watts) and 93.1 (1 kw.), respectively.

Official languages are Danish, Faroese, and Greenlandic. Purpose of international broadcasts from Copenhagen are "to maintain contacts with 10,000 Danish sailors on board ships all over the world and with Danes living abroad."

International broadcasts are directed to Europe, Iceland, North America, Far East, Australia, and New Zealand. Languages used include Danish, Spanish, and *English*. Programs consist of news, talks, and features about life in Denmark, reports, Danish instrumental music and songs. Program time is 7 hours and 20 minutes daily—including 4 hours and 50 minutes relayed from Copenhagen-Kalundborg (Home Service).

Current schedules are daily 1245-1730 on 7.260 with omnidirectional antenna (relay of Home Service); daily *except* Sunday 2100-2230 on 9.520 to North America (2100-2200 in Danish; 2200-2230 in *English*, with DX session "Denmark Calling World Listeners," compiled by O-Lund Johansen, publisher of *"World Radio Handbook,"* on Monday around 2225); Sunday *only* 2100-2200 on 9.520 to North America; Monday, Wednesday, Friday at 1900-2000 on 15.165 to South America (in Danish *except* a half-hour program in Spanish each Friday); Tuesday, Thursday, Saturday at 0500-0600 on 15.165 to the Far East, Australia, and New Zealand (in Danish with the *exception* of a Mailbag Program in *English* called "Everybody's Program"—including the DX session which is on the air *only every two weeks on Tuesday*—and a five-minute news bulletin in *English* which concludes *each* transmission).

(In addition is OZI, 5.942, 1 kw., located at Godthaab, Greenland; transmissions from Godthaab are *not* international, but are intended solely for listeners in Greenland; broadcasts are made in Danish and Greenlandic daily at 1630-1745.)

New services planned include transmissions for the Faroe Islands in Faroese and for Greenland in Danish and Greenlandic.

Approximately 8000 letters have been received from listeners abroad since July 1948; promotion of inter-

(Continued on page 114)

This modern building is Radio House, Copenhagen. From these studios international broadcasts are made to Europe, North and South America, Far East, Australia and New Zealand.

(Note: Unless otherwise indicated, all time is expressed in American EST; add 5 hours for GCT. "News" refers to newscasts in the English language. In order to avoid confusion, the 24 hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 p.m. to midnight are shown as 1300 to 2400.)
The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given.

Extending MULTIMETER UTILITY

By

RUFUS P. TURNER, K6AI

Use your V-O-M for extra duties. It can be adapted to tests that normally would be beyond the original limits of the unit.

Fig. 1. The Simpson Model 260 multimeter used by the author in compiling data on meter extension.

THE service technician or experimenter who can afford only a few instruments wants to do as many things as possible with his limited equipment. Often, there are functions which may be performed in addition to the normal specified ranges of an instrument. This is true especially of the a.c.-d.c. multimeter.

This article explains several useful applications of the multimeter not ordinarily covered in the instruction literature accompanying this type of meter. In checking these applications, the author based his studies on the popular *Simpson* Model 260. This meter has had wide circulation in the electronic field. However, the same principles may be applied to other multimeters having similar characteristics. The additional jobs which can be done by means of the schemes outlined in the following paragraphs will increase the utility of the already versatile multimeter several-fold.

Multiplying Ohmmeter Range

Fig. 2A shows a circuit arrangement for multiplying the highest-resistance range of the meter by 10. With this scheme, the 20 megohm range of the Model 260 was extended to 200 megohms.

An external 90-volt battery (which can be two of the small-sized 45-volt batteries in series) is used with a 1 megohm scale-adjusting potentiometer (R_1) and 1 megohm safety resistor (R_2).

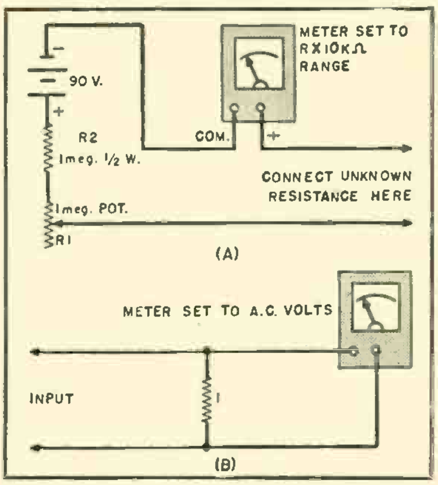
The circuit is set up for operation in the following manner: (1) Set the Model 260 to its Rx10,000 resistance range. (2) Touch the test prods together and "zero" the meter by means of the "Zero Ohms" knob of the instrument. Do not disturb this adjustment afterward. (3) Connect the meter in the circuit shown in Fig. 2A. (4) Temporarily short-circuit the test leads and reset the meter to zero ohms by means of potentiometer R_1. (5) Connect the unknown resistance to the test leads and read its value by adding one cipher to the resistance value indicated on the Rx10,000 scale of the meter. Thus, 100,000 ohms deflection is read as 1 megohm.

Checking A.C. Amperes

In some forms of experimental work, it may be desirable to measure low a.c. ampere values. Few multimeters are equipped to make these measurements directly.

Fig. 2B shows how the multimeter can be converted simply into an a.c. ammeter. The multimeter is set to "A. C. Volts" and connected in parallel with a 1 ohm shunt resistor.

Fig. 2. (A) Circuit for checking high resistance. (B) A.C. ammeter circuit.



Current values are read directly on the a.c. voltage scales. Thus, the 10 volt scale indicates directly 0-10 a.c. amp.

A 100 watt wirewound resistor will allow the 2½ and 10 volt a.c. scales of the meter to be used for 2½ and 10 a.c. amperes respectively. In order to read higher currents, it is best to reduce the size of the shunt resistor and use the 2½ volt range. For example, if a 0.1 ohm, 100 watt shunt were used, actual current would be the voltage reading on the 2½ volt scale multiplied by 10. Such a shunt could be used to give a 25 ampere range.

D. C. Kv. Measurement

A 5000 volt d.c. range is provided in the Model 260 and in several similar multimeters. However, higher voltages than this value must be checked in television receivers and in some industrial electronic equipment.

For this purpose, external safety-type high-voltage probes now are obtainable to extend the d.c. voltmeter range to several kilovolts. Thus, a *Simpson* 25 kv. probe currently is available, the *Sylvania* Type 220 Series probes extend the meter range to 10 and 30 kv., and the *I.C.A.* Type 6167 probe adapts the meter to 15 kv. measurements.

For use with the 5000 volt d.c. range of a 20,000 ohms-per-volt meter, a 10 kilovolt probe must have a resistance of 100 megohms. A 30 kv. probe must have a resistance of 500 megohms.

D. C. Millivoltmeter

The 100 microampere d.c. range of the multimeter also provides an ex-

(*Continued on page* 134)

VIDEO AMPLIFIER FREQUENCY RESPONSE

By WALTER H. BUCHSBAUM*

A review of the factors affecting video amplifier performance and hints on troubleshooting methods.

MOST television and service technicians are aware of the influence of the video i.f. response curve on picture detail. If the i.f. bandwidth is close to 4 mc. the vertical lines can be seen clearly all the way to the center of the test pattern. Less bandwidth results in blurring of these lines before they reach the center. Experienced technicians can often align receivers just by looking at the test pattern and concentrating on the vertical lines.

While the importance of proper i.f. alignment cannot be underestimated, it is not the only step necessary to assure high quality pictures. Often the vertical lines are distinguishable down to the center and the i.f. curve appears to be perfect, but on closer inspection it is found that the contrast in the vertical wedge is much poorer than in the horizontal wedge. The picture seems to lack life and gives a dull, flat impression. This is a typical indication of poor video amplifier response.

By designing the time constant of coupling condensers and grid resistors properly the loss of the low frequencies can be minimized and this portion of the response curve is rarely troublesome.

To obtain good amplification at the higher video frequencies, special video peaking coils are used almost universally. It is the combination and design of these coils that determines the video response curve and the amount of "snap" or contrast between the lines of the vertical wedge in the test pattern. Although the circuit may be designed to give a proper response curve, a defect can occur in the compensating network. Many small screen receivers have rather poor response curves and when such a set is converted for use with a big screen tube, the loss of high frequency components becomes quite apparent. For these and many other reasons it is important that the technician understand the problems involved and is able to check the frequency response of the video amplifier section.

H. F. Compensating Networks

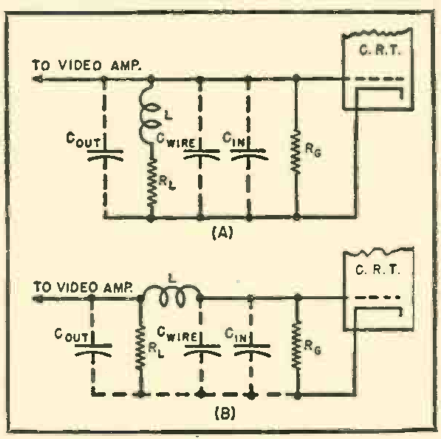
The frequency response of any amplifier is limited by the shunt capacities of the circuit. The output capacity of the last stage, plus the input capacity of the following stage, plus the stray wiring capacity are combined and their effect is that of a condenser shunted across the output of the amplifier. Four different methods of overcoming this effect are available and in most receivers all of them are employed.

(a) Video load resistors: One obvious way to reduce the divergence in amplification between low and high frequency components is to use a low value plate load resistor.

Using low value of plate load resistors does not increase or peak the high frequencies, it merely brings the lower frequency signals closer to the level of the highs. Reducing the load resistor also reduces the gain of the tube.

(b) RC networks: A resistor in the cathode of an amplifier will cause degeneration and a loss in output signal. If the resistor is shunted with a small condenser, a different impedance will result at different frequencies. At low frequencies the shunting effect of the condenser is negligible, but at the higher frequencies the effect of the condenser will be considerably increased.

Fig. 1. (A) Diagram illustrating shunt peaking; (B) series peaking in TV sets.



Often the contrast control consists of an unbypassed potentiometer in the cathode of the video amplifier as shown in Fig. 4. To improve the high frequency response on strong stations a small value condenser is shunted across the control, so that when some degeneration is present, the high frequencies will receive more amplification than the lower ones. It should be understood that the *RC* network does not actually increase the gain at the high frequencies, but reduces the amplification at the lows.

(c) Shunt peaking coils: One of the methods which actually boosts the high frequencies, without affecting the lows, employs an inductance to compensate for the capacity which otherwise reduces the highs. In Fig. 1A a small coil, *L*, is inserted in series with the plate load resistor. Its inductance, together with the combined capacity, forms a resonant circuit, tuned to the highest desired video frequency. At the resonant frequency the *LC* network represents a high impedance, limited only by the plate load resistor, R_L, which is part of the tuned circuit. The grid resistor, R_g, is a high resistance and hardly affects the tuned circuit. In this manner an actual peak can be obtained on the video response curve. Most television receivers use shunt peaking with small coils, often wound on a ½ watt resistor and ranging from about 150 to 400 microhenrys.

(d) Series peaking coils: In addition to shunt peaking a coil is often inserted in series with the coupling condenser or, if a direct connection is made to the picture tube, in series with the lead to this tube. Such an arrangement is shown in Fig. 1B. The effect of this series coil is to split the total capacity into two parts, the output capacity of the tube and the input and wiring capacity. Only the output capacity shunts the load resistor, R_L, and can affect the gain at high frequency signals. This permits the use of a larger load resistance and therefore more amplification. When the se-

* Author of the recently published book "Television Servicing, Principles and Practice" (Prentice-Hall).

ries peaking coil forms a tuned circuit with the output and wiring capacity resonant at the high frequency end, an actual peak can result on the response curve.

Desirable Response Curves

From a theoretical point of view the response curve of the video amplifier should be absolutely flat to 4 mc. and then drop sharply to zero at 4.5 mc. This is shown as curve *A* in Fig. 2. The drop at 4.5 mc. is due to the composition of the television signal. The picture and sound carriers are 4.5 mc. apart. In intercarrier type circuits the 2nd detector produces a 4.5 mc. beat from these two carriers which is then used as the second sound i.f. signal. It is removed from the video amplifier before it can reach the picture tube. In receivers using split i.f. sections it can happen that on strong signals enough sound carrier reaches the second detector to produce a substantial 4.5 mc. signal. If the 4.5 mc. beat gets to the picture tube it causes a fine grain interference. This appears as if a fine wire mesh were placed over the screen. To avoid this it is desirable to have very little amplification at 4.5 mc. and in some receivers a special trap is used in the video stages to keep this interference from the picture tube.

To obtain a curve like *A* in Fig. 2 would be quite complicated and certainly not economical. The more gradual slope of curve *B* is satisfactory for all practical purposes and can be achieved in most well-designed, high-priced receivers. The curve shown as *C* in Fig. 2 is what should be found in the average television receiver.

If the high frequency video signals are boosted considerably, the image appears to be crisper, clearer and is said to have more "snap." Actual tests conducted by the author showed that a picture resulting from a curve like *B* in Fig. 2 was considered dull and lifeless compared to one resulting from curve *C*. To obtain such a curve some coils are peaked at 3.1 and others at 3.5 mc. This results in a fairly broad peak. To further broaden it and to prevent regeneration some of the peaking coils are wound on damping resistors ranging from 22,000 to 47,000 ohms.

In determining the frequency response curve of the video amplifier it would obviously be advantageous if a visual method could be employed. Since the video frequencies range from about 60 cycles to 4 mc., the sweep generator must furnish a signal varying over at least 5 mc. at a fixed rate. In addition, since no detector is present at the output of the video amplifier, a detector stage must obviously be added.

Fig. 3 shows a suggested crystal diode circuit which can be mounted on a terminal board and clipped into the television receiver when needed. While a 1N34 diode is shown, a 1N56 or similar unit can be used, or else a vacuum tube could be employed. One advantage of the circuit shown in Fig. 3 is that it has very little capacitive loading and therefore will not affect the response curve greatly. The resistors should be of the non-inductive, carbon type and C_1 should be a 600 volt mica condenser. Some oscilloscopes have a special diode probe in which case the circuit given here is not needed.

Direct Sweep Method

The circuit in Fig. 4 is typical of the single stage video amplifier found in many inexpensive television receivers. The contrast control is part of the cathode resistor and an *RC* peaking network is employed in the cathode. Both series and shunt peaking are used and a relatively low plate load resistor helps to further improve the frequency response. To obtain the response curve of the amplifier the output of the generator is connected to the free end of the coupling condenser. The connection to the diode load resistor is broken to avoid the high frequency losses due to the 10 $\mu\mu$fd. diode load bypass condenser. The crystal detector probe is connected directly to the grid of the picture tube. The detected signal is then brought to the vertical input terminals on the oscilloscope. The horizontal scope terminals are connected to the generator sync terminals.

In order to tell what frequency the peaks are, a marker signal must be used. Any signal generator furnishing an unmodulated signal from about 1 to 5 mc. will be satisfactory. The output of this marker generator is connected directly across the sweep generator output. A small wiggle or "birdie" will appear on the response curve, indicating the location of the marker frequency.

Another method of marking video response curves is by means of a calibrated wavetrap. Commercially available units like the *Millen, McMurdo-Silver* and *General Radio* absorption type wavemeters are ideal for this purpose. To insure sufficient pick-up, a three-turn loop of ordinary hook-up wire is slipped over the trap coil and connected in series with the "hot" side of the sweep generator output cable. By adjusting the wavetrap condenser the desired frequency is obtained. On the response curve the effect of the trap will be a slight dip as shown in Fig. 6D.

The main advantage of the direct method of sweeping is its simplicity and the relatively few adjustments required. But since not all sweep generators can be used with this method an alternative system can be employed.

Beat Frequency Sweep Method

The output of the sweep generator used for aligning the video i.f. amplifiers usually ranges from 20 to 30 mc. If the generator is set for this i.f. range and connected into the receiver before the second detector, a regular signal generator can be used, together with the sweep unit, to produce a 0-5 mc. signal in the video amplifier. With the connections as shown in Fig. 5 the second detector acts like a mixer for

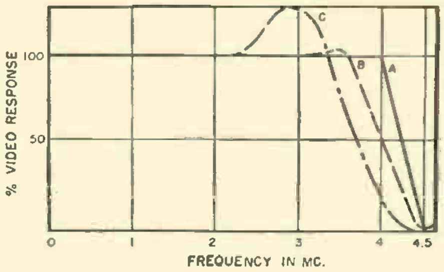


Fig. 2. Graph of theoretical video response.

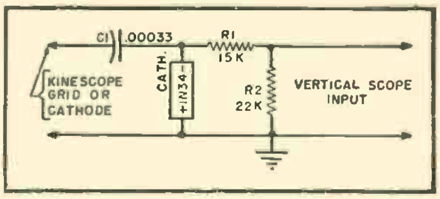
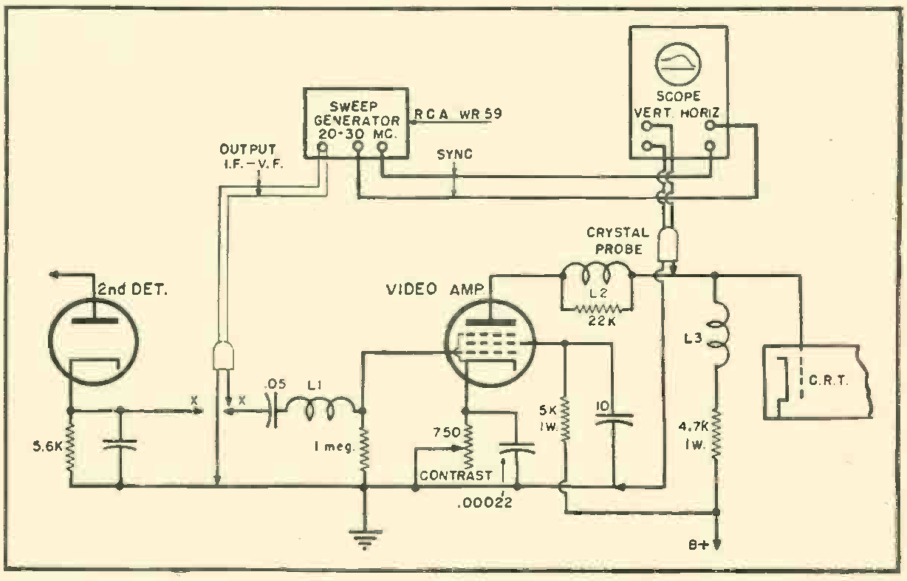


Fig. 3. Crystal diode probe circuit.

Fig. 4. Test setup for the direct video sweep method of checking video amplifiers.



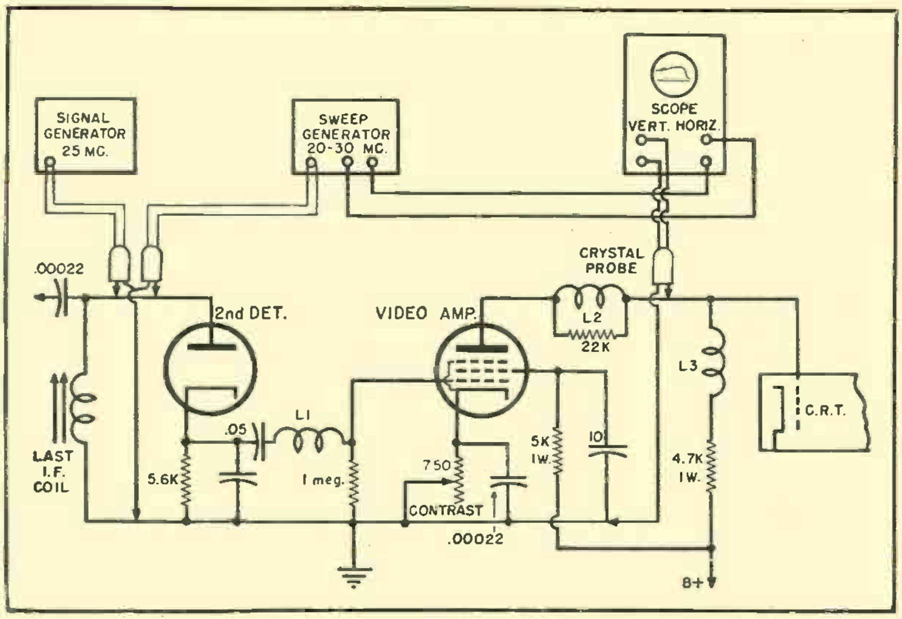


Fig. 5. Setup for checking video amplifier performance by the i.f. beat method.

the fixed frequency of the signal generator and the varying frequencies of the sweep generator.

For example, at one instant the sweep frequency may be 25 mc. and the fixed generator frequency is also 25 mc. This results in a zero beat. In the next instant the sweep signal may be 100 cycles above or below the fixed frequency, producing a 100 cycle signal in the video amplifier. When the difference frequency reaches maximum, the end of the sweep is reached and the return trace on the scope begins. If the fixed signal is not in the exact center of the sweep range, the video response curve will not be symmetrical. Should it be desired to sweep a 7 mc. curve, the fixed frequency generator can be set for either 27 or 23 mc. and the result will be a curve where the short end represents the 3 mc. sweep and the long end the 7 mc. portion. In any event, the location of the fixed signal is clearly visible on the curve as described later.

The advantage of using the beat frequency method is twofold. First, it permits the use of any i.f. sweep generator and the requirements for the fixed frequency generator are not very exacting. Secondly the true response curve is obtained, including the effect of the second detector. If the 10 $\mu\mu$fd. diode load bypass condenser in Fig. 5 were shorted or of the wrong value this effect would not become apparent in the direct sweep method.

Marking the response curve is accomplished in the same manner as before. A signal generator set at the desired video frequency is connected through a small condenser across the detector load resistor. When an absorption type wavemeter is used it will be necessary to connect the pick-up loop in series with the .05 μfd. coupling condenser.

The connection of the crystal detector probe and the oscilloscope terminals is identical to that for the direct sweep.

Interpreting Curves

Using either direct or beat sweep method the first response curve on the oscilloscope screen usually requires some adjustment before it can be used for interpretation. Fig. 6A was taken with direct sweep from an *RCA* WR-59 with no blanking and no phasing adjustment. Actually, four curves are visible, each similar to the other. By adjusting the phasing and turning on the blanking, the curve shown in Fig. 6B results. This represents a range of about 10 mc. with a zero frequency point in the center. Since we are interested only in a single response curve the horizontal gain of the scope is increased and the horizontal centering adjusted until the curve shown in Fig. 6C is obtained. The zero point is still visible at the left, but now only the actual response curve appears on the scope and is ready for closer examination.

When the beat method is used for sweeping the video amplifier the adjustments and their results are the same as those outlined above. The only difference may be that the curves in Fig. 6A and B may be non-symmetrical because the fixed signal is not at the center frequency of the sweep. This can be corrected by adjusting the fixed frequency generator until the zero beat appears centered.

The curve in Fig. 6C shows a very pronounced peak, small bump, and then a drop to near zero level. In Fig. 6D an absorption wavemeter was used to give the small pip shown near the peak. When the frequency was checked it turned out to be 3 mc. Interpreting the response curve of this particular video amplifier, it becomes apparent that the peak occurs slightly below 3 mc., but is rather sharp and the drop from the peak to zero level contains a bump at about 3.1 mc. This indicates that some peaking coils are resonant at 3.1 mc. and one below that, with a higher *"Q."* A simple resistance check revealed that the 22,000 ohm resistor shunting L_2 in Fig. 5 had opened up, causing this coil to peak very sharply.

As was mentioned earlier, some television receivers use a special trap to prevent the 4.5 mc. beat signal from interfering with the picture. The response curve of such a receiver is shown in Fig. 6E, but the trap is shorted out. Instead, two absorption type frequency meters were used to indicate the 3 mc. and the 4.5 mc. points on the curve. When the trap was activated and tuned to coincide with the 4.5 mc. dip from the wavemeter the curve shown in Fig. 6F was obtained. To show the effect of the *RC* network in the cathode of the video amplifier a change in contrast control setting was made between Fig. 6E and F. In the former the control was set for maximum contrast, *i.e.,* the cathode was grounded. In Fig. 6F some resistance was inserted and the effect of the peaking condenser became quite pronounced. The lower frequencies are attenuated from what they were in Fig. 6E but the 3 mc. peak remains substantially the same.

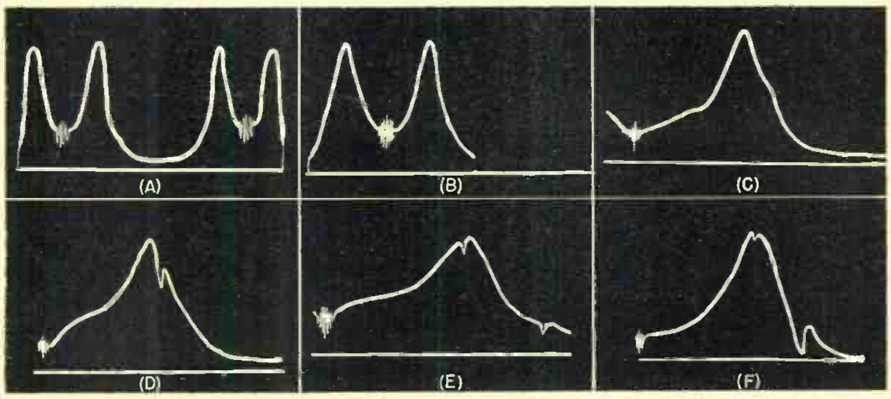
A simple way of checking the effectiveness of each peaking coil is to short it out temporarily and observe the change in waveform.

Video Amplifier Defects

The most frequent defect is total loss of the picture. In this case the first step is to check the wiring thor-

(*Continued on page* 134)

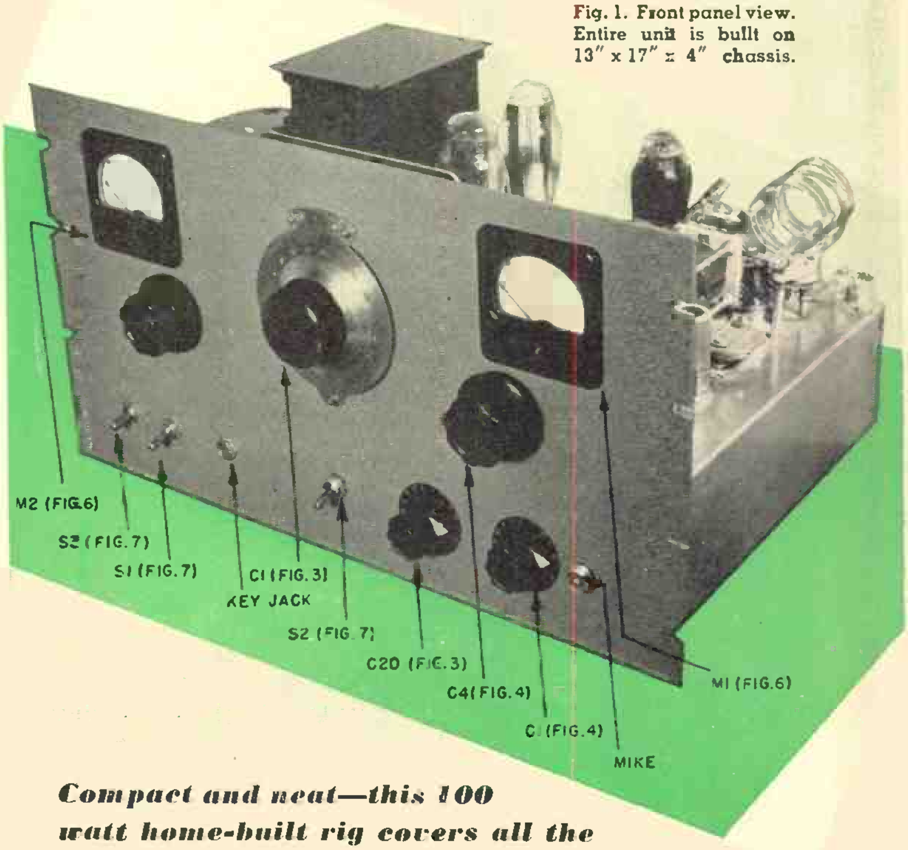
Fig. 6. Oscilloscope patterns obtained with the direct and the beat sweep methods of checking video amplifier frequency response. See text for explanation of patterns.



COMPACT 100-WATT AM-NBFM TRANSMITTER

By
H. H. PATTERSON,
W5DAH
and
A. D. MIDDELTON,
W5CA

Fig. 1. Front panel view. Entire unit is built on 13" x 17" x 4" chassis.



Compact and neat—this 100 watt home-built rig covers all the amateur bands from 10 through 80 meters.

TWO requirements were fulfilled in the design and construction of this transmitter. The first—*versatility;* with operation on c.w. and phone, NBFM or AM with output on all bands from 10 through 80 meters, and up to 100 watts input, depending on the power supply.

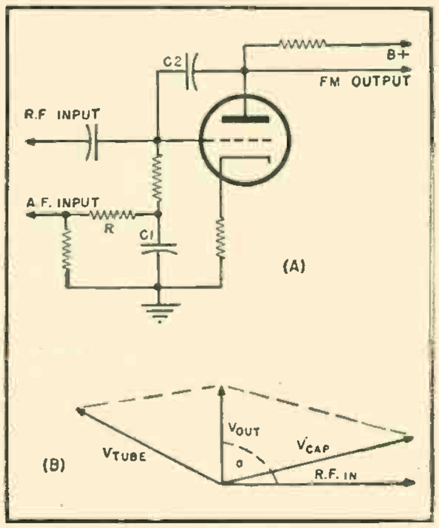
The second—*compactness;* wherein the complete transmitter is built on a single 13" x 17" x 4" chassis and a standard 10½" relay rack panel. The band-changing system involves a set of small plug-in coils and the final plate tank coils. The usual assortment of screen-dropping resistors and bypass condensers in the multiplying stages was eliminated with no sacrifice in efficiency. Direct-coupled cathode-follower drivers are used in the AM audio section to eliminate parts and to obtain the low impedance source necessary to drive the 815 modulator grids into class AB_2.

The NBFM circuit, one developed by F. M. Link, is used in a number of military and commercial units. Its adaptation to amateur use has proven unusually successful. As incorporated in this transmitter this system enables changes from AM to NBFM with the flip of one d.p.d.t. toggle switch.

Not the least of the advantages of the NBFM is that it has enabled W5DAH to operate in an apartment house without first walking up and down the hall to see if anyone is using his "all band" a.c.-d.c. receiver.

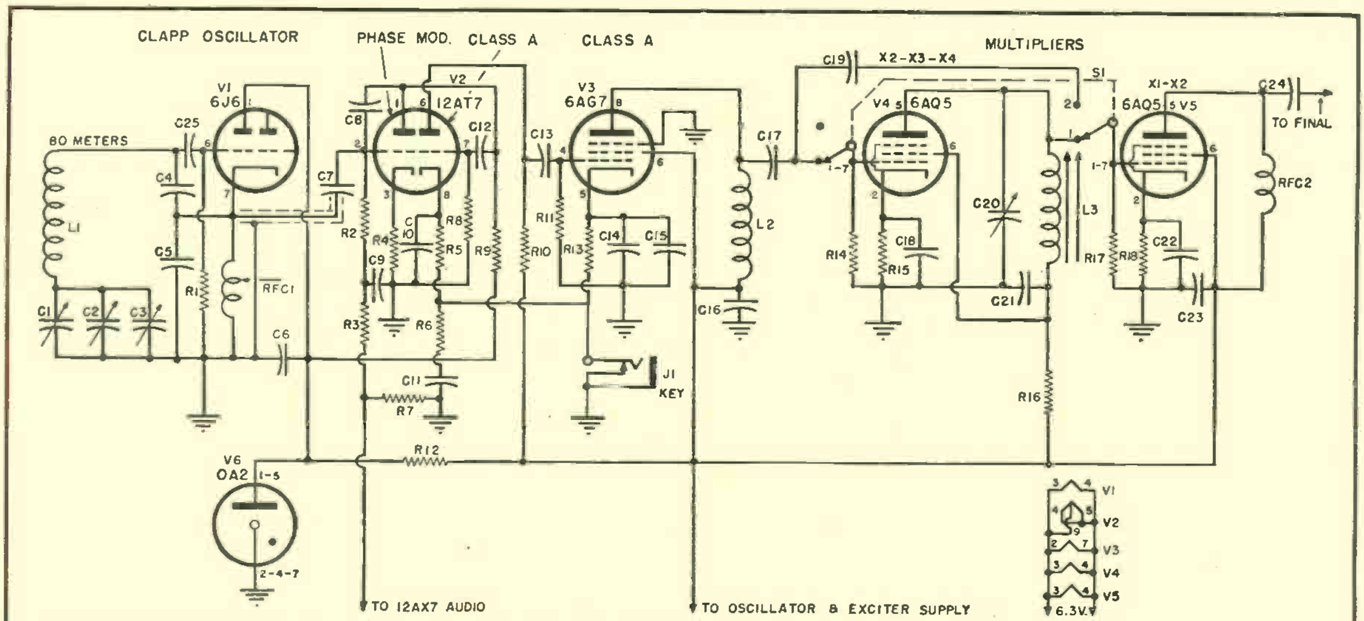
The diagram of this phase modulator is shown in Fig. 2 along with the vector diagram. Considerable cathode degeneration is employed. This cuts down the amplification of the tube until the amount of signal reaching the plate by the amplifying action of the tube is about the same magnitude as that appearing on the plate by coupling through the grid-to-plate capacitance and C_2. The resultant is designated as V_{out}. The vector resulting from tube action is denoted V_{tube} and that one designated as $V_{cap.}$ is the result of grid-to-plate capacity plus C_2. A variation in grid potential caused by the audio voltage results in a change of G_m of the tube and causes the V_{tube} vector to vary in length. This causes the resultant vector, V_{out}, to swing back and forth in-phase producing phase modulation. The series resistance R and the capacitance C_1 constitute a filter to attenuate the highs. The correct selection of these values washes out the high frequency emphasis of phase modulation and the result is NBFM that is pleasing to hear. The circuit should be used at low level r.f. since the developing of grid bias by a strong r.f. input signal will keep the small voltage caused by the audio from having the desired effect on the G_m of the tube. Also, no power gain is available due to the large unbypassed cathode resistor.

Fig. 2. (A) Circuit diagram of phase modulator system. (B) The vector analysis.



The R.F. Section

The *Clapp* oscillator was chosen because of the stability that can be obtained without undue effort. One difficulty that may be experienced, however, is that of failure of the circuit to oscillate throughout the desired range. This may result because the capacitance in use in the series resonant circuit is of too low a value to provide sufficient coupling for sustained oscillations. This condenser should not be much larger than this minimum value since a large value represents an excessive amount of coupling which decreases the isolation of the tuned circuit from the tube. This would result in a circuit less immune to capacitance changes in the tube due to heating. The oscillator

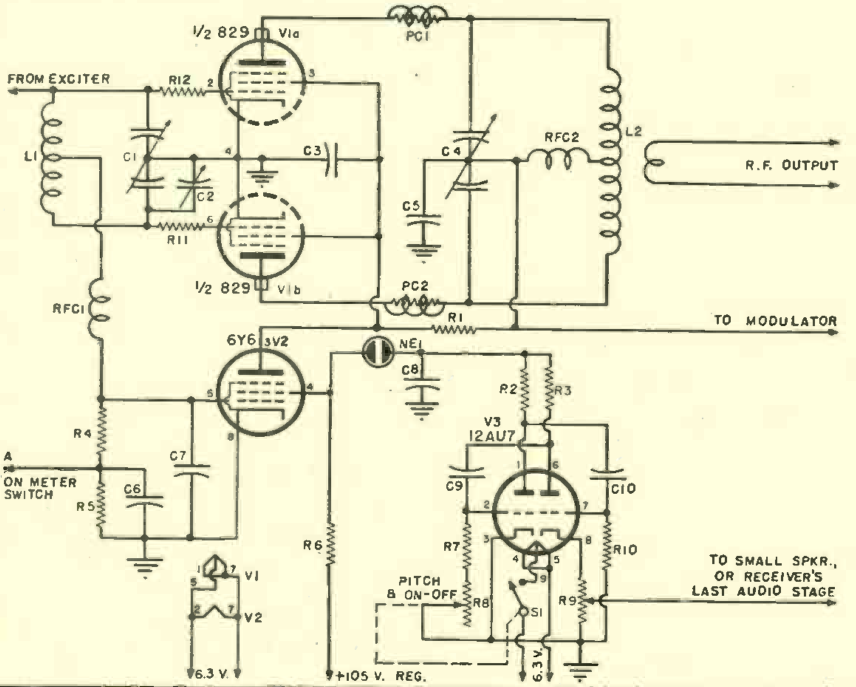


R_1, R_8—100,000 ohm, ½ w. res.
R_2—50,000 ohm, ½ w. res.
R_3—27,000 ohm, ½ w. res.
R_4—10,000 ohm. 1 w. res.
R_5—1000 ohm. 1 w. res.
R_6—20 ohm, ½ w. res.
R_7—270,000 ohm, 1 w. res.
R_9—22,000 ohm, 1 w. res.
R_{10}—10,000 ohm, ½ w. res.
R_{11}—22,000 ohm, ½ w. res.
R_{12}—4000 ohm, 10 w. wirewound res.
R_{13},R_{15},R_{18}—560 ohm, 1 w. res.
R_{14},R_{17}—68,000 ohm, 1 w. res.
R_{16}—1000 ohm, 2 w. res.
C_1—30 μμfd. double-spaced, double-bearing midget cond.
C_2,C_3—35 μμfd. var. cond. (APC)
C_4,C_5—.001 μfd. silver mica cond.
C_6,C_9—.005 μfd. mica cond.
C_7,C_{12},C_{13},C_{17}—100 μμfd. mica cond.
C_8—3 μμfd. mica cond.
C_{10},C_{14},C_{16},C_{18},C_{21},C_{22},C_{23}—.004 μfd. mica cond.
C_{11},C_{15}—8 μfd., 150 v. elec. cond.
C_{19}—12 μμfd. mica cond.
C_{20}—140 μμfd. var. cond.
C_{24}—250 μμfd. mica cond.
C_{25}—100 μμfd. silver mica cond.
S_1—D.p.d.t. ceramic rotary sw.
L_1—Osc. tank (National AR-16 80 E). Remove end link and 16 t.
L_2—R.f. choke chosen to resonate with tube and stray capacity to around 3.2 mc. (Approximately 80 μhy.)
L_3—20 t. #26 e. spaced to fill National XR50 form
RFC_1—2.5 mhy. choke
RFC_2—1 mhy. choke
J_1—Closed circuit jack
V_1—6J6 tube
V_2—12AT7 tube
V_3—6AG7 tube
V_4,V_5—6AQ5 tube
V_6—0A2 tube

Fig. 3. Schematic diagram and complete parts lists covering the r.f. section of the AM-NBFM transmitter.

Fig. 4. Complete schematic diagram of the c.w. monitor incorporated in the transmitter.

R_1—13,500 ohm. 20 w. wirewound res.
R_2, R_3—30,000 ohm. 1 w. res.
R_4, R_6—5000 ohm, 2 w. res.
R_5—200 ohm, ½ w. res.
R_7—30,000 ohm, ½ w. res.
R_8—500,000 ohm pot. (with sw. S_1)
R_9—1000 ohm pot.
R_{10}—10,000 ohm, ½ w. res.
R_{11}, R_{12}—15 ohm. ½ w. carbon res.
C_1—50 μμfd. (per sec.) var. cond.
C_2—7-45 μμfd. ceramic cond.
C_3—.002 μfd., mica cond.
C_4—100/100 μμfd. dual-condenser, single-spaced
C_5—.002 μfd., 1000 v. mica cond.
C_6,C_7—.004 μfd. mica cond.
C_8—.1 μfd., 400 v. cond.
C_9,C_{10}—.01 μfd., 400 v. cond.
L_1—Wound on 1" plug-in form (See Table 1A)
L_2—75 w. variable center link (B & W JVL)
RFC_1—1 mhy., 300 ma. choke
RFC_2—1 mhy., 300 ma. choke
PC_1,PC_2—7 t. #18 e. on 1000 ohm, 2 w. carbon res.
S_1—S.p.s.t. sw. (on R_8)
NE_1—1 w. neon lamp (with res. removed)
V_1—829 tube
V_2—6Y6 tube
V_3—12AU7 tube



shield can is attached only to the front panel. This avoids deformation of the box and consequent frequency shift that would result from a movement of the front panel if the can were tied *both* to front panel and chassis.

Following the oscillator (Fig. 3) is the phase modulator followed by the Class A isolation stage. A broad-banded 6AG7 stage provides the necessary power increase to drive the 6AQ5. The 80-microhenry choke in the plate circuit of the 6AG7 (see L_2 in Fig. 3) was chosen to resonate with the tube and wiring capacitance at a frequency of approximately 3.2 mc.

After the 6AG7 stage is the first 6AQ5 multiplier stage. Its function is to multiply the v.f.o. frequency by 2, 3, or 4. Any of these may be selected by means of C_{20} (Fig. 3), controlled from the front panel. When quadrupling to 10 meters the condenser is practically all out. The result is a broad-banded stage that requires very little retuning when moving from 28.5 to 29.7. The use of a slug-tuned inductance allows setting the inductance of the circuit to the correct value for operation with the single 140 μμfd. variable without excessive coil pruning. This stage is followed by a second 6AQ5 used as a driver, either doubling or straight through. The circuit arrangement utilizes the 829 grid tank as a plate impedance and thus gains in simplicity and ease of band changing.

Condenser C_2 (Fig. 4) should not be overlooked since it balances the side of the 829 grid tank opposite the plate capacitance of the 6AQ5 and tends to equalize the drive on the 829 grids.

The two parasitic suppressors in the plates of the 829 (Fig. 4) are good insurance and should not be left out. A 6Y6 is used to lower the screen voltage on the final when keying the exitation for c.w. The voltage on the screen of the 6Y6 follows the keying and is also used to operate the 12AU7 multivibrator for a keying monitor. The monitor output will operate a small speaker or may be fed into the last audio stage of the receiver.

C.W. Click Elimination

Condensers C_{11} and C_{15} (Fig. 3) form a click-eliminating circuit that proved effective. However, since overdriving any final amplifier will produce clicks, it is recommended that the drive to the final should be limited to the required value to provide full output.

829 On Low Frequencies

A word of caution about low-voltage, high-current tubes on the lower bands. If it is found that the maximum output does not correspond to the minimum dip in plate current it is an indication that the "Q" of the tank is low. Additional capacitance is indicated and this should be added equally across the two halves of the final tank condenser. Do not add it in a lump across the tank coil unless you wish to increase the power in your harmonics.

Additional capacitance in the final tank will be necessary on 80 meters. The procedure is to add capacitance and prune the coil to restore resonance until maximum output occurs *at the dip.* A 75-watt lamp forms a convenient load and helps to locate the maximum output.

From the photographs it will be noted that shielding has been held to a minimum. This was by necessity rather than desire since the rig was

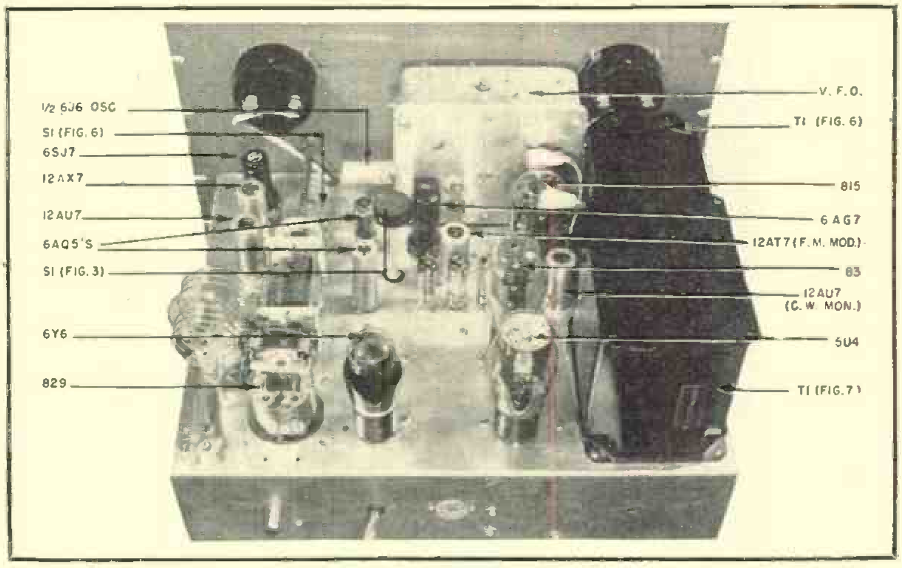
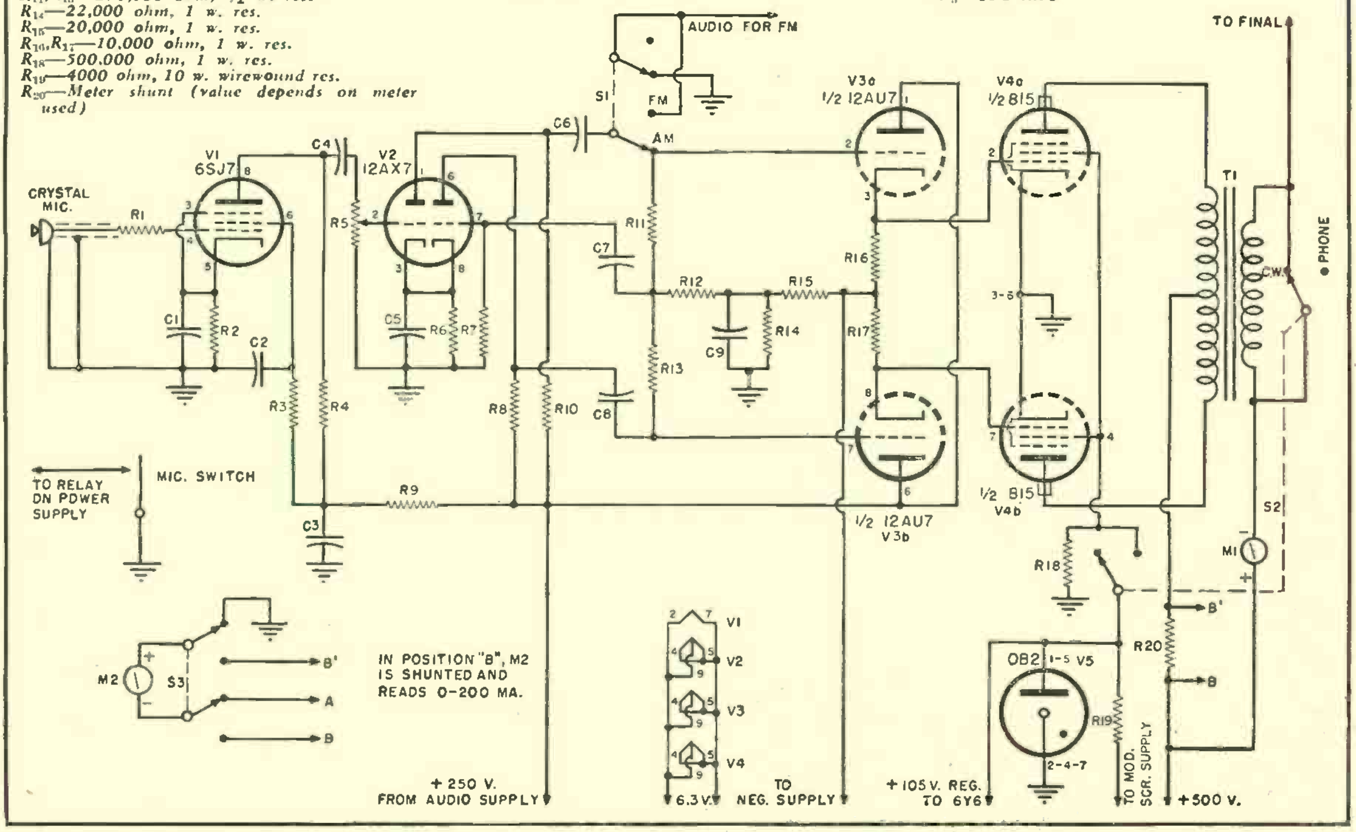


Fig. 5. Top chassis view of the compact AM-NBFM transmitter. The physical arrangement permits enclosing the transmitter in a single table-mounted cabinet. Controls are easily accessible.

Fig. 6. Complete schematic and related parts list for the audio systems and meter switch connections.

R_1,R_{12}—100,000 ohm, ½ w. res.
R_2,R_6—1000 ohm, 1 w. res.
R_3—1 megohm, 1 w. res.
R_4—270,000 ohm, 1 w. res.
R_5—1 megohm pot.
R_7—1 megohm, ½ w. res.
R_8—200,000 ohm, ½ w. res.
R_9—330,000 ohm, 1 w. res.
R_{10}—200,000 ohm, 1 w. res.
R_{11},R_{13}—270,000 ohm, ½ w. res.
R_{14}—22,000 ohm, 1 w. res.
R_{15}—20,000 ohm, 1 w. res.
R_{16},R_{17}—10,000 ohm, 1 w. res.
R_{18}—500,000 ohm, 1 w. res.
R_{19}—4000 ohm, 10 w. wirewound res.
R_{20}—Meter shunt (value depends on meter used)
C_1,C_5—8 µfd., 50 v. elec. cond.
C_2—.1 µfd., 400 v. cond.
C_3—8 µfd., 450 v. elec. cond.
C_4—.001 µfd. mica cond.
C_6,C_7,C_8—.01 µfd., 400 v. cond.
C_9—50 µfd., 150 v. elec. cond.
S_1—D.p.d.t. toggle sw.
S_2—D.p.d.t. ceramic rotary sw.
S_3—D.p.d.t. toggle or rotary sw.
T_1—60 w. modulation trans. (UTC VM-2)
M_1—100 ma. d.c. meter (with shunt to double reading when S_3 is operated)
M_2—300 ma. d.c. meter
1—Crystal mike
V_1—6SJ7 tube
V_2—12AX7 tube
V_3—12AU7 tube
V_4—815 tube
V_5—0B2 tube



(PART A)

829 GRID COIL DATA

80 m.	60 t. #26 e., closewound, two 30-t. halves, 1/8" apart, 1" form
40 m.	22 t. #24 e., closewound, 1" form
20 m.	10 t. #24 e., closewound, two 5-t. halves, 3/16" apart, 1" form
15 m.	6 t. #24 e., closewound, two 3-t. halves, 3/16" apart, 1" form
10 m.	6 t. #24 e., spaced to 5/8", 1" form

80 METER 829 PLATE COIL

B & W BVL. Short out turns and add capacity until plate meter's dips and power output agree. Then remove undesired turns.

(PART B)

FREQUENCY MODULATION DATA

OUTPUT	1ST 6AQ5	2ND 6AQ5	SW. S_1 (FIG. 3)
80 m.	out	straight through	Position 2
40 m.	out	doubles	Position 2
20 m.	doubles	doubles	Position 1
15 m.	triples	doubles	Position 1
10 m.	quadruples	doubles	Position 1

Table 1. Specifications of coil assemblies along with details of NBFM operation.

built in an apartment without shop facilities. The final grid coil is below chassis for isolation, reducing shielding problems. It can be changed through a hole in the chassis.

The Audio Section

The audio section requires little comment except for one or two features. The 100,000 ohm resistor in the grid of the 6SJ7 (Fig. 6) is a good precaution in a compact transmitter as it insures against r.f. pickup and resultant feedback. The 12AX7 tube is a twin-triode similar to the 6SL7 and the 12AU7 is similar to the 6SN7. The negative voltage to which the cathode resistors of the driver stage are returned is adjusted to give the correct bias voltage to the grids of the 815. It will be noted that the screens of the 815 are regulated. This may seem an unnecessary refinement but a well-regulated screen supply is necessary on this and similar beam power tubes when running class AB_2 and the 0B2 is a natural for the job. Only with a well-regulated screen can the maximum peak output be obtained.

Switches

S_3 (Fig. 7) is the power switch. S_1 (Fig. 7) is the send-receive switch and, when closed, makes available 115 volts a.c. on the octal socket at the rear for use in operating the antenna changeover relay and receiver silencing relay. S_2 (Fig. 7) is the calibration switch and is used for beating the v.f.o. with a received signal. S_1 (Fig. 3) is used to bypass the first multiplier for operation on 80 and 40 meters. S_1 (Fig. 6) changes from AM to NBFM phone operation. S_2 (Fig. 6) removes the screen voltage from the 815 and shorts the modulation transformer during c.w. operation. S_3 (Fig. 6) is the meter switch. S_1 (Fig. 4) is the "on-off" switch on the c.w. monitor pitch control.

Power Supplies

The power supplies (Fig. 7) are conventional except perhaps the lack of equalizing resistors across the two series electrolytics in the filter. This, it is realized, is a controversial point and this is being tried as an experiment. (Do not try leaving them out if you are using paper condensers.) The condensers should be the same capacitance and of the same type and brand.

Firing Up the Rig

When firing up this or any new transmitter for the first time it is important to make a careful check for spurious oscillations of any frequency. A quick way to check the final is to apply enough fixed bias (300 ohms in the 829 cathode will do the trick here) to hold the plate current within ratings, remove the excitation and if no r.f. is observed you have been lucky. Turning plate and grid condensers through their ranges should produce no grid current. A neon bulb held near the tank while grid and plate condensers are rotated through their entire range will give a quick indication of oscillation. A wavemeter will then serve to determine the frequency of any r.f. present. If the spurious frequency is near the operating frequency more isolation between input and output circuit (and possibly, neutralization) is indicated. If the frequency is in the v.h.f. region parasitic suppressors of the type shown in this circuit are indicated.

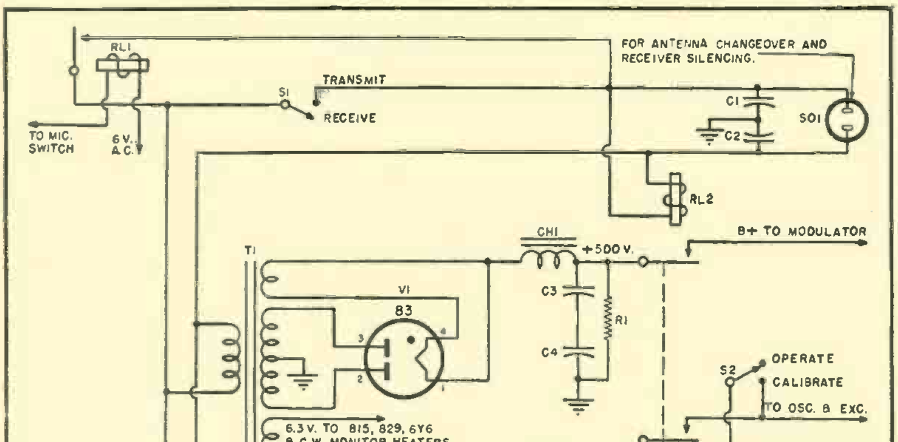
Low frequency parasitics should also be suspected and they can usually be detected as spurious carriers near the operating frequency. Identical r.f. chokes in plate and grid circuits sometimes cause these as well as a parasitic oscillation of the modulator stage.

The final check should be made with a receiver with input shunted to produce about an S-9 signal. More signal than this may cause the receiver to generate spurious responses in itself.

It is necessary to use a calibrated

(Continued on page 108)

Fig. 7. Schematic diagram of the power supplies used in the AM-NBFM transmitter.



R_1, R_2—270,000 ohm, 2 w. res.
R_3—10,000 ohm, 10 w. wirewound adj. res.
R_4—5000 ohm, 10 w. res.
C_1, C_2, C_5, C_6—.005 μfd. mica cond.
C_3, C_4, C_7, C_8—20 μfd., 450 v. elec. cond.
C_9, C_{10}—8 μfd., 450 v. elec. cond.
S_1, S_2, S_3—S.p.s.t toggle sw.
T_1—Power trans. 600-0-600 v. @ 300 ma.; 5 v. @ 3 amps.; 6 v. @ 5 amps.
T_2—Power trans. 325-0-325 v. @ 150 ma.; 5 v. @ 3 amps.; 6.3 v. @ 5 amps.
RL_1—S.p.s.t. 6 v. relay a.c. coil
RL_2—3-pole, s.t. 115 v. relay a.c. coil
SO_1—Chassis type socket
CH_1, CH_2—4.5 hy., 200 ma. filter choke
V_1—83 tube
V_2—5U4 tube
V_3—6X4 tube

WHY, STRATEGIC AIR COMMUNICATIONS

By MAJOR GEN. F. L. ANKENBRANDT

Director of Communications, Headquarters, U. S. Air Force

Graduated from the U. S. Military Academy in 1926 and commissioned second lieutenant of Signal Corps. Attended Sheffield Scientific School at Yale University receiving his MS in 1927. In June of that year reported to Fort Monmouth where he served in various capacities until he entered the company officers' course of the Signal School in September 1928, which he completed a year later. He subsequently served as an instructor in chemistry and electricity at West Point where he remained for five years except for a short period of study at Columbia University. He held various commands during the war and in 1945 returned to the United States to become air communications officer at Air Force Headquarters in Washington. He served in other capacities and received his present post in 1947.

From take-off to "bombs away"—at the flip of a switch—our giant global air armadas are in constant contact with their headquarters.

IN THE few years since the end of World War II the development of an aerial concept of strategic national defense has presented the public with a new family of terms—terms that inspire visions of a shrinking globe and suggest the elimination of boundaries previously thought insuperable. The sonic barrier has been penetrated and supersonic speeds have been attained. We have devised aerial tankers for in-flight refueling. We have indirectly brought every spot on the globe within range of USAF strategic bombers. Concepts of tactics and strategy have necessarily been revised to ensure that new capabilities are exploited to the utmost.

Central to the concept and to the revision of our strategy is the super-bomber—the inter-continental land-based bomber that can deliver its bomb-load from a base in this country to an enemy-held target anywhere in the world. This bomber can pulverize an industrial target; it can support our Army; it can eliminate the source of an attack directed against our Navy. It is a weapon new to the history of warfare, and unique in its application. The bomb-load it carries spreads destruction beyond the capacity of any other weapon. Its range is unrestricted. It introduces problems previously unknown to military strategists and tacticians. But the principles directing its use are as old as warfare itself, because they are the principles of command and control. And command and control mean communications.

It makes little difference to the commander of a strategic air force where his command post is located as long as he is in communication with the aircraft he dispatches. The world, to him, is an onion and the vast distances that face a land or sea commander are just so many hours—or minutes—in span. He can dispatch aircraft from a number of points in the world to far-distant targets with almost push-button ease—but when the aircraft are out of sight of their bases, does he still have the command and control that was exercised in making them airborne?

If he has good ground-air radio communications, his command is extended directly to the aircraft in flight and he can redirect it to alternate targets or recall it to its base at will. However, if the communication link to aircraft in flight cannot be established or maintained, his command ends the instant the aircraft becomes airborne and the aircraft is committed irrevocably to the destruction of the target, regardless of sudden political changes that may make recall or diversion a matter of grim urgency.

On paper, the problem of keeping the strategic air commander in touch with his pilots is simple. To illustrate, take a number of fixed points and draw a number of radial lines in all directions at random. Draw another family of lines across the radials at random to indicate the possible flight paths of aircraft. The radials now are communications circuits. Let's take a closer look at them.

Applying scale to our drawing, we find that the circuits are from a few hundred to a few thousand miles in length. We consult the frequency prediction charts furnished by the Central Radio Propagation Laboratories and make a series of calculations. The optimum working frequencies will vary from about five to twenty megacycles depending upon which circuit is selected, the time of day, and the distance from the station. We select a frequency from the five, eight, twelve, eighteen, and twenty megacycle bands and send them out to the half-dozen or so ground stations associated with the relay stations of the main point-to-point communications axis.

Now that our frequency problems seem to be taken care of, let's pause a moment and examine the ground plant. Making a tremendous arc around the globe somewhere between thirty and sixty degrees north are a number of ground terminal stations that form the main line. The circuits have a maximum capacity of 300,000 groups a day, and associated with each radioteletype tape-relay facility is a high powered ground-air station capable of transmitting simultaneously on three of the five selected frequencies. Modern, professionally engineered, and capable, the lash-up seems foolproof enough and we turn with confidence to an examination of the airborne terminal.

We walk along the ramp to an actual terminal, admiring the sleek aerodynamic shape that looms higher against the sky as we approach, our eyes search for the familiar fixed-wire antenna and the fairlead with its trailing antenna weight tucked tightly in the cup. But our eyes search in vain. A closer inspection reveals no sign of insulators or sky-wires.

A non-commissioned officer steps down a ladder from the bomber and looks quizzically in our direction. "Sergeant," we ask, "where are the antennas?" The sergeant gives us that look reserved for mere laymen and points at the wing that seems to reach the vanishing point as we scan the trailing edge for the hitherto invisible antenna array. "I'm afraid that you'll have to point it out" we say in embarrassment, and the sergeant signals us to follow. We walk in his wake to the tip of the wings. "That's the insulator for the wing cap," he says with a pitying look.

"And that's the antenna?"

"There's one just like it at the other end."

"Mind if we go inside and look at the radio operator's position?"

"It's all right I guess; anything special you want to see?"

"Yes," we reply as the radio operator sergeant leads the way into the cavernous interior, "everything."

The sergeant sits down at a table and moves a headset to one side. At the back of the table is a panel with a collection of unidentifiable knobs and firmly attached to the table is the usual radiotelegraph key. "Well" he says with a wave of his hand, "this is it."

"But where is the transmitter and receiver?"

The crew chief says "In the wing though all you can see is a tank that looks more like it holds gas or oil or something. Doesn't look like a radio set. Anyhow, it works, wherever it is."

We smile a little to ourselves as the sergeant goes on to explain that the radio set and all of its immediate complexities have been removed from the radio room and stored in some remote portion of the aircraft. The maintenance section is responsible for keeping it a serviceable set, but even so, the radio operator still has his hands full handling his briefing folder (containing frequencies, propagation data, schedules, and call signs) and the plain business of getting a message through.

"I hear a rumor," the sergeant tells us, "that the long hairs have cooked up a 'black-box' that will put me out of business one of these days. Some gadget that prints the message on a roll of paper—something simple enough for the co-pilot to operate."

"I wouldn't worry, sergeant," we assure him, "we can make 'black-boxes' do everything but use common-sense. That's where the human element comes in."

"Right," says the sergeant; "'black-boxes' can work out problems that would take me weeks, but when a channel's jammed or the frequency predictions don't work out just right the 'black-box' just quits. A sharp radio operator won't quit until he's got the message through."

We leave the aircraft trying to absorb the effect of this airborne terminal station on the probabilities of maintaining the chain of command between the Strategic Command and this bomber once it becomes a striking force. The efficiency of this airborne terminal is certainly far below that of the ground-air station with its high-power, its high-gain directive antenna arrays, its diversity reception, and its surface-level operating conditions. The airborne radio operator, encumbered with clothing and protective devices against the cold and low pressures of the sub-stratosphere (in case cabin pressures are lost) certainly cannot be expected to come up with the same degree of performance that another operator, sitting at the control console of the ground-air station, can. Furthermore, the airborne sergeant can't entirely free himself from certain anxieties over the hours that he is airborne. The fatigue of his unrelieved attention to his job mounts at a faster rate than that of the ground operator who can say: "Hey, Joe, take my position for a minute, I wanna run over and getta cuppa coffee."

We can't escape the fact that the airborne operators of our strategic bomber force loom up as the single element in the whole chain that must come through with perfect performance against heavy odds. But now that we are acquainted with the problem and the mechanisms involved, let's look at the conditions that the airborne sergeant will have to surmount before he can assure us that the command line is intact.

Because of the distances involved, he must use frequencies from the congested—and somewhat irresponsible—high frequency band. The properties of the band permit us to make an educated guess as to what frequencies will be the most suitable for a given path at various times of day and night. However, when we consult the "Berne Book" to see what other countries may be using our choice of frequencies, and monitor the channel for a first-hand survey of users, the call signs we hear somehow or other don't coincide with Berne listings. The conviction dawns on us that at some other point in space, where we have no monitoring stations the interference pattern may be substantially different.

A glance at the world map and its present political divisions is proof enough that large land masses of the world under a single political philosophy can only be controlled by high-powered ground point-to-point radio communications circuits. Industrial developments require high-traffic-capacity communications, and when that nation is at war the civil and military communications requirements will exhaust almost every communications channel in the high frequency band. Even though certain countries may not subscribe to international agreements, in peacetime, at least, they must operate their circuits on a "live-and-let-live" basis or there will be hopeless confusion.

Skilled technicians repair the USAF's electronic equipment.

Interior view of the Ground Controlled Approach equipment.

Not only are the big powers a source of congestion. A host of smaller nations have been urged to develop, and the United States has provided them with high-frequency radio communications and broadcasting equipment, and we have seen to it that they have frequencies for its use. Furthermore, the vast quantity of radio frequencies required for the United States military forces in all parts of the world will further burden the capacity of the high frequency band in providing usable channels.

As a mitigating factor to the apparently hopeless situation, a further study of the radio propagation charts shows that if a number of stations throughout the world are transmitting simultaneously on the same frequency (which they certainly are) they will not necessarily be all heard at a given point at the same time. Short-wave listeners and radio amateurs can verify this phenomenon. It is not at all unusual to hear a radio amateur say: "That's funny—last night at this time the Aussies were booming in, now all I can pick up is South American stations." These anomalies of the high-frequency band are in our favor, though one can be certain that some interference can be anticipated. Our ability to work through that interference will depend upon the personal skill of the airborne operator and the quality of the receiving equipment he operates.

If he can get his own signal just a few hundred cycles away from the interference (depending upon its modulation or bandwidth) he can slice away the signal completely. Except for outright jamming, he has a good chance of getting a message out of the hash that meets his ear when he switches to a new channel and listens out for his call sign.

Let us now follow through on a mission and see how well the system works.

Let us imagine that unannounced aggression has committed us to war and a message from the Joint Chiefs of Staff arrives, directing that proper measures be taken by the Strategic Air Force commander in carrying out an effort to insure our defense and end the aggression. Simultaneously, from a number of vastly separated points bombers must take to the air and fly to targets in the enemy's heartland and on his perimeter. The first bomb release is four hours away.

At this instant a flash message is delivered to the commander. A country in alliance with the aggressor has broken its ties with the enemy power in the face of potential bombing attacks, and all targets within its borders must be immediately deleted from the current list of priorities. On the situation map is a steadily lengthening line reaching from the base from which our counter attacking planes were launched to the industrial capital of the now unshackled country. Slicing through the sub-stratosphere, and closing in rapidly upon this country that has sued for peace, is an aircraft capable of indescribable harm unless it is diverted or recalled.

A diversion message with "FLASH" precedence is placed on the main communications axis and addressed to the aircraft. The message is converted to perforated tape and is transmitted outward along the main line from tape-relay station to tape-relay station, branching off to a ground-air facility at key points where it is passed to the operator on duty.

A ground operator takes the message from the hands of the supervisor. When he sees the precedence, the paper suddenly feels hot to the touch. He clips it in front of his position and hurriedly consults the frequency plan that was transmitted with the mission order a few minutes earlier and presses a lever on the intercom. "Hey, Joe—Charlie—get this!—put transmitters four, five, and seven on the antenna that covers zone 'B.' This is it!"

Exterior view of the Ground Controlled Approach equipment.

The plotting board at the USAF Radar Approach Control center.

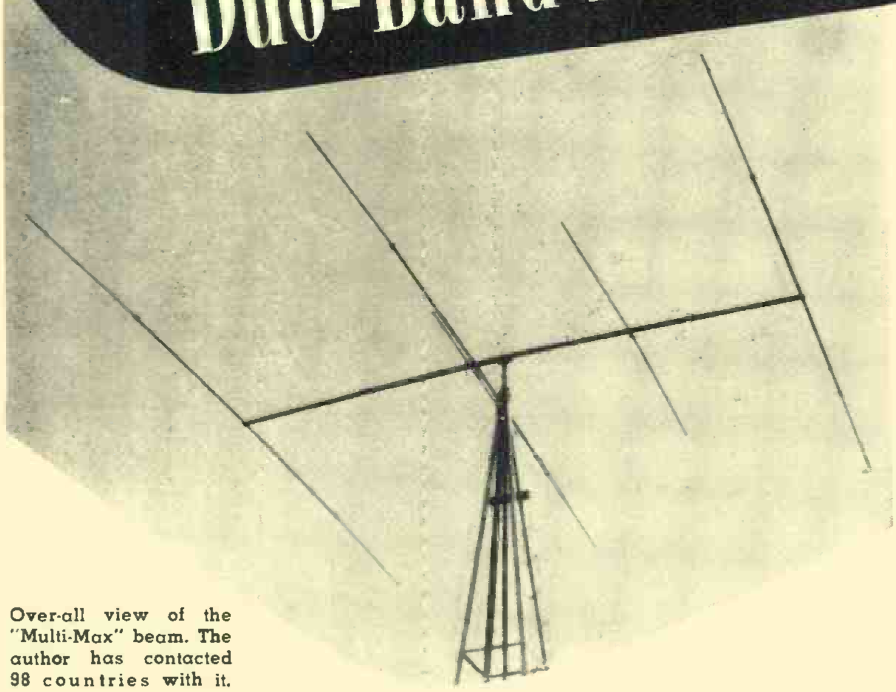
He dials the three transmitters in on frequencies that for the next two hours the airborne operator will be guarding in succession, and starts transmitting the call-sign followed by the message. He repeats, and repeats again. When transmission has been completed the ground operator logs the message and listens out. In a minute or so he will be able to hear another ground operator repeating the transmission from a point a little further along the axis of communications.

On the mission, in the aircraft, the airborne operator is keeping an eye on the clock for frequency changes in accordance with his briefing chart. As he makes his first shift at the appointed time, he hears his call sign deep down in the "hash." He rapidly shifts back to his previous frequency and can barely make out his signal in the noise. He shifts up again to the previous channel and turns his receiver to "sharp" reception. He fishes around a moment then hears his call-sign coming in loud and clear.

He copies the message the first time over and waits for the repeat to verify the text and the authentication. He consults his code book. No, (*Continued on page* 154)

Duo-Band Ham Antenna

By
C. L. BUCHANAN, W3DZZ



Over-all view of the "Multi-Max" beam. The author has contacted 98 countries with it.

Covers both 10- and 20-meter bands. In one year, using a 100-watt transmitter, 98 countries have been worked.

ONE of the most serious objections to the use of parasitic arrays has been the fact that this type of antenna is essentially a one-band affair. In spite of this limitation its obvious advantages have caused its wide acceptance by the amateur. Many attempts have been made to overcome this limitation, some with considerable success.

The antenna system described herein uses a principle of operation which eliminates the necessity for mechanical switches or "black boxes." In addition, this antenna system can be designed to operate on any number of bands which need not be harmonically related.

The frequency sensitive circuit used to control the element lengths in this design is the familiar parallel resonant circuit. Such "traps" have been used extensively by amateurs in preventing BCI, and their use in series with an antenna has been suggested by Terman for multi-band reception.

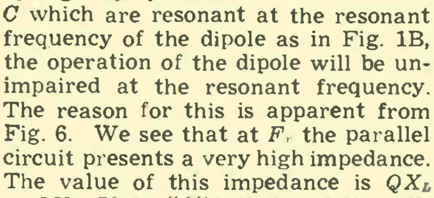
The theory of operation of the *"Multi-Max"* is simplicity itself at the design center frequency. At other frequencies the operation is much more difficult to predict.

The familiar dipole (see Fig. 1A) is the old standby and its performance is taken as the standard of antenna comparison.

If the insulators at the ends of the dipole of Fig. 1A are replaced by high *"Q"* parallel circuits of *L* and *C* which are resonant at the resonant frequency of the dipole as in Fig. 1B, the operation of the dipole will be unimpaired at the resonant frequency. The reason for this is apparent from Fig. 6. We see that at F_r the parallel circuit presents a very high impedance. The value of this impedance is QX_L or QX_c. If the *"Q"* is high and X_L or X_c is high the circuit will work very well as an insulator at F_r. If, however, the dipole is excited at a frequency other than F_r the parallel circuit becomes reactive as shown in Fig. 6, and the value of the impedance is reduced. Fig. 7A shows the equivalent circuit of the antenna above resonance and Fig. 7B shows that below resonance. A practical dipole for 10 and 20 meter operation is shown in Fig. 7C.

At 29 mc. this antenna operates as an ordinary dipole with the "traps" serving as insulators. Over the limits of the 10-meter band no detrimental effects were observed. When excited at 20 meters the impedance of the traps is quite low and is inductive. The lengths of antenna beyond the traps is adjusted to cause the antenna to resonate at this frequency. As seen from the dimensions, the total length of the antenna is considerably shorter than normal due to the series inductance of the traps. The center impedance of this antenna is not appreciably different than that of an ordinary dipole.

Fig. 1. (A) A standard dipole antenna. (B) A two-band dipole for ham band operation.



If ordinary condensers were used in the trap circuits, a weather-proof enclosure and a strong mechanical support would be required. It is also necessary that the voltage rating of the condenser be very high since with any appreciable power the voltage at the end of a dipole antenna is quite high. These requirements were met by constructing the high frequency section of the antenna of large dural tubing and the low frequency extensions of small tubing with an insulating bushing between them. The inductor is connected across the bushing by metal clamps. The resonant frequency of the trap is adjusted by moving one of these clamps, causing the coil to lengthen or shorten. The mechanical construction of a practical trap for 10 meter operation is shown in Fig. 2.

The capacitance across the bushing is approximately 25 $\mu\mu$fd. and the *"Q"* of the trap at 30 megacycles is over 300. The effective resistance of the coil at resonance is, therefore, several megohms and the insulation is sufficient for operation at several thousand volts. The coil consists of 5 turns of 1/8 inch copper tubing approximately 3 inches in diameter and 3 inches long, mounted concentric with the element as shown. The polystyrene bushing is extended beyond the large size tubing to provide a long surface leakage path. When assembled, a generous coating of silicone compound was used to protect the surface of the plastic against crazing, and to prevent the entrance of moisture into the spaces between the tubing and the bushing. The end of the large tubing was slit with a hack saw so that when the inductance clamp is tightened the bushing is securely held in the end of the tubing. The small tubing was pressed into the bushing which had been reamed to exact dimension. The dipole shown in Fig. 7C used the traps shown in Fig. 2. This dipole was tested on both 10 and 20 meters and compared on each band with a dipole cut for that band. No measurable difference could be found.

Having developed the technique of

working with multi-frequency dipoles, a parasitic array was built to test the operation of such dipoles as parasitically-excited elements. Since the previous antenna used for 10 meter operation at W3DZZ was a four-element, wide-spaced parasitic array, it was decided to make the new antenna a four-element array too. Since, however, the element spacing on 20 meters would be electrically only half as great as that on 10 meters, it was decided to use only three elements on 20 meters. Previous experimental results have shown that little additional gain is obtained by using two directors spaced at one-tenth wavelength intervals over a single director spaced two-tenths from the driven element. The spacing decided upon was: Reflector spaced .3 wavelength from the antenna, one director spaced .2 wavelength from the antenna while the second director is placed .2 wavelength from the first director on 10 meters. On 20 meters this spacing becomes .15 wavelength from reflector to antenna and .2 wavelength from antenna to the director. The calculated impedance of such an array is about 15 ohms on each band.

The boom for the array was constructed of two 12-foot lengths of 2¼ inch dural tubing spliced together by a 20-inch length of the same material. A ⅜ inch slit was cut from this piece which allowed it to be collapsed sufficiently to be forced into the ends of the 12-foot sections. If the width of the slot is accurately maintained a very strong splice can be obtained. The forward director and the reflector were mounted by cutting a hole through each end of the boom and inserting the element into the boom. A bolt through the joint securely holds the element in place. The hole through the boom must be accurately made to hold the element at right angles to the boom. In order to preserve the strength of the boom, the driven element and the first director were mounted by means of machined collars constructed as shown in Fig. 3. The element is held in place by "U" bolts.

Each of the elements is made of four sizes of tubing as shown in Fig. 4 except, of course, the 10 meter first director, which consists of a 12-foot section of ⅞ inch diameter dural tubing with ¾ inch inserts in each end. When completely assembled the antenna weighs only 37 pounds.

Tuning the Beam

Tuning and adjusting the beam was done in three steps as follows:

1. Adjust the 10 meter array with no traps or extensions.
2. Adjust the traps.
3. Adjust the 20 meter array.

For tuning purposes the beam was set up on a 20-foot "A" frame mast with a hinged arrangement so all adjustment could be made from the ground. Such an arrangement allows tuning the antenna at a considerable height and still affords the safety of working on the ground all of the time.

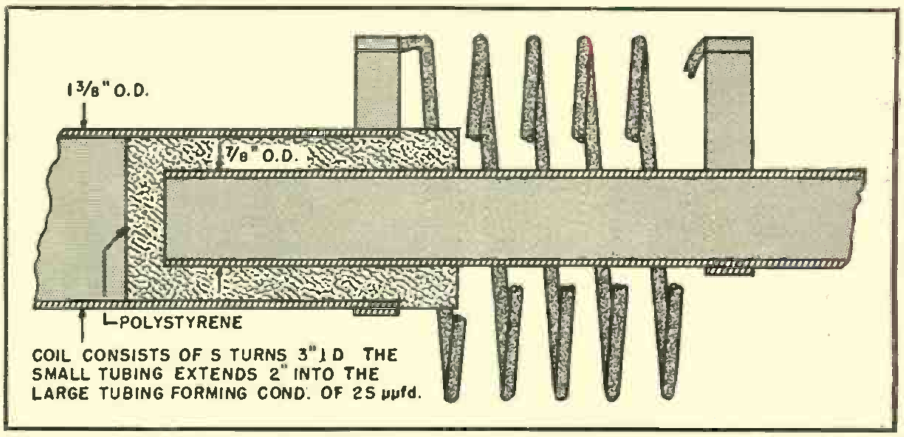


Fig. 2. Practical trap circuit for antenna applications. The length of the coil is adjusted to resonate the trap to the center of the ten meter amateur band.

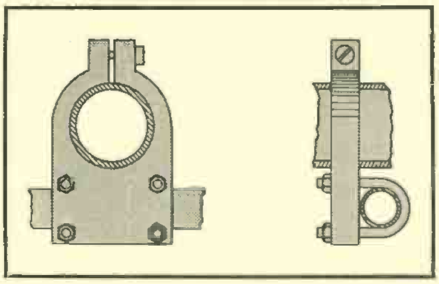


Fig. 3. Mechanical details of element clamp.

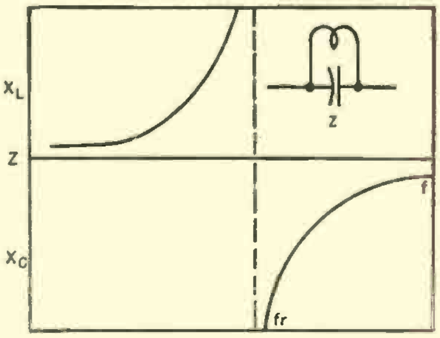


Fig. 6. Impedance of parallel tuned trap.

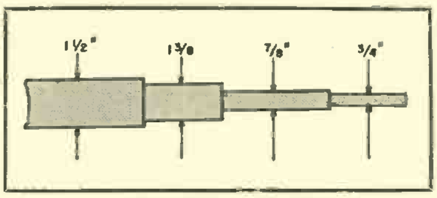
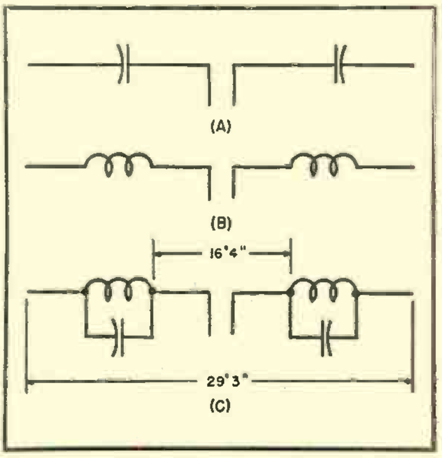


Fig. 4. Construction details of elements. All of the tubings used have .049" walls.



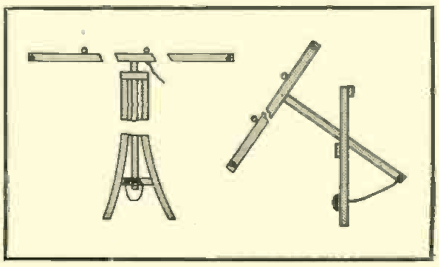
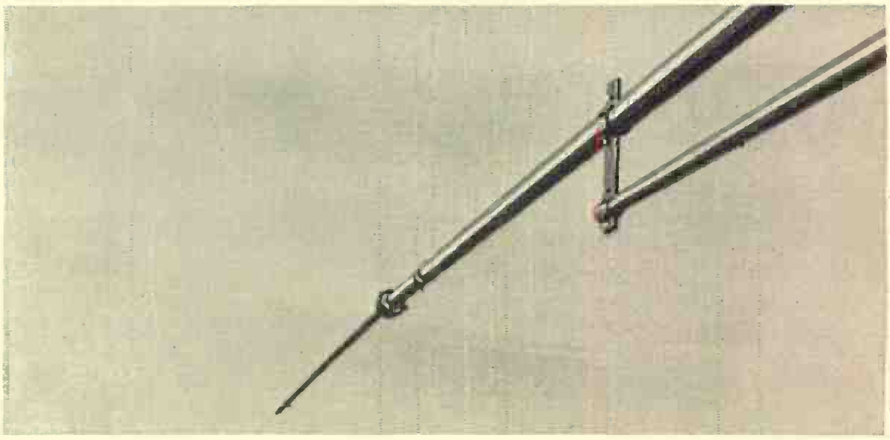


Fig. 5. Details of the temporary support which is used to facilitate the tuning.

Fig. 7. Equivalent circuit (A) above resonance, and (B) that below resonance. (C) A practical ten and twenty meter dipole.

Close-up view of the "T" match section of the antenna. Loading coil is also visible.



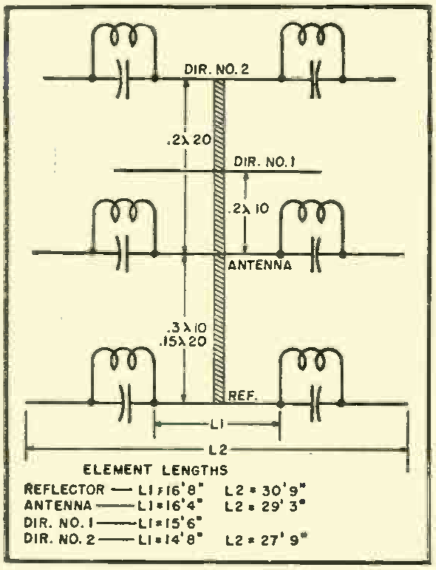


Fig. 8. Details of the "Multi-Max" beam.

A rough idea of the construction can be gleaned from Fig. 5. The hinge should be located just below the center of gravity of the antenna and the pipe mast combined, in order that the antenna will be entirely stable in the lowered position. The antenna can be lowered by merely swinging the bottom of the mast away from the "A" frame with a tie rope to keep it from swinging out farther than necessary.

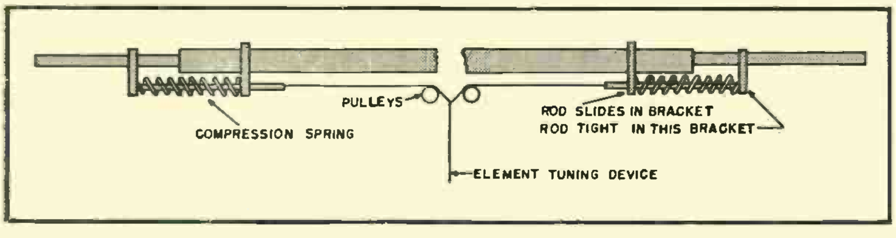
The actual adjustment of the element lengths is greatly facilitated if a set of tuning gadgets such as those shown in Fig. 9 are used.

The sliding joints must work smoothly so the springs can force the element extensions back out after having been drawn in. The control line may be brought over suitable pulleys to end in a loop. A board should be secured to the pipe mast near the bottom and a series of nails or pegs driven in at about 1-inch intervals. The loop in the control line can then be hooked over the proper peg. The tuning procedure is to pull the control line down until the tuning indicator used shows that the point of maximum gain (or attenuation) has been passed, and then release the line slowly and repeat until the exact point is found. Other variations of this idea will no doubt suggest themselves to the reader. If necessary, the control line can be fastened directly to the end sections of the elements without the spring and clamps. The tuning system then will work in only one direction, but if the indicator is watched carefully, one or two trials will permit an accurate determination of the proper length.

The beam was set up without the traps or 20 meter extensions. A test dipole was set up about four wavelengths away from the antenna and at the same height. A crystal diode was inserted in the center of this dipole with an r.f. choke from each side of the crystal to the end of a 75 ohm transmission line. The transmission line extended from the test dipole to a point near the beam where it terminated in a d.c. meter. Any low range d.c. meter can be used for this purpose, but some means will be required for shunting the meter when testing for forward gain since otherwise the range of the meter will be inadequate. Better still, one of the meters from the antenna switching unit of the command sets can be used. These meters are calibrated to read r.f. current with an external thermocouple. It is interesting to note that the scale on this instrument is linear. With the thermocouple removed the meter becomes a logarithmic d.c. ammeter with a full scale current of 6 ma. Used in a test setup as described the meter will read approximately linear in db. with a scale factor of around 3 depending on the characteristics of the line and the dipole and crystal used. The scale factor is easily checked by making two readings at different power levels. The 30 db. range is ideal for such tests.

The beam was fed through a length of 75 ohm twin lead "T" matched to the driven element. No special precautions were taken to get a correct match, but rather to get sufficient power into the antenna. With the antenna pointed toward the test dipole the elements were adjusted one at a time for maximum reading on the logarithmic meter. After all the elements had been adjusted, they were rechecked twice to eliminate errors caused by retuning the second element after the first one had been set, etc. It is suggested that the first director be adjusted first since it is the more critical as far as forward gain is concerned. After this procedure was completed, the beam was reversed to point directly away from the test dipole. Each element was then readjusted for minimum back radiation. The length of each element was carefully noted during these adjustments and it was found that there was very little difference in the adjustment for maximum forward gain and that for minimum backward radiation. Slight changes in the reflector length had very little effect on the forward gain but had a considerable effect on the backward radiation. The front-to-back ratio of the array at 29 mc. was almost 30 db.

Fig. 9. Mechanical details covering the device used for tuning the antenna elements.



The 10 meter section of the antenna was now finished and ready for the assembly of the traps and extensions. The traps were tuned by assembling them on short pieces of tubing and adjusting the length of the coil until the resonance point, as measured by a grid dip meter, was exactly 29 mc. In the process each coil was numbered and its length noted when the trap was resonant at 28.9 mc. 29.0 mc., and 29.1 mc. When this process was completed for each trap, all the traps were assembled on the 20 meter extensions. With the beam still energized on 10 meters, the 20 meter extensions with their associated traps tuned to 29.0 mc. were added, one at a time, to the adjusted 10 meter beam. Surprisingly enough the addition of these traps and extensions had no noticeable effect on either the forward or backward radiation, or on the loading of the beam.

The beam was now energized on 20 meters and the tuning procedure repeated in the same manner as for the 10 meter section. The front-to-back ratio on 20 meters was higher than that for 10 meters, probably due to the closer reflector spacing. The length of the elements at 20 meters was considerably shorter than normal due to the series inductance of the traps at this frequency. The antenna was again excited on 10 meters and no change in the beam patterns or gain was noted. The final dimensions are shown in Fig. 8 with the "finished product" shown in the photograph.

During the adjustment the SWR on the feedline was not known since no attempt had been made to adjust the match. A plot was now made of SWR *vs* "T" match length for each band. The two curves crossed each other at a SWR of 1.4:1 with a length of 106 inches. This was not considered too high for use and it eliminated the necessity of constructing a complicated matching network. The patterns were rechecked on both bands to make sure that the "T" match adjustment had not upset the adjustment of the beam. No such effect was observed.

When adjusting a "T" match, the matching section should be made of telescoping tubing in order to prevent any of the tubing from extending beyond the clamps. If this is not done the reactance of the short length of tubing beyond the clamps will be reflected back into the system. If at the end of the adjustment, these lengths are cut off, the SWR will change.

General Details

The appearance of the antenna is more conventional than might be expected. The traps are hardly visible from a distance and the element sag is no worse than in a regular 20 meter beam.

Operation of the antenna at frequencies between the two "fundamental" frequencies is of interest. If, for example, the excitation frequency is

(*Continued on page* 73)

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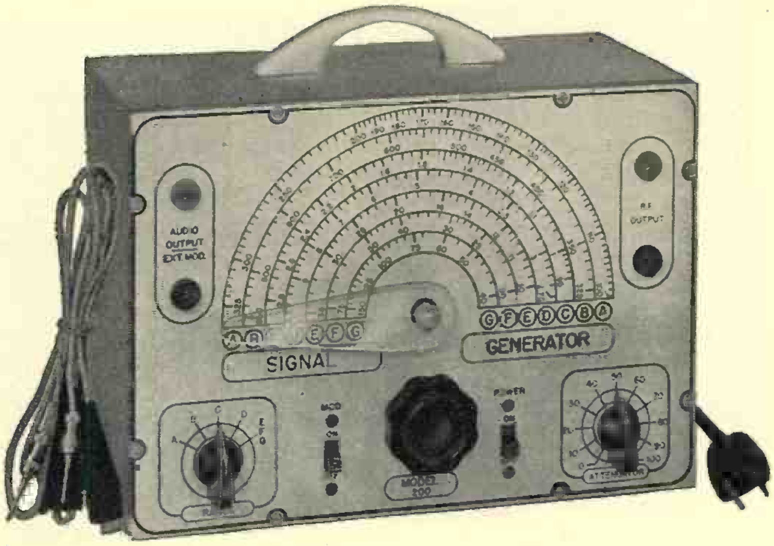
But that's not all! In addition, this finely engineered instrument provides a degree of accuracy never before attained in a unit selling for even double this price. Furthermore—in designing this unit, we took advantage of every recent improvement in components. For example, by using slug-tuned coils, we are able to efficiently adjust each instrument for perfect accuracy. This feature will also enable you to recalibrate the model 200 periodically without having to return it to the factory. The use of a Noval tube (the 12AU7) with its extremely low inter-electrode capacity enabled us to reach a higher frequency range than was heretofore possible in a unit of this type.

THE NEW MODEL 200 **AM and FM**

SIGNAL GENERATOR



SPECIFICATIONS

★ **R.F. FREQUENCY RANGES:** 100 Kilocycles to 150 Megacycles.

★ **MODULATING FREQUENCY:** 400 Cycles. May be used for modulating the R. F. signal. Also available separately.

★ **ATTENUATION:** The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the output cable.

★ **OSCILLATORY CIRCUIT:** Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.

★ **ACCURACY:** Use of high-Q permeability, tuned coils adjusted against 1/10th of 1% standards assures an accuracy of *1% on all ranges from 100 Kilocycles to 10 Megacycles* and an accuracy of 2% on the higher frequencies.

★ **TUBES USED:** 12AU7—One section is used as oscillator and the second is modulated cathode follower. T-2 is used as modulator. 6C4 is used as rectifier.

The Model 200 operates on 110 Volts A.C. Comes complete with output cable and operating instructions.

$18.85 NET

2

TO ORDER—TURN TO PAGE 72 FOR RUSH ORDER FORM

GENERAL ELECTRONIC DISTRIBUTING CO.

DEPT. RN-12, 98 PARK PLACE, NEW YORK 7, N. Y.

MONEY BACK GUARANTEE!!

SUPERIOR'S new model 770 **AN ACCURATE POCKET-SIZE**

VOLT-OHM MILLIAMMETER

(SENSITIVITY: 1000 OHMS PER VOLT)

FEATURES

★ Compact-measure 3⅛" x 5⅞" x 2¼".

★ Uses latest design 2% accurate 1 Mil. D'Arsonval type meter.

★ Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range.

★ Housed in round-cornered, molded case.

★ Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

SPECIFICATIONS

6 A.C. VOLTAGE RANGES:
0—15/30/150/300/1500/3000 VOLTS

6 D.C. VOLTAGE RANGES:
0—7.5/15/75/150/750/1500 VOLTS

4 D.C. CURRENT RANGES:
0—1.5/15/150 MA. 0—1.5 AMPS.

2 RESISTANCE RANGES:
0—500 OHMS 0—1 MEGOHM

$14.90 NET

SUPERIOR'S new model 670 **SUPER-METER**

***A COMBINATION* VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS**

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts

A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes

RESISTANCE: 0 to 500/100,000 Ohms 0 to 10 Megohms

CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics)

REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms

INDUCTANCE: 1.75 to 70 Henries 35 to 8,000 Henries

DECIBELS: —10 to +18 +10 to +38 +30 to +58

ADDED FEATURE:

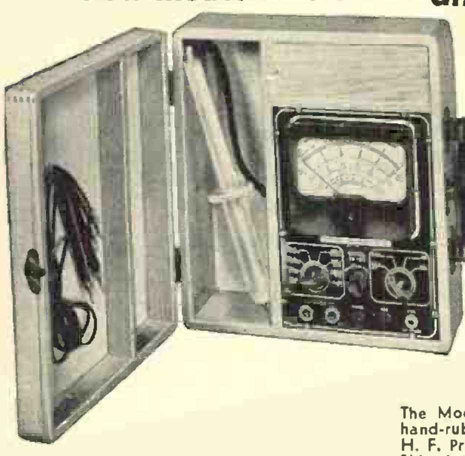
The Model 670 includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

SUPERIOR'S *new model TV-20*

20,000 OHMS PER VOLT MULTI-METER and TELEVISION KILOVOLTMETER



SPECIFICATIONS

- 9 D. C. VOLTAGE RANGES: (At 20,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000/50,000 Volts
- 8 A. C. VOLTAGE RANGES: (At 1,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000 Volts
- 5 D. C. CURRENT RANGES
  0-50 Microamperes
  0-5/50/500 Milliamperes
  0-5 Amperes
- 4 RESISTANCE RANGES:
  0-2,000/20,000 ohms 0-2/20 Megohms
- 7 D. B. RANGES: (All D. B. ranges based on ODb = 1 Mv. into a 600 ohm line)
  — 4 to + 10 db
  + 8 to + 22 db
  + 22 to + 36 db
  + 28 to + 42 db
  + 36 to + 50 db
  + 42 to + 56 db
  + 48 to + 62 db
- 7 OUTPUT VOLTAGE RANGES:
  0 to 2.5/10/50/100/250/500/1,000 Volts

ADDED FEATURE:

The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20, the V. H. Probe converts the unit into a Negative Peak-Reading H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V.; check capacity and impedance; test efficiency of all oscillator circuits; measure band-width of F. M. and T. V.; etc.

The Model TV-20 operates on self-contained batteries. Comes housed in beautiful hand-rubbed oak cabinet complete with portable cover. Built-in High Voltage Probe. H. F. Probe. Test Leads and all operating instructions. Measures 4½" x 10¼" x 11½". Shipping Weight 10 lbs.

$39.95 NET

TO ORDER—TURN TO PAGE 72 FOR RUSH ORDER FORM

GENERAL ELECTRONIC DISTRIBUTING CO.

98 PARK PLACE DEPT. RN-12 NEW YORK 7, N. Y.

3

Superior's model CA-12

SIGNAL TRACER

THE WELL KNOWN MODEL CA-12 IS THE ONLY SIGNAL TRAILER IN THE LOW PRICE RANGE INCLUDING BOTH METER AND SPEAKER!!!

SPECIFICATIONS

- ★ Comparative Intensity of the signal is read directly on the meter—quality of the signal is heard in the speaker.
- ★ Simple to Operate—only one connecting cable—no tuning controls.
- ★ Highly Sensitive—uses an improved vacuum-tube voltmeter circuit.
- ★ Tube and Resistor Capacity Network are built into the detector probe.
- ★ Built-in High Gain Amplifier—Alnico V Speaker.
- ★ Completely Portable—weighs 8 pounds—measures 5½" x 6½" x 9".

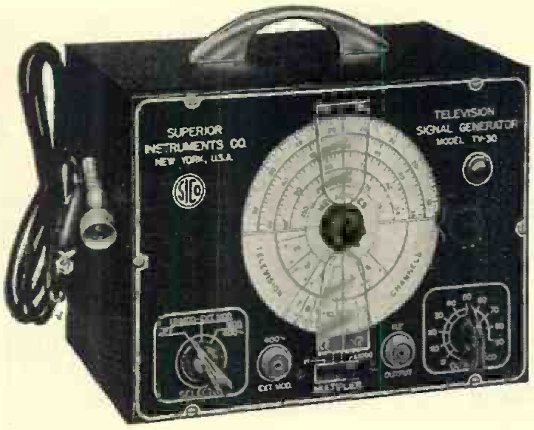
MODEL CA-12 COMES COMPLETE WITH ALL LEADS AND OPERATING INSTRUCTIONS

$29.95 NET

Superior's new model TV-30

TELEVISION SIGNAL GENERATOR

ENABLES ALIGNMENT OF TELEVISION I. F. AND FRONT ENDS WITHOUT THE USE OF AN OSCILLOSCOPE!



FEATURES Built-in modulator may be used to modulate the R. F. Frequency, also to localize the cause of trouble in the audio circuits of T. V. Receivers.

Double shielding of oscillatory circuit assures stability and reduces radiation to absolute minimum.

Provision made for external modulation by A. F. or R. F. source to provide frequency modulation.

All I. F. frequencies and 2 to 13 channel frequencies are calibrated direct in Megacycles on the Vernier dial. Markers for the Video and Audio carriers within their respective channels are also calibrated on the dial.

Linear calibrations throughout are achieved by the use of a Straight Line Frequency Variable Condenser together with a permeability trimmed coil.

Stability assured by cathode follower buffer tube and double shielding of component parts.

SPECIFICATIONS Frequency Range: 4 Bands—No switching; 18-32 Mc., 35-65 Mc., 54-98 Mc., 150-250 Mc.

Audio Modulating Frequency: 400 cycles (Sine Wave). Attenuator: 4 position, ladder type with constant impedance control for fine adjustment. Tubes Used: 6C4 as Cathode follower and modulated buffer. 6C4 as R.F. Oscillator. 6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions. Measure 6" x 7" x 9". Shipping Weight 10 lbs.

$29.95 NET

RUSH ORDER FORM

CUT OUT AND MAIL TODAY!

4

GENERAL ELECTRONIC DISTRIBUTING CO.
DEPT. RN-12, 98 PARK PLACE, NEW YORK 7, N. Y.
GENTLEMEN:
PLEASE RUSH THE MATERIAL LISTED BELOW:

QUANTITY	MODEL	PRICE	

TOTAL

$............(Payment in Full Enclosed) $.............(Deposit Enclosed—Ship Balance C.O.D.)

SHIP TO:

Name ....

Address ....

City .... Zone .... State ....

Duo-Band Antenna

(*Continued from page* 68)

decreased starting at 29 mc. the dipole proper becomes too short. At the same time, however, the trap impedance is reduced and begins to be inductive. At some lower frequency the inductance of the trap and the reactance of the 20 meter extension offset the foreshortening of the dipole and the system again becomes resonant. By proper choice of the element size and the *LC* ratio of the traps, the frequency of this resonance can be caused to fall in the 11 meter band. The antenna described here works well in this band although the front-to-back ratio suffers appreciably. To correct the front-to-back ratio on this band without spoiling it on the other bands would probably require the use of different *LC* ratios in the various elements. It would probably help also if the first director was made a two-band element like the others. This, of course, would immediately make the problem of matching more difficult.

The circuits of Fig. 7 indicate that this type of antenna has certain broadband characteristics. In practice the antenna has worked well over the entire 10 and 20 meter phone bands and no other check on this factor has been made.

Since the antenna was intended to radiate on 10 meters, it was feared that radiation on this band when working in the 20 meter band might be excessive. Strangely enough, this has not been found to be true. The explanation apparently is that harmonics are generally coupled into the antenna system capacitively. In this antenna system the feedline is a low impedance to the second harmonic as well as the fundamental, and therefore the energy getting into the antenna through these stray capacitances is less than with the normal 20 meter antenna where the feedline impedance is high at the second harmonic.

Operation

The antenna was mounted on a 40 foot windmill tower and fed through 120 feet of 75 ohm twin-lead. No antenna tuner was used and no difficulty was experienced in loading it on either band when link-coupled to the final amplifier. The transmitter was the old 100 watt standard—push-pull 807's.

The antenna was put into operation a few days before the DX contest in March, 1949. In eight hours of operation on 10 meter phone (during the contest), 47 contacts were made with 17 countries. After the contest was over operation on 20 meters was tried. The results were equally good on this band. In approximately one year of operation 98 countries have been contacted, mostly on 20 meter phone.

It should be understood that this antenna is no better on either band than a similar single-band beam designed, constructed, and adjusted, with equal care. —30—

THE AD-VISER

4 ADVERTISING COPY MUST SELL THE PRODUCT

By
IRVING SETTEL

COPY refers to the reading matter of an advertisement. Its purpose is to stimulate sales by attracting the reader's attention and maintaining his interest in the advertised product. An effective piece of copy will sell merchandise. There is no other measurement.

Many radio and television merchants insist on writing their own copy for newspaper advertisements and direct mail pieces. Even when advertising departments are maintained, supervision may be desirable or necessary. Consequently, a few of the more important rules of effective copy writing will not be amiss.

Important Rules

1. *Address your copy to the reader.* The ultimate consumer is the most important critic of the advertisement. If he reads the copy, he may or may not act upon its suggestions. Remember that he is human. He possesses emotions, opinions, and preferences. Adjust your copy appeal to his wants and desires. Talk in terms of what you believe your potential customer wants to get out of the product. Instead of saying, "*We* have the lowest prices in town," say, "Here's a place that's easy on *your* pocketbook." Tell the reader how *he* will benefit from the purchase. Don't talk in terms of your needs because the reader is interested only in satisfying his own.

2. *Know the claims and advantages of your competitor's products.* Always watch your competitor's advertisements. If you feel that he is outselling you, change your copy accordingly. Always compare and improve your own copy content and ideas.

3. *Make your copy "clear, simple, and specific."* Modern readers are always in a hurry. The reading life of an average newspaper is about 15 minutes. Readers will not waste time reading unnecessary material. They prefer, instead, to get the message quickly and clearly. A good copy writer gives a reader what he wants. Clever phrases and catchwords are all right, if they do not detract from the thought. This does not mean that you should "write down" to what you believe to be the level of public intelligence. Never assume that the reader is stupid. It does mean, however, that you should write plainly.

Types of Copy

Institutional Copy. Institutional copy is designed to create goodwill for the radio and television retailer. It usually describes the store's policies, ideals, payment plans, etc., in order to build prestige. It is not aimed at immediate sales but instead at long range attitudes. Because of this, it is used infrequently, usually on holidays such as Easter or Christmas.

Promotional Copy. This type of copy is aimed at immediate sales. In this case, an advertiser will attempt to bring a customer into his place to make a purchase. This type of copy, of course, makes up the bulk of current advertising.

It is also called "selling copy" and it may talk about the advantages of the radios and television sets, prices, benefits derived from their use, etc. Copy in a promotional ad can either make or break a sale. Either it will create the desire to buy or it will be a dud. Consequently, great care must be taken in the writing of promotional copy.

Writing the Copy

You do not have to be a great writer to turn out effective copy. If you follow a few basic rules, and write as you would make a *sales talk,* you can bring customers into your place of business with the magic of words. Here are the rules:

Watch your grammar. Correct grammar and spelling are essential. Mistakes are seen immediately by the reader and the sales message may be lost.

Choose simple words which are pleasant to read. Do not waste the reader's time or patience. Tell what your products are, what they will do, how they will benefit the reader. Don't try to be too clever with words or trick phrases, with a play on words. Remember that the most effective advertising copy written is clear down-to-earth language.

Make your copy as short as possible. Always remember that a reader is instinctively in a hurry. Save him time by writing your message in the fewest possible words.

Write in terms of the reader's needs. Remember that an advertisement is

YOUR OPPORTUNITY IS HERE NOW!

LEARN TELEVISION

RIGHT AT HOME!

By the new method of

TRANSpONDENCE

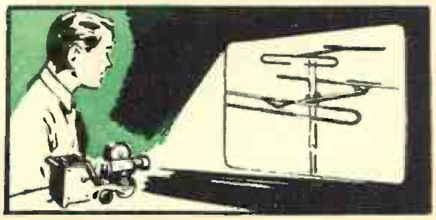
training on film and tape recordings

Now the De Forest-Sanabria Corporation—a division of the world's largest television training school—brings *class-room instruction* to you right in your own home! You actually hear your instructor's *recorded* voice. At the same time you watch "blackboard" size projected pictures, diagrams and illustrations. It's the quick, easy way to equip yourself for the big earnings in television—*today!*

LOOK . . . *You get the tape recorder and projector right at the start of your course!*

HEAR ***your instructor***

It's even better than the classroom, because you can *repeat* the instructor's lectures until they're thoroughly understood.



SEE ***2000 illustrations***

You learn quicker when you see diagrams and illustrations in *blackboard size.*

You get the famous "TRANSPONDER" precision built, high fidelity tape recording machine with your very first lesson—*and* a powerful projector with which you can view diagrams and illustrations enlarged to a size that makes them easy to see and understand.

READ ***from reference library***

You receive complete books, pamphlets and manuals to supplement your instructor's lessons.

ASK ***your questions on tape***

Tell your instructor about anything that puzzles you and get his answers back pronto.

BE A SUCCESS . . . ACT NOW!

Millions of television set owners are demanding qualified television technicians to service their sets. There is a tremendous shortage of such qualified men today and will be for many years to come. Get in on the ground floor of this booming industry and be prepared to accept a steady, big pay job for life. We can qualify you quickly, easily, surely—and help get you a job when you complete your course. Send for illustrated booklet that gives the complete details.

The De Forest-Sanabria Corp.
An affiliate of American Television, Inc.
5050 North Broadway, Chicago 40, Illinois

MAIL COUPON TODAY!

De Forest-Sanabria Corporation
Dept. RN-12
5050 Broadway, Chicago 40, Ill.

FREE BOOK TELLS HOW

Dear Sirs:
Please send me copy of your free illustrated booklet which describes the new TRANSPONDENCE method of learning television at home under the direction of Dr. Lee de Forest and U. A. Sanabria.

NAME ______________________ AGE ______
ADDRESS ______________________
CITY ______________________ STATE ______
(Mail in envelope or paste on a postcard.)

often forced upon a reader's attention. Therefore, you must portray in your copy an understanding of the reader's needs and desires. Suggest that the person buy the radio or television set, not because your store is selling them, but because they will benefit the user.

Many ads use illustrations of various types to expand and amplify the copy or reading material. Since there are several effective ways of displaying your merchandise in your advertisements we will discuss these different techniques in some detail in next month's article.

—30—

"Williamson" Amplifier
(Continued from page 53)

left to the discretion of the builder. Care should be taken in the wiring to ground the filament line adjacent to pin No. 7 on the 6SJ7 stage. This tube is biased by a combination of cathode and grid leak bias; an arrangement that minimizes tube noise.

Performance

The distortion-free characteristics of the amplifier are immediately apparent upon the first playing. The lack of false bass response and bass transient hangover is also striking, and can be attributed to the exceptionally low output impedance of the amplifier which is in the neighborhood of three-tenths of an ohm on the sixteen ohm tap. The damping factor seen by the speaker is, therefore, about 48, and results in a real improvement in the transient characteristics of the speaker.

The curves taken of intermodulation, shown in Fig. 4, reveal the low distortion content of the output. It is clearly seen that the 10 watt rating of the amplifier is a conservative one, since for any condition of measurement the intermodulation is less than 1%. It might also be mentioned that these curves were taken at a lower-than-normal plate supply voltage of 400 volts on the 807 output tubes. For

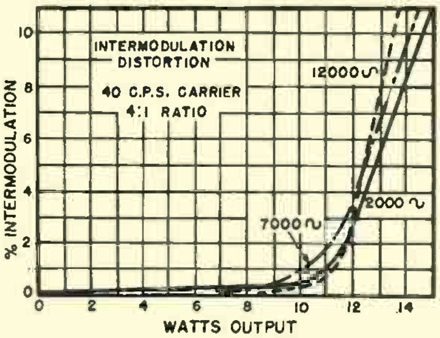


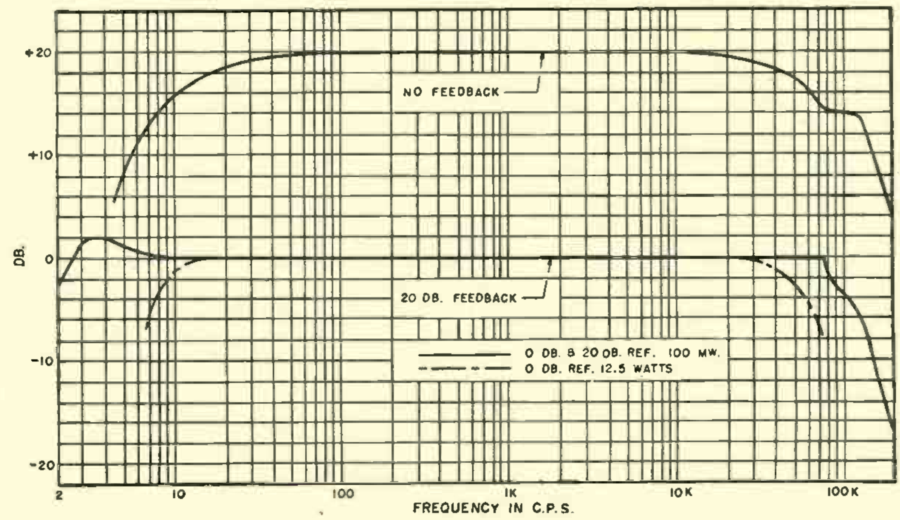
Fig. 4. Intermodulation distortion.

the normal plate supply voltage of 425 volts, about 15% more output or 11.5 watts can be expected for the same amount of intermodulation distortion.

The excellent transient characteristics of the amplifier can be deduced from the frequency response curve shown in Fig. 5. The response is shown for a 100 milliwatt output level and under the conditions both with and without feedback. The influence of the output transformer can easily be judged from these curves. Without feedback the response is down 3 db. at 55 kc. and at 12 c.p.s. It should be noted that this response is that of the complete amplifier and includes the normal roll-off in gain of the individual stages as caused by the tube input capacities and the effect of the stage coupling condensers. With feedback the curve is flat to 75 kc. and lacks the usual resonant rise associated with feedback amplifiers at the high frequency end of the band; a condition that causes ringing and a dissipation of power at unwanted frequencies. The response at maximum output power taken with distortion limited to 2% is also noteworthy and indicates the undistorted response to be down only 3 db. at 8 c.p.s. and at 50 kc.

It is the excellence of these results and the uniformity with which they may be achieved that is largely responsible for the growing popularity of the Williamson amplifier.

—30—

Fig. 5. Frequency response characteristics of the audio amplifier.


You GET THE BEST IN Heathkits

Heathkits are the Quality Line of TEST INSTRUMENT KITS

Modern STYLING KITS THAT MATCH

Heathkits are styled in the most modern manner by leading industrial stylists. They add beauty and utility to any laboratory or service bench. There is a complete line of Heathkit instruments allowing a uniformity of appearance.

An attractive service shop builds a feeling of confidence. Many organizations have standardized on Heathkits providing uniform service departments.

There is no waste space or false effort to appear large in Heathkits — space on service benches is limited and the size of Heathkit instruments is kept as small as is consistent with good engineering practice.

Famous HEATHKIT PARTS

- MALLORY FILTER CONDENSERS
- WILKOR PRECISION RESISTORS
- GRIGSBY ALLISON SWITCHES
- ALLEN-BRADLEY RESISTORS
- GENERAL ELECTRIC TUBES
- CHICAGO TRANSFORMER
- CENTRALAB CONTROLS
- SIMPSON METERS
- CINCH SOCKETS

Complete KITS WITH PARTS THAT FIT...

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument.

Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110 V 60 Cy. power tranformer operated by a husky transformer especially designed for the job. Heathkit chassis are precision punched for ease of assembly. Special engineering for simplicity of assembly is carefully considered.

Accuracy ASSURED BY PRECISION PARTS

Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields.

These transformers are built by several of the finest transformer companies in the United States.

Complete INSTRUCTION MANUALS

Heathkit instruction manuals contain complete assembly data arranged in a step-by-step manner. There are pictorials of each phase of the assembly drawn by competent artists with detail allowing the actual identification of parts. Where necessary, a separate section is devoted to the use of the instrument. Actual photos are included to aid in the proper location of wiring.

Used BY LEADING MANUFACTURERS

Leading TV and radio manufacturers use hundreds of Heathkits on the assembly lines. Heathkit scopes are used in the alignment of TV tuners. Impedance bridges are serving every day in the manufacture of transformers. Heathkit VTVM's are built into the production lines and test benches. Many manufacturers assemble Heathkits in quantity for their own use thus keeping purchase cost down.

Used BY LEADING UNIVERSITIES

Heathkits are found in every leading university from Massachusetts to California. Students learn much more when they actually assemble the instrument they use. Technical schools often include Heathkits in their course and these become the property of the students. High schools, too, find that the purchase of inexpensive Heathkits allows their budget to go much further and provides much more complete laboratories.

YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER—USE ORDER BLANK ON LAST PAGE

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The HEATH COMPANY
...BENTON HARBOR 15, MICHIGAN

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT

Only **$39.50**

- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage. The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100.000 cycles

The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2 ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only **$19.50**

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NEW YORK CITY (16)
CABLE: ARLAB-N.Y.

The **HEATH COMPANY**

. . . BENTON HARBOR 15, MICHIGAN

New 1951 • • MODEL V-4A

Heathkit

VTVM KIT

HAS EVERY EXPENSIVE *Feature*

- ★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
- ★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (500 ohm source).
- ★ New accessory probe (extra) extends DC range to 30,000 Volts.
- ★ New high quality Simpson 200 microampere meter.
- ★ New ½% voltage divider resistors (finest available).
- ★ 24 Complete ranges.
- ★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
- ★ Crystal probe (extra) extends RF range to 250 megacycles.
- ★ Modern push-pull electronic voltmeter on both AC and DC.
- ★ Completely transformer operated isolated from line for safety.
- ★ Largest scale available on streamline 4½ inch meter.
- ★ Burn-out proof meter circuit.
- ★ Isolated probe for dynamic testing no circuit loading.
- ★ New simplified switches for easy assembly

New LOW PRICE $23.50

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resisrors.

New 200 microampere 4½" streamline meter with Simpson quality movement Five times as sensitive as commonly used 1 MA meters.

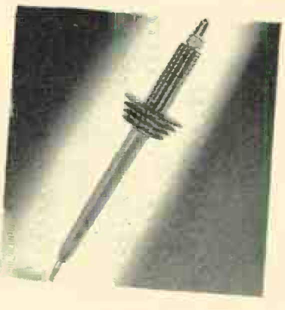
Shatterproof plastic meter face for maximum protection

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs Note new low price, $23.50



New 30,000 VOLT DC PROBE KIT

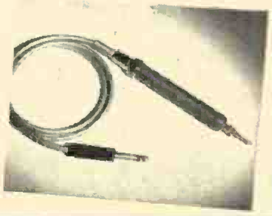
Beautiful new red and black plastic high voltage probe Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety Comes complete with PL55 type plug.

No. 3366 High Voltage Probe Kit. Shipping Wt., 2 pounds. **$5.50**

Heathkit RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles = 10% comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit. Shipping Wt., 1 lb. **$5.50**



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The HEATH COMPANY

... BENTON HARBOR 15, MICHIGAN

NEW *Heathkit* T. V. ALIGNMENT GENERATOR KIT

Shipping Wt., 16 lbs.

$39.50

- ★ New simplified circuit for easy calibration and assembly.
- ★ New 2 band built-in marker covers 19 to 75 Mc.
- ★ New dual spider sweep motor for long life.
- ★ New blanking circuit gives base line for better alignment.
- ★ New variable oscillator gives high output fundamentals on high TV band.
- ★ New standby switch keeps instrument ready for instant use.
- ★ New 6 to 1 slow speed drive on both master oscillator and marker tuners.

The new Heathkit TV Alignment Generator incorporates the new developments required for modern TV servicing. An absorption marker circuit covering all possible IF bands and even several of the RF bands. The new blanking circuit provides a base reference line which is invaluable in establishing proper traces. The new sweep motor incorporates dual spiders in the speaker frame assuring better alignment and long life. The mounting of the speaker sweep motor has been simplified for easy alignment.

The variable master oscillator covers 140 to 230 Mc. thus giving high output fundamentals where they are most needed. Low band coverage 2 Mc. to 90 Mc.

A new step attenuator provides excellent control of output.

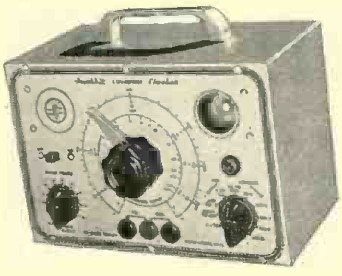
Planetary 6 to 1 drives on both oscillator and marker provides smooth easy control settings.

A standby position is provided making the instrument always instantly available.

Horizontal sweep voltage with phasing control is provided. No other sweep generator under $100.00 provides all these features — comes complete with instruction manual. Model TS-2.

Heathkit CONDENSER CHECKER KIT

Only **$19.50**



Features

- Power factor scale.
- Measures resistance.
- Measures leakage.
- Checks paper-mica-electrolytics.
- Bridge type circuit.
- Magic eye indicator.
- 110 V. transformer operated.
- All scales on panel.

Checks all types of condensers over a range of .00001 MFD to 1,000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read. A leakage test and polarizing voltage for 20 to 500 Volts provided. Measures power factor of electrolytics between 0% and 50%. 110 V. 60 cycle transformer operated complete with rectifier and magic eye tube, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Model C-2. Shipping Wt., 7 lbs.

NEW *Heathkit* SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

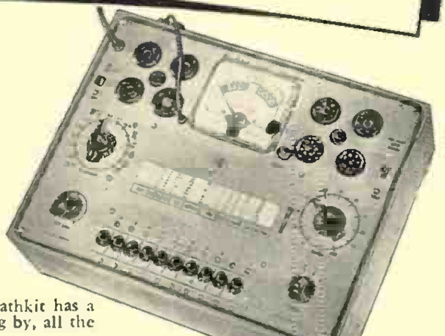
$19.50

Features

- High sensitivity
- Complete set of speaker impedances
- Tests microphones and PA systems
- Tests both single and push-pull speaker circuits

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast — FM or TV receivers. The test speaker has assortment of switching ranges to match push-pull or single output impedance. Also test microphones, pickups, PA systems — comes complete — cabinet, 110 V. 60 cycle power transformer — tubes, test probe, all parts and detailed instructions for assembly and use. Model T-2. Shipping Wt., 8 lbs.

Heathkit TUBE CHECKER KIT



Features

- Sockets for every modern tube — blank for new types.
- Fastest method of testing tubes — saves time — makes more profit.
- Rugged counter type birch cabinet.
- Gear driven roller chart gives instant setup for all types.
- Tests each element separately for open or short and quality.
- Beautiful 3 color meter — reads good-bad and line set point.

Test your tubes the modern way — dynamically — the simplest, yet fastest and surest method — your Heathkit has a switch for each tube element and measures that element — no chance for open or shorted elements slipping by, all the advantages of the mutual conductance type without the slow cumbersome time consuming setups.

Your Heathkit Tube Checker has all the features — beautiful 3 color BAD-GOOD meter — complete selection of voltages — roller chart listing hundreds of tubes including the new 9 pin miniatures — finest quality Centralab lever switches for each element — high grade birch counter type cabinet — continuously variable line adjust control — every feature you need to sell tubes properly. The most modern type tube checker with complete protection against obsolescence. The best of parts — rugged oversize 110 V. 60 cycle power transformer — finest of Mallory and Centralab switches and controls, complete set of sockets for all type tubes with blank space for future types. Fast action brass gear driven roller chart quickly locates the settings for any type tube. Simplified switching cuts necessary testing time to minimum and saves valuable service time. Short and open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangements of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker Kit today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better assemble it now. Complete with instructions — pictorial diagrams — all parts — cabinet — ready to wire up and operate. Model TC-1 Shipping Wt., 12 lbs.

$29.50

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. . . BENTON HARBOR 15, MICHIGAN

NEW 1951 *Heathkit* SIGNAL GENERATOR KIT

Features

- Sine wave audio modulation.
- Extended range 160 Kc. to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 5 to 1 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles; makes this Heathkit ideal as a marker oscillator for T.V. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a husky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers.

A best buy — think of all the features for less than $20.00. The entire coil and tuning assembly are assembled on a separate turret for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator. Shipping Wt., 7 lbs.

$19.50

Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

- Either sine or square wave.
- Stable RC bridge circuit.
- Covers 20 to 20,000 cycles.
- Less than 1% distortion.

Hundreds of Heathkit Audio Generators are used by speaker manufacturers—definite proof of their quality and dependability. The added feature of square wave opens up an entirely new field of amplifier testing. Uses the best of parts, 4 gang condenser, 1% calibrating resistors, metal cased filter condensers, 5 tubes, completely calibrated panel and detailed instruction manual. One of our best and most useful kits. Model G-2. Shipping Wt., 12 lbs.

$34.50

THE NEW *Heathkit* HANDITESTER KIT

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% Precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 Microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-300-1,000-5,000 Volts.
- Large quality 3" built-in meter.

$13.50

A precision portable volt-ohm-milliammeter. An ideal instrument for students, radio service, experimenters, hobbyists, electricians, mechanics, etc. Rugged 400 ua meter movement. Twelve complete ranges, precision dividers for accuracy. Easily assembled from complete instructions and pictorial diagrams. An hour of assembly saves one-half the cost. Order today. Model M-1. Shipping Wt., 2 lbs.

NEW *Heathkit* BATTERY ELIMINATOR KIT

Features

- Provides variable DC voltage for all checks.
- Locates sticky vibrators-intermittents.
- Voltmeter for accurate check.
- Has 4000 MFD Mallory filter for ripple-free voltage.

Even the smallest shop can afford the Heathkit Battery Eliminator Kit. A few auto radio repair jobs will pay for it. It's fast for service, the voltage can be lowered to find sticky vibrators or raised to ferret out intermittents. Provides variable DC voltage 5 to 7½ Volts at 10 Amperes continuous or 15 Amperes intermittent. Also serves as storage battery charger. Ideal for all auto radio testing and demonstrating.

$22.50

A well filtered rugged power supply uses heavy duty selenium rectifier, choke input filter with 4,000 MFD of electrolytic filter for clean DC. 0-15 V. voltmeter indicates output which is variable in eight steps. Easily constructed in a few hours from our instructions and diagrams — better be equipped for all types of service — it means more income. Model BE-2. Shipping Wt., 19 lbs.

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New LABORATORY INSTRUMENT KITS

HUNDREDS OF LABORATORIES USE

Heathkit IMPEDANCE BRIDGE *as Standard*

Features

• Measures inductance 10 microhenries to 100 henries • Measures resistance .01 ohms to 10 megohms • Measures capacitance .00001 MFD to 100 MFD • Measures "Q" and power factor.

Measures inductance from 10 microhenries to 100 henries, capacitance from .00001 MFD to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1,000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1,000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated capacity and inductance standards of Silver Mica, accurate to ½ of 1% and with dissipation factors of less than 30 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

$69.50

Internal 6 Volt battery for resistance and hummer operations. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited. Model IB-1. Shipping Wt., 15 lbs.

NEW *Heathkit* LABORATORY RESISTANCE DECADE KIT

Features

- ½% Accuracy
- Birch Cabinet
- Ceramic Switches
- Covers 1 ohm to 99,999 ohms

The new Heathkit Resistance Decade is a handy tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

$19.50

Uses the finest Centralab ceramic switches, ½% ceramic decade resistors and heavy birch cabinet matching other laboratory equipment. The range is 1 ohm to 99,999 ohms in one ohm steps.

Finest quality throughout to withstand school usage — heavy aluminum panel — laboratory type binding posts — the fine decades are extremely simple to assemble — complete kit. Model RD-1. Shipping Wt., 4 lbs.

NEW *Heathkit* LABORATORY POWER SUPPLY KIT

Features

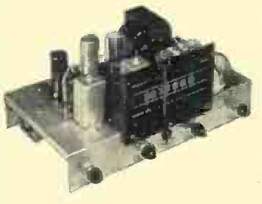
- Supplies 6.3 V. AC at 4.5 Amps.
- Heavy duty construction.
- Handy for schools, labs., and service shops.
- Supplies variable DC 50-300 Volts.
- Shows voltage or current on 3½" meter.

This new Heathkit Variable Power Supply Kit fills hundreds of needs — use it for experimental circuits — no need to build a separate power supply — use it for a test voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltage, etc. This new Heathkit supplies 50 to 300 Volts continuously variable DC together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1 MA 3½" meter has proper shunts to read 0-500 Volts and 0-200 Milliamperes. The circuit uses a 5Y3 rectifier, two 1619 tubes as electronic control tubes to vary the output voltage with a single potentiometer. Case measures 7⅛" x 13" x 7⅛". Has instruction manual for assembly and use. Model PS-1. Shipping Wt., 18 lbs.

$29.50

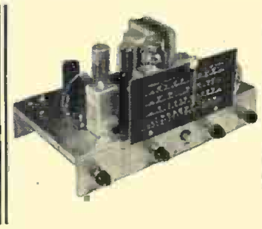
Heathkit RECEIVER & TUNER KITS for AM and FM

TWO HIGH QUALITY *Heathkit* SUPERHETERODYNE RECEIVER KITS



Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt., 10 pounds.

$19.50



Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

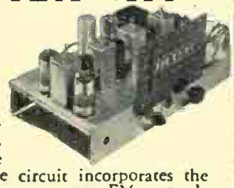
$23.50

Two new Heathkits. Ideal for schools, replacement of worn out receivers, amateurs and custom installations.

Both are transformer operated quality units. The best of materials are used throughout — six inch calibrated slide rule dial — quality power and output transformers — dual iron core shielded I.F. coils — metal filter condensers and all other parts. The chassis has phono input jack — 110 Volt outlet for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

TRUE FM FROM *Heathkit* FM TUNER KIT

$22.50



The Heathkit FM Tuner Model FM-2 was designed for best possible tonal reproduction. The circuit incorporates the most desirable FM features — true FM — ready wound and adjusted coils — 3 stages of 10.7 Mc. I.F. (including limiter).

Tube lineup: 7E5 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6SH7 limiter, two 7C4 diodes as discriminator, 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coils are ready wound — mounted on the tuning condenser and the condenser is adjusted — no R.F. coils to wind or adjust.

A calibrated six inch slide rule dial has vernier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformers, condensers and complete instruction manual. Model FM-2. Shipping Wt., 10 lbs.

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ENJOY MUSIC AT ITS *Finest* WITH *Heathkit* AMPLIFIERS

NEW *Heathkit* HIGH FIDELITY 20 WATT AMPLIFIER KIT

$21.50

Features

- Push-pull 6L6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation stage.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedances 3.2 ohms to 500 ohms.

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boost type for maximum listening pleasure. Optional preamplifier stage for use with G. E. reluctance pickup or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SJ7 preamplifier stage, 6J5 phase splitter stage, two 6L6's in push-pull and 5Y3 rectifier. (6SC7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3.2, 8, 15, 60 and 500 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 3 db 20 to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G. E. cartridges or microphone $23.50
12" 20 Watt Speaker, No. 326 .... 7.50

Heathkit ECONOMY 6 WATT PUSH-PULL AMPLIFIER KIT

$12.50

No. 304, 12-inch Speaker... $6.95

This new Heathkit Amplifier was designed to give quality reproduction at a very low price. Has two preamp stages, phase inverter stage and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watt output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at new low price. Better build one. Model A-4. Shipping Wt., 7 lbs.

Heathkit RECEIVERS and TUNER CABINETS

$4.95

Order No. 350 for FM tuner

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset to any room. 5" speaker fits in end of cabinet when used with receivers. Size 7 x 13½ x 8¼ inches. Shipping Wt., 5 lbs.
Order No. 345 for either receiver

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 5" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7¾ inches. Shipping Wt., 6 lbs.

5" Permoflux Speaker for either cabinet for use with either Heathkit Receiver
No. 320 5" Speaker........ $2.75

$4.50

No. 335 Cabinet for receivers only.

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BENTON HARBOR 15, MICHIGAN

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☐ Express
☐ Freight
☐ Best Way

Quantity	Item	Price	Quantity	Item	Price
	Heathkit Oscilloscope Kit — Model O-6			Heathkit VTVM Kit — Model V-4A	
	Heathkit T.V. Alignment Gen. Kit — TS-2			Heathkit R.F. Probe Kit — No. 309	
	Heathkit FM Tuner Kit — FM-2			Heathkit H.V. Probe Kit — No. 336	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit Three Band Receiver Kit — Model AR-1			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Amplifier Kit — Model A-4			Heathkit Handitester Kit — Model M-1	
	Heathkit Amplifier Kit — Model A-5 (or A-5A)			Heathkit Variable Power Supply Kit — Model PS-1	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Audio Generator Kit — Model G-2			Heathkit Impedance Bridge Kit — Model IB-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Signal Tracer Kit — Model T-2	
	Heathkit Electronic Switch Kit — Model S-2				

On Parcel Post Orders, include postage for weight shown and insurance. (We insure all shipments.)

On Express Orders, do not include transportation charges — they will be collected by the Express Agency at time of delivery.

Enclosed find ☐ Check ☐ Money Order for________

Please ship C.O.D. ☐ Postage enclosed for______lbs.

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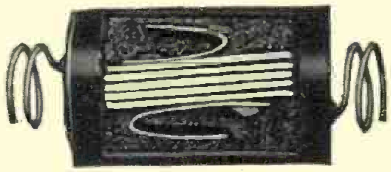
What's New in Radio

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

SELENIUM RECTIFIER

Precision Rectifier Corporation of 131 Boerum Street, Brooklyn 6, New York, has developed a new type of selenium rectifier which is currently on the market.

Tradenamed "Plastisel," these rectifiers resemble paper condensers in



appearance and may be installed quickly and easily as no mounting holes are required. The units are completely sealed but run comparatively cool up to their rated capacities.

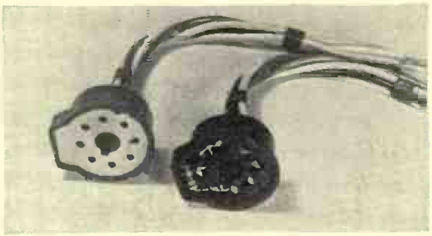
Production is under way on 40, 65, and 100 ma. models. The manufacture of units up to 500 ma. is expected to begin shortly.

Manufacturers, jobbers, and dealers can obtain complete literature and specifications by writing direct to the company.

BASE CONNECTOR

Alden Products Company, 117 North Main, Brockton, Massachusetts, has designed a new octal base connector with a fully-insulated, built-in resistor for use with a 6AL7-GT electron ray tuning indicator tube.

Ready for immediate connection, the 208FERC with a fully-insulated 3300 ohm resistor built in the molding and complete with leads, enables television manufacturers to incorporate the tuning indicator tube in the set



design and thus obtain precision tuning for optimum audio quality at a minimum effort and cost.

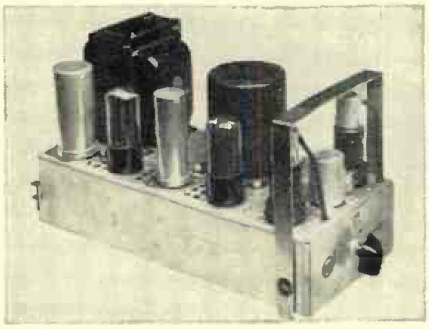
Available in production quantities, the new connector can be supplied with either 5 or 6 leads of any length specified.

RCA LINE AMPLIFIER

Of particular interest to those connected with custom sound installations is the versatile plug-in line amplifier with self-contained power supply recently introduced by the Sound Products Section of the *RCA* Engineering Products Department, Camden, New Jersey.

The new line amplifier, the *RCA* Type MI-12160, can be used as a master mixer for up to four preamplifiers, a booster amplifier for supplying zero level to a telephone line, a line amplifier capable of operating from a telephone line, a driver amplifier supplying voltage for up to 500 power amplifiers, a monitor amplifier supplying two watts of audio power to a speaker, or a bridging amplifier for bridging a low impedance line.

The unit, which is designed for shelf mounting, will provide good frequency response from 30 to 15,000 cycles with low distortion, according to the company. It features inverse feedback control and voltage-regulated power supply and has a rated power output

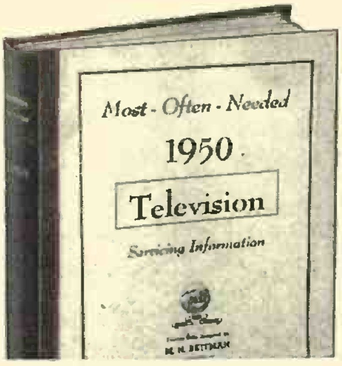


of up to two watts. An interstage gain control with positions 0-10 is mounted on the front apron of the chassis for easy operation. The self-contained power supply consists of a power transformer, a high vacuum full-wave rectifier tube, and a low hum output filter.

CONSOLETTE RECORDER

The "Magnemaster Consolette," a popularly-priced tape recorder designed specifically for professional and broadcast use, has been added to the "Twin-Trax" recorder line by *Amplifier Corp. of America,* 398-2 Broadway, New York 13, N. Y.

The new recorder may be operated at 15" per second with a frequency response of 50 to 15,000 cycles, or at 7½" per second with a frequency response of 50 to 10,000 cycles ± 2 db. After the reel has been run through, the instrument instantaneously and automatically changes direction of tape travel and plays an equal length of time in the opposite direction. This feature provides 30 minutes of playing time at the 15" speed and 60 minutes at the 7½" speed, using standard 7" diameter, 1200 foot reels of tape.



New 1950 Television Manual

This newest giant volume of the series covers 1950 factory data on all popular television sets of all makes. There are circuit explanations, 144 pages of alignment procedure, test patterns, response curves, pages of waveforms, voltage charts, service hints, and ten mammoth 11x15" blueprints. Manual style binding. Price postpaid, only.... **$3**

1949 T-V Manual. Similar to the volume listed above. Has 160 extra-large pages, plus 9 double-spread giant blueprints. To order see coupon below, only........ **$3**

1948 T-V Manual. Earlier volume has material on all popular T-V sets of this period. Large size: 8½x11". Remarkable value. Including 8 fold-out blueprints, only... **$3**

1947 FM and T-V Manual. Covers all needed FM and television sets including popular R.C.A. 630TS. Data on 192 pages. Only........................... **$2**

New SUPREME TELEVISION *Manuals*

INCLUDES ALL POPULAR SETS

All you need to service any television set are the four SUPREME TV manuals described at left. Every popular television set, from the early 1947 models to the very latest 1950 receivers, are here. Covered in great detail making adjustment and servicing really easy. Manuals have data on circuits, alignment, test patterns, response curves, service hints, voltage charts, waveforms, factory recommended changes, and many mammoth 11 x 15-inch blueprints. These manuals will give you the practical know-how of a TV expert and will repay for themselves with time saved on a single TV job.

FIND—FIX ALL T-V FAULTS

Use these timely television manuals as your guide to quick fault finding and repair of any television set. Eliminates guesswork—tells you just where to look and what to do. Cuts hour-wasting jobs to pleasant moments. Use test patterns for quick adjustment, or look up probable cause of trouble in the pages of hints after simply observing fault in video picture. No equipment needed with these tests. Or use your voltmeter and compare values with many voltage charts included. With an oscilloscope you can get waveforms similar to hundreds illustrated using test points suggested and in a flash locate what used-to-be a hard-to-find fault. Order at our risk for a 10-day trial. Use coupon at bottom of page.

AMAZING BARGAIN OFFER

The television series manuals are the most remarkable values offered by Supreme Publications in their 17 years of business. These TV manuals at only $3 and $2 each are amazing bargains and defy competition. There is nothing else like them. Each manual is a virtual treatise on practical television repairs. By normal standards, each such large manual packed as it is with practical facts, hundreds of illustrations, diagrams, charts, photographs, and expensive extra-large blueprints, should sell for $10—but as SUPREME special values they are priced at $3 and $2 each. Only a publisher who sold over one million TV and radio manuals can offer such bargains based on tremendous volume-sales.

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Decide to have in your shop all four Television Manuals as described in the first column at the left. Or try the new 1950 TV manual to see what an amazing bargain you get for only $3. Order on no-risk trial by using coupon at bottom of page.

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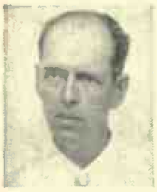
COVERS EVERY TOPIC OF RADIO SERVICING



"You should get more money for your Course. The first week I studied it, I made $10.00 repairing sets. I built my own test outfit from details given in this course. I have repaired 100 radios to date. . . ." Signed: *Robert C. Hammel*, 120 W. 13th, Davenport, Iowa.

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The easy-to-follow lessons of this home-study **course** will show you quickly how to repair all types of radio sets. There are lessons on how to open a shop and operate a successful radio business. Every lesson is well illustrated, interesting to read, really easy to understand and apply. No special previous knowledge is needed. The early lessons explain important principles. Other lessons cover test equipment, trouble-shooting, circuit tracing, television, and every important topic of radio servicing.

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Learn new speed-tricks of radio fault-finding, case histories, servicing short-cuts, extra profit ideas. Included are many large lessons on the use of regular test equipment, explanation of signal tracing, use of oscilloscope, transmitters, P.A., television, recorders, etc. Let this information save for you enough time on a single job to pay the full price of $2.50, for the complete course of these money-making lessons.

EASY TO UNDERSTAND AND APPLY

The practical lessons of this course-manual are easy to follow and apply to actual radio jobs. Hundreds of radio and television facts that puzzled you will be quickly cleared up. You will find yourself doing radio repairs in minutes instead of hours—quickly finding faults or making adjustments. Every new radio development of importance and thousands of time-saving facts are packed into this giant-sized complete course-book.

SATISFACTION GUARANTEED

Use the NO-RISK coupon at right to order the complete COURSE for 10-day examination in your own home. Look over the material, read a few lessons, use this aid to fix several radios. Only then decide to keep the lessons at the bargain price of $2.50 (full cost), or return the material for a cash refund. Act today, while the price is still only......... **$2.50**

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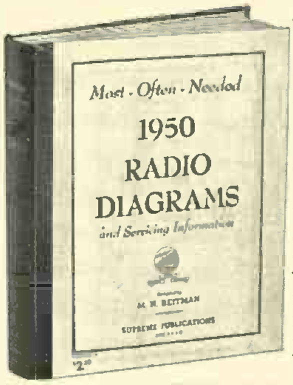

New 1950 Radio Diagrams

Now you can benefit and save money with Supreme amazing scoop of 1950. This one giant volume has all the service data you need on all recent radio sets. Here you have clearly-printed large schematics, needed alignment data, parts lists, voltage values, and information on stage gain, location of trimmers, and dial stringing illustrations. This is the help you need to find tough faults in a jiffy. The new 1950 radio manual is a worthy companion to the 9 previous volumes used to an advantage by over 128,000 shrewd radio men.

BIGGEST BARGAIN IN SERVICE DATA

Wise servicemen know that Supreme Publications manuals have all the material needed at the lowest prices. For the remarkable bargain price (only $2 for most volumes) you are assured of having on hand needed diagrams and all other essential repair facts on almost all sets you will ever service. Every popular radio of all makes, from old-timers to new 1950 sets is covered. Select manuals wanted, see list below, and rush no-risk order coupon.

SUPREME RADIO MANUALS for PREVIOUS YEARS

1949 1948 1947 1946 1942 1941 1940 1939 | 1926-1938

SUPREME Most-Often Needed RADIO DIAGRAMS Each Manual only $2. (1949 is $2.50); 192 pages of diagrams, alignment data, voltage values, parts lists, and service hints; large size, 8½" x 11". To order, see coupon below.

RADIO Diagrams 240 Pages Price $2.50

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Send on trial manuals checked below and at right. You guarantee complete satisfaction.

☐ 1950 Television Manual, $3. ☐ 1949 TV, $3.
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☐ 1948
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PRICED AT ONLY $2 EACH
☐ 1926-1938 Manual, $2.50

Separate sets of heads for record-erase and a monitor permit the simultaneous monitoring of the recorded

signal to be made of the tape for quality control.

Complete technical specifications on the new recorder are available from the company upon request.

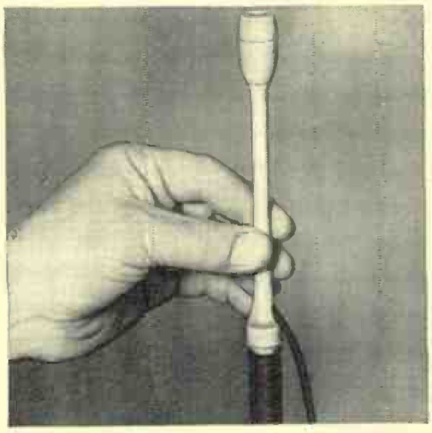
"TRU-SONIC" MICROPHONE

Stephens Manufacturing Corporation of Culver City, California, has recently introduced a group of three microphone systems for swivel, stand, and lapel applications.

Each of the new systems employs a head of extremely small size. The company claims that the new "True-Sonic" models are essentially non-directional throughout the entire audio range. In addition, the company states that it is the only microphone currently on the market that makes use of a condenser type diaphragm in a circuit which does not require vacuum tube circuits mounted adjacent to the head.

With these new systems, all auxiliary equipment can be used up to 400 feet away from the head, connected only by a small standard single conductor microphone cable which carries no high currents and voltages to feed critical low level circuits.

A booklet containing complete specifications on these new units is avail-



able from the company. When writing, ask for Bulletin M-1 and address the company at 8538 Warner Drive in Culver City.

NEWCOMB PHONOGRAPH

The newest addition to the *Newcomb Audio Products Co.* line of audio

(*Continued on page* 103)

McGEE'S 20TH ANNIVERSARY "BIG DEALS" SAVE YOU BUCKS—ORDER NOW!

100 MOLDED PLASTIC BYPASSES $9.49

100 molded plastic tubular by-pass condensers. All 600 volt. And all by the same nationally known mfgr. Regular dealers net is over two and one half times our 20th Anniversary sale price. You'll chuckle when you look these over. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 20—.02, 10—.05 and 10—.1. Our big deal No. RN-202. 100 plastic tubulars. Shipping weight 2 lbs. Net price $9.49.

100 TOP QUALITY 600 VOLT TUBULARS $6.49

100 top quality 600 volt tubular by-pass condensers. Made this year by a famous condenser factory. Don't confuse these with grab bag surplus. McGee's deals are guaranteed to please you. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 10—.02, 20—.05 and 10—.1 600 volt condensers. Our big deal No. RN-203. Shipping weight 2 lbs. Net price $6.49.

20 50x30 MFD. 150 VOLT $9.75

Here's a red hot value. 20 of our XX quality replacement electrolytics. The most popular condensers in use today. Takes care of 90% of your AC-DC radio filter needs. Compact construction 1950 production. 1 year guarantee. 50-30 mfd. 150 volt, housed in a cardboard tube with common negative, has long flexible leads. 20th Anniversary, big deal No. RN-204. Sale price $9.75.

10 SELENIUM RECTIFIERS $5.95

Be Prepared for Rectifier Shortages

10 top quality selenium rectifiers. Guaranteed 2nd to none. Latest compact construction. All standard 130 volt. Use these for your AC-DC sets when tubes are hard to get. 5-65 mil and 5-100 mil selenium rectifiers. McGee's big deal No. RN-211. Shipping weight 2 lbs. Net price $5.95.

5 OZ4 TUBES 5—4-PRONG VIBRATORS ALL FOR $8.49

Here's a red hot deal for you fellows that do a lot of auto radio service. 5 standard brand metal OZ4 tubes and 5 of our famous 4-prong serrated can vibrators. This vibrator is of the latest design, for long life. Standard diameter can, short enough to fit all Chrysler auto sets, also fits Motorola, etc. Our 20th Anniversary, big deal No. RN-V10. You can get 5 OZ4 metal tubes and 5 4-prong vibrators, all for $8.49. Shipping weight 3 lbs.

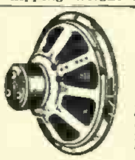
SERVICEMAN SPECIAL $24.95

- 5 5-INCH P.M. SPKRS.
- 5 50x30 150 VOLT COND.
- 5 4-PRONG VIBRATORS
- 25 .01 600 VOLT
- 5 OZ4 TUBES
- 5 35Z5 TUBES
- 25 .05 600 VOLT
- 5 100 MILL SEL. RECTIFIERS

Here is a real value for the radio repair man. All these parts listed are fast moving items. Fully guaranteed. Tubes are standard brand. The 5" PM speakers have 1 oz. magnet. The by-passes are all 1950 production. This deal is sold as a deal only and not broken up. A McGee 20th Anniversary special, deal No. RN-245. Net price $24.95.

10 MOTOROLA REMOTE CONTROL HEADS $7.95

Genuine Motorola Controls Heads, 99c each. Pick any of these automatic control heads in factory cartons at 99c each. Automatic heads with push buttons and manual tuning for the following: 42-46 Cadillac, 42, 46, 47 Hudson, 40 Lincoln Zephyr, 42-46 Lincoln Zephyr, 40 LaSalle, Cadillac, 42 Oldsmobile, 41, 46, 47 Packard. Shipping weight 3 lbs. each, Net 99c. 10 for $7.95. 2A1 Push button and manual universal under dash mounting head; fits all cars and trucks. Net $1.95 each.



CHOICE OF 4" or 5" P.M. SPEAKERS SALE PRICE $1.29

McGee's fine quality line of replacement PM speakers. All have Alnico V magnets and standard 3.2 ohm voice coils. McGee has a tremendous stock of 100,000 speakers to fill your needs. Every speaker is fully guaranteed. Order your speakers now.

4 inch, square	1 oz. magnet	$1.29
5 inch, pincushion	1 oz. magnet	1.29
6 inch, pincushion 1.47	oz. magnet	1.79
4 x 6 inch	1 oz. magnet	1.69
5 x 7 inch, oval	1.47 oz. magnet	2.19
7 inch, pincushion 2.15	oz. magnet	2.95
8 inch, pincushion 2.15	oz. magnet	3.29
6 x 9 inch, oval	2.15 oz. magnet	2.95

1 or 4 VOLT CRYSTAL CARTRIDGES $1.99

McGee offers you a famous make crystal cartridge. Standard size and shape, but very light weight. Will track on 3/4 oz. or more pressure. Stock A-6, one volt output, replaces Astatic L-70 etc., Net $1.99. Stock No. A-10, 4 volt output, replaces Astatic L-72 and L-82, etc., Net $1.99. Buy 10 assorted for $19.00.

100 KNOBS Set-Screw Type $3.95

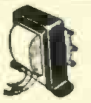
100 bakelite set screw knobs, for radio set replacement. All fit standard 1/4" shaft. Assorted walnut, black and ivory. Enough of each style to give you matched sets. This value worth $7.50. Shipping weight 2 lbs. Deal No. RN-10K. 100 knobs. Net $3.95. or DE 1/2 a Deal or 50 knobs. $2.00.

65 Mil Selenium Rectifier	59c
75 Mil Selenium Rectifier	69c
100 Mil Selenium Rectifier	69c
150 Mil Selenium Rectifier	79c
200 Mil Selenium Rectifier	$1.09
250 Mil Selenium Rectifier	1.19

McGee's XX quality selenium rectifiers. Small size, compact construction. All 1950 production, by a No. 1 factory. Not surplus, but uniform quality. Fully guaranteed. 130 volt RMS rated.

$2.95 FOR A REG. $7.77 PROBE

Boes signal tracer probe, with instructions. Made to sell to you for $7.77. A heavy bakelite probe containing a 6F5GT tube. (The end of the probe is secured by three screws and may be taken apart easily.) A 5 foot lead with 3 circuit amphenol plugs and receptacle and Mueller peewee clip. Connect this probe to any AC amplifier and have a signal tracer. Shpg. wt. 1 lb. Net. $2.95; 2 for $4.95.



UNIVERSAL OUTPUT TRANS. DEAL. RN-UP6 $5.29

Any push-pull or single plate to any voice coil. Popular strap mounting, the same as you use every day. You get 4-5 watt, 1-8 watt. 1-15 watt transformers. Shipping weight 4 lbs. Deal #RN-UP6, Net $5.29.

10 SMALL OUTPUTS DEAL RN-10PT $4.49

5 outputs for any single universal plate to voice coil. 5 watt. And 5 single 50L6 outputs to voice coil. These outputs are small size strap mounting. Shipping weight 4 lbs., Deal #RN-10PT. Net $4.49.

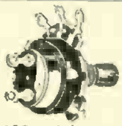
115 PHONO NEEDLES $4.95

2 $3.50 list Duotone Ruby needles, with handy record brush, 3 $2.50 list Duotone Sapphire needles in plastic case and 4 packages of 25 cheap needles and 1 package of 10 cheap needles. 115 phono needles, Deal #RN-P12. Net $4.95.

22 AC LINE CORDS $4.95

20 6 ft. AC cords, with G.E. unbreakable molded caps. 10 brown and 10 ivory, plus 2 ICA universal resistance AC-DC cord sets. Shipping weight 3 lbs. Deal #GE-22. Net $4.95.

20 CONTROLS $5.95



All have SPST switch, which may be used by pulling a small tab. A red hot value. All National Union, individually boxed. 1 each 5.000, 10.000, 25.000, 50.000, 100.000 and 5 each 250.000, 500.000 and 1 megohm. Shipping weight 1 lb. Deal #RN-NU20. Net $5.95.

$19.95 BUYS A NEW St. George Wire Recording Mechanism

ONLY 200 TO SELL

McGee offers you at a terrific saving the St. George Series 1100, wire recording mechanism. Brand new and factory cartoned. This unit will record and playback from a standard recording wire, up to 1 hour. The wire take-up reel turns at 78 RPM and will play and record from a 78 RPM phono record. The base is punched for a phono pickup. Space required, 9x13x3½". Shipped with a diagram of how to connect and also how to wire a 3 tube converter to enable the wire recorder to be used in conjunction with any radio or amplifier. St. George wire recording mechanism, Series 1100. Shipping weight 15 lbs. Net price $19.95 each. Crystal phono pickup arm and cartridge $1.95 extra. Recording wire: 15 minute spool. Net price $1.19. 30 minute spool. Net price $1.79. 1 hour spool. Net price $2.79. Crystal mike and desk stand $4.95 extra.

WIRE RECORDER CONVERTER

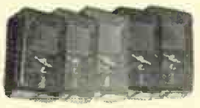
3 tube AC wire recorder oscillator and erase circuits for use with the above St. George mechanism, or any wire recorder head. Adapts any radio or amplifier to operate a wire recorder, mike and phono inputs, self powered. Wired, with tubes and instructions. Model RR-Y, shipping weight 6 lbs. Net price, $12.95.

20TH ANNIVERSARY INTERCOM SALE!

$25,000 WORTH OF INTERCOMS AT SCOOP PRICES

5-STATION INTERCOM MASTER

MASTER STATION $14.95 SUB STATION $3.95 EACH



5 station intercom master station, in an attractive walnut cabinet, 10x5½x6". 5 pushbuttons. You can call any one or more substations. Talk-listen switch has a silent position. Volume control on front panel for easy access. The amplifier is of the conventional AC-DC design, with plenty of power. Equipped with a full size Alnico V PM speaker. This intercom master is new 1950 production by a well known factory. Made to sell at a much higher price. Only 300 to sell at the special purchase price of $14.95 each. 5 station intercom master No. 2700. Weight 7 lbs. Net price $14.95.

Intercom master, same as above, except in addition to the 5 station switch a 6th pushbutton is added to call all stations at once. Stock No. 2701. Net price $16.95 each.

Molded walnut plastic substations for use with Model 2700 Master. Full size Alnico V magnet PM speaker, spring return call-back switch, size 5½ x 8½ x 3½". Shipping weight 2 lbs. each. Mounts either on the wall or may be set on desk top. Very attractive. Net price $3.95 each. 5 for $18.95.

3-wire plastic intercom cable. $1.95 per hundred ft.

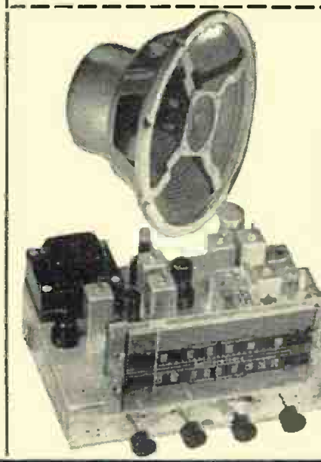
10-STATION A.C. MASTER STATION $24.95

- Powerful—6V6 Output Tube
- Walnut Vernier Cabinet
- Push Button Selector
- Sub Stations $3.95 Each

Super heavy duty, 10 station intercom master, designed for continuous service. A powerful AC transformer type with 80 rectifier, 6V6 output and 6SJ7 driver. 5" speaker with 2.15 oz. Alnico V magnet. Housed in a walnut cabinet 14" long, 6½" deep and 7½" high. Designed to install as a 3 wire system. 10 push button station selector on front, with separate all station call switch. Talk-listen switch has silent position. Made to sell for a much higher price. McGee made a fortunate purchase and passes the bargain on to you. Shipping weight 12 lbs. Stock No. 2520. Net $24.95 each.

We have a few Model 2520. Built for Master to Master use. Price on Master to Master $25.95.

Attractive walnut plastic cabinet, sub station for use with the model 2520 master. Has lever acting call back switch and Alnico V PM speaker. Net price $3.95 each, 10 for $37.50. 3 conductor plastic intercom cable. $1.95 per hundred ft.



HALLICRAFTERS S-78 AM-FM CHASSIS WITH 12" COAXIAL PM $89.95

Sensational new Hallicrafters, 10 tube, plus rectifier. Model S-78 AM-FM chassis, for custom installation. A complete radio chassis with its own power supply and push-pull high fidelity audio system. Chassis size, 12½ x 7¾" high and 11" deep. Output transformer matches 3.2 ohm speaker and 500 ohm. Receives FM, 88 to 108 mc and standard broadcast. Automatic frequency control (AFC) on FM holds receiver in perfect tune. A set used in radios of the $500 class. Frequency response, 50 to 14,000 CPS. Bass boost tone control and phono input. Why buy an ordinary chassis, when you can buy a Hallicrafters from McGee? Complete with dial escutcheon, knobs and tubes. Buy your S-78 Hallicrafter chassis, with a wide range speaker. S-78 Hallicrafter chassis, complete. Net price $79.95. S-78 chassis with $32.50 list 12" coaxial PM speaker, both for $89.95. S-78 chassis with $60.00 list 15" coaxial PM speaker, both for $84.95. See automatic record changers listed elsewhere in this ad. One tube pre-amplifier for S-78; adapts chassis for use with the G.E. variable reluctance pickup or crystal mike. SS-69. Net $3.95. Crystal mike and desk stand, $4.95 extra.

SCOOP PRICES ON ELECTROLYTICS

MN-8.	8 mfd	450 volt	29c
MN-16.	16 mfd	450 volt	39c
MN-20.	20 mfd	150 volt	29c
MN-40.	40 mfd	150 volt	39c
MN-220.	20-20 mfd	150v	39c
MN-53.	50-30 mfd	150v	49c

Save on these. One year guarantee. All single condensers are in sealed metal tubes with paper insulating sleeves. Dual banks in cardboard tubes with long flexible leads. Not surplus, but the best.

19 TUBULAR ELECTROLYTICS DEAL RN-PL19 $5.95

19 tubular electrolytics, guaranteed for one year. All fresh stock in aluminum tubes with cardboard insulating sleeves. You must be satisfied or money back. You get, 10 8 mfd. 450 volt. 4 16 mfd. 450 volt. 3 20 mfd. 150 volt and 2 40 mfd. 150 volt condensers. Shipping weight 2 lbs. Deal #RN-PL19. Net $5.95.

10 FP ELECTROLYTICS DEAL RN-10DS $3.49

10 assorted F.P. aluminum can electrolytics. Popular twist tap mounting. Mostly multiple section banks. 150, 350 and 450 volts. A red hot deal. Shipping weight 2 lbs. Deal #RN-10DS. Net $3.49.

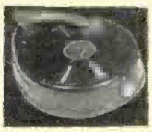
10 BOXES OF PILOT LIGHTS $5.49

Pilot lamps, boxed 10 to a handy carton. American made. 7 boxes #47. 1 box #40. 1 box #44 and 1 box #46. A total of 100 lamps. Deal #CM-51. Net $5.49. 100 #47 imported panel lamps. Guaranteed. 100 to the carton. Deal #RN-J47. Net $4.49.

RECORD PLAYER SALE

78 R.P.M. RECORD PLAYER $11.95

Self-Contained Amplifier and Speaker. Here is a red hot value. A complete self-contained 78 rpm record player with its own amplifier built in. It has a 1.5 oz. Alnico V PM speaker. Extra heavy duty 78 rpm phono motor. The amp and speaker are concealed under the attractive plastic base. This is a complete built-up player and has better tone and more power than you would expect for a player of its size. Only 100 to sell. Stock No. E-100P. Sale price, $11.95.



G.E. RECORD PLAYER ATTACHMENTS SALE PRICE $6.95

General Elec. 78 RPM Record Players to attach to any radio or amplifier. Heavy duty motor and standard crystal phono pick-up. Volume control and off-on switch. Shpg. weight 8 lbs. (No pre-amp necessary.) 78 RPM Model, Stock No. GE-78. $6.95. 33⅓ RPM Model, Stock No. GE-33 has Webster crystal pick-up with needle. Net, $6.95. Buy 3 for $19.50.

McGEE RADIO COMPANY Prices F.O.B. K.C. Send 25% Deposit with Order, Balance Sent C.O.D. With Parcel Post Orders, Include Postage. TELEPHONE VICTOR 9045. WRITE FOR FLYER 1422 GRAND AVE., KANSAS CITY, MISSOURI

McGEE ANNOUNCES NEW 1951 MODEL 8 TUBE ALL PURPOSE AMPLIFIER KIT

- 22 WATTS POWER OUTPUT
- PUSH PULL TRIODES
- RESPONSE 18 TO 20,000 CPS
- TWIN ELECTRONIC TONE CONTROLS
- NEW TONE RANGE SWITCH
- TUNER-MIKE-PHONO INPUTS
- FINEST VALUE IN AMERICA
- TUBES AND ALL PARTS FURNISHED
- WHY PAY $100.00 FOR AN AMP—WIRE YOUR OWN

This is a complete kit. Everything furnished, including tubes and diagram. Designed in our own audio lab. to produce music and voice, with full wide range fidelity, and just the way you like to hear it, whatever your own personal taste. Response 20 to 20,000 CPS. A new range selector switch gives the tone controls two ranges. In the low position the amp sounds like a big juke box. In the high position the highs, as well as the bass, is boosted to the brilliance of a symphony orchestra. A variable needle scratch filter is built in. Separate bass and treble boost controls circuits, using separate tubes. Inputs for mike and phono pickup, G.E. variable reluctance or standard crystal cartridge. (No pre-amp is required.) The high fidelity output matches any PM speaker up to 12 ohms. This amp kit uses all triodes. No odd or even harmonics are introduced within the amp. Power output, 22 watts. Complete with all parts and tubes: 3—7E5, 2—7F7, 2 triodes in push-pull, either 6A3 or Western Electric VT-52, 5V4. This is the finest music lovers' amp kit that we have ever designed. Use with a radio tuner (buy our kit Model BT-38, broadcast tuner, $11.95), mike or a record player. Controls may be mounted on the chassis or extension leads, so that the amplifier can be used in any available space. Stock No. 7X5 Amplifier Kit. Shipping weight 25 lbs. Net $29.95. Custom wired and tested, $12.50 extra. Why not order a 12", or 15" coaxial or 3 of our 10" PM speakers, with this kit?

8-TUBE MODEL 7X5 AMP KIT $29.95

NEW 1951 MODEL 15" "COAXIAL" PM SPEAKER

20TH ANNIVERSARY SALE PRICE

$17.95

Model P15-9

McGee's new 1951 Model 15" coaxial PM speaker is here! And at a price everyone can afford, $17.95. This speaker is ideal for all types of radio and audio amplifier use. It may be connected to any 8 ohm output transformer. The 15" woofer has a 32 oz. Alnico 3 magnet and the coaxially suspended 5" speaker has its own magnet and voice coil. A true coaxially built speaker. The high pass filter prevents low frequency notes from reaching the tweeter. The response of this 15" coaxial is from below 20 CPS to above 17,500 CPS. It is the best speaker value in the U.S. today. We buy these by the carload and pass our savings on to you. If you have or are building one of our high fidelity amplifier kits, this speaker is the one you should have. It is a tremendous value. Why pay more than McGee's price, for a 15" coaxial PM speaker? Stock No. P15-9. Shipping weight 14 lbs. 20th Anniversary sale price $17.95 each. 2 for $34.00.

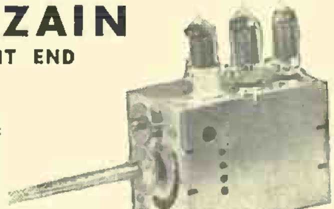
NEW 12-INCH COAXIAL P.M. SPEAKER $12.95

McGee announces our new 1951 model 12-inch coaxial speaker, designed for the critical music listener; for use with high fidelity audio systems and radios. This new model reproduces all music and voice with a natural quality. It is improved over our last model in that the 12" woofer now has a heavy duty 31 oz. Alnico 3 magnet. This reproduces the lower musical register down to 40 cycles. The coaxially suspended tweeter has a specially designed cone for the higher register of music and voice. It will respond up to 17,500 CPS. The high pass filter is attached and combined impedance will hook up to any 8 ohm output transformer. It will connect in place of any ordinary speaker (only two wires to connect). Why pay $20 to $40 for a speaker? McGee has them made to their own specifications, by the thousands and passes the savings on to you. We have sold over 10,000 coaxial speakers. Why pay more than McGee's price? McGee's 12", 20 watt wide range coaxial PM speaker, Model CU-14X. Net price, $12.95; 2 for $25.00. Shipping weight 10 lbs.

SARKES-TARZAIN

13-CHANNEL T.V. FRONT END

WITH TUBES AND DIAGRAM **$7.95**



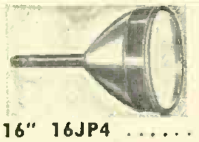
This popular Sarkes-Tarzain television front end is widely used today. The 13 channel rotary switch type with individually tuned coils. Price includes a schematic diagram and 3 tubes, 6C4 osc. 6BH6 RF and 6AG5 mixer. Regular factory cost is twice our price. Each tuner and its own tube sockets are wired. Ready to hook up to a video and sound IF strip. May be used with either intercarrier or separate sound IF circuits. Built-in fine frequency control. Ship. weight 3 lbs. Sarkes-Tarzain Type 2 TV tuner with tubes net.......$7.95
Combination deal. Sarkes-Tarzain TV tuner and 205-XX video coil kit both for..$14.95
Sarkes-Tarzain Type 3—Same as Type 2 only has input IF coil built-on. Tapped for sound IF channel. Net.......$9.95
Sarkes-Tarzain Type 3 tuner and 205-XX coil kit both for.......$16.95

TELEVISION VIDEO COIL KIT— 20 MATCHED COILS FOR PICTURE AND SEPARATE SOUND I.F.

Order with a Sarkes-Tarzain Front End for $14.95

$7.95

20 matched TV coils; video and sound I.F. McGee Scoop price $7.95. Television video coil kit, for TV sets up to 16", using separate sound and picture circuits. Consists of 20 coils for use in the nationally famous 30 tube and 22 tube TV circuit. All coils are of the finest construction, furnished to you, just like they go to a TV set maker. Each coil is identified. These are not made by RCA, but by a top quality coil company, especially for McGee. If you are going to use the RCA circuit, you can use this set of coils.
Coil kit has 1-180 uh, 1-250 uh, 2-120 uh, 2-93 uh speaking coils, 4 picture IF coils for 25.75 mc. 1 cathode trap, 2 sound IF's 21.25 mc. 1 discriminater, 1 converter and 5 filament chokes. Stock No. 205-XX, shipping weight 3 lbs. McGee's price $7.95.



Picture TUBES

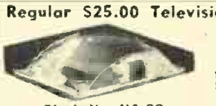
16" 16JP4 ....$19.95
12½" 12LP4 ....$17.95

Number one quality television picture tubes. Guaranteed by us; unconditionally for 90 days. Best quality, with neutral or white face. Factory design changes made this value possible. Why, pay more than McGee's price? Only 500 left to sell, 1000 already sold. No more will be available, when these are gone. 16" tube, weight 25 lbs. 12" tube, weight 19 lbs. Order now, these 12 and 16" tubes will replace most of the glass tubes types. 12KP4, 12"

T.V. AERIALS WITH 300 OHM LINE

201/XL, all band conical, as picture, less mast. Individually cartoned, with 50 feet of good standard quality 300 ohm twin lead. Net price, $7.95 each; 10 for $69.95.
402-XL, all band, stacked conical, less mast, Individually cartoned with 50 feet of good standard quality 300 ohm twin lead. Net price, $12.45 each; 10 for $114.95.

Regular $25.00 Television Magnifier



Stock No. HA-22

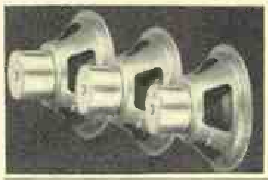
SALE PRICE FOR 7-10-12 INCH TUBES $7.95

Stock No. HA-22 12 x 17 in. television magnifier. Made of crystal-clear plastic and oil-filled. Magnifies your present 7-, 10-, or 12-inch television picture up to four times. We offer you these new factory cartoned magnifiers, you provide your own means of mounting to your set. Edge of magnifier may be drilled and hung on your set with cord. This lens is a $25.00 value, but McGee offers them to you for only $7.95. Shipped by express only. Ship. wt. 22 lbs.

REG. $20.58 MASCO T.V. BOOSTER FOR $13.39

Masco MTB-13X, 13 channel television booster. A regular $20.58 dealers' net item, on sale at McGee for only $13.39. Housed in an attractive walnut cabinet, 5½x5x5½". Self powered, operates on 110 volts AC. Priced complete with 2—6AK5 tubes. These boosters are brand new and factory cartoned. Shipping weight 6 lbs. McGee's sale price only $13.39 each. Two for $25.00. The price is good only as long as our supply lasts.

SUPER HEAVY DUTY 10" PM $4.95



We made a special purchase on several hundred 20 watt, 10", 32 oz. Alnico 3 magnet PM speakers. Deep throat and easy moving cone. Ideal for all high fidelity sound systems and radio replacement. The magnet on this speaker is usually used on a 15" size. Very efficient, good high and bass response. You'll appreciate it when you get your hands on this speaker. Attractive copper finish. 8 ohm voice coil. Stock No. 1025PS. Weight 7 lbs. Net price $4.95 each.

Order three of these and use them in a cluster of three. They will take 60 watts of audio and have more cone area than any 15" speaker. For high power, top quality P.A. work. Think this over. 3 No. 1025PS speakers for only $13.95.

NEW 1950 MODEL 5-TUBE SUPERHET RADIO KIT

MODEL NS-5X **$11.95**

McGee's new 1950 Model 5 tube AC-DC superheterodyne radio kit. Has loop antenna and 2 gang condenser, with lighted slide rule dial and attractive plastic cabinet. Receives broadcast, 550 to 1650 kc. Full size dynamic speaker, matched 456 I.F.'s, automatic volume control. This is a complete radio kit. Everything furnished, including diagram, photos and tubes: 14B6, 14Q7, 14A7, 50B5 and 35Z5. Shipping weight 7 lbs. Stock No. NS-5X. Net price, $11.95.

RADIO AND RECORD PLAYER $14.95

For your children's room. Buy this superhet radio and record player. Here is what you get: A full 5 tube superhet broadcast chassis all wired and tested, Walnut cabinet, 78 RPM phono motor and crystal pickup. All you do, when you receive your set is drill mounting holes in cabinet. We are offering you this radio-phonograph at the price of an ordinary record player. Shipping weight 15 lbs. Stock No. JA-70. Net price, $14.95. Stock No. AUT-JO. Same radio chassis and cabinet as above, but furnished with a 78 RPM automatic record changer. Shipping weight 25 lbs. Net price, $24.95.

COMPLETE 5-TUBE A.C. SELF-POWERED BROADCAST TUNER KIT

USE WITH ANY AMPLIFIER **$11.95**

A self powered, 3 gang superhet tuner kit, with R.F. stage. When wired according to our diagram will make the best possible broadcast tuner (550 to 1650kc), for use with any amplifier. Has a 6" lighted slide rule dial. Don't class this with ordinary tuners, this has its own transformer. The complete kit is furnished with a diagram and photo, with tubes: 6SK7 R.F., 6SA7 converter, 6SK7 I.F., 6H6 detector, 6X4 rectifier. Connect to any audio amplifier. Ideal for use with our 7X5 Amp Kit. Chassis size: 9¼x8¼x4½" high. Shipping weight 8 lbs. Broadcast tuner kit. Model BT-38. Net price, $11.95.

RECORD PLAYER KIT $9.95

Complete record player kit, for 78 RPM records. All parts, tubes and diagram for building a 70L7 type amplifier. Attractive ready cut walnut base (speaker cut-out on top). Ballentine phono motor and Astatic pickup with permanent needle. Shipping weight 10 lbs. Model No. MD-78. Net price $9.95.
Three-speed model No. D-3378, same as above only has 3 speed motor and fly weight crystal pick up arm with Universal 3-speed needle. Net price $13.95.

3-SPEED RECORD PLAYER KIT $16.95

New 3-speed portable record player kit, housed in the attractive Capitol portable case. Has 33⅓, 78 and 45 RPM phono motor and Dual Purpose pick-up arm, with needles. Alnico V PM speaker and complete kit of parts and tubes to build AC-DC type amplifier, with separate tone and volume controls. Kit Model 348-K, complete with wiring instructions. Weight 16 lbs.

HALLICRAFTER 16" T.V. Chassis Complete $149.95

COMPLETE WITH PICTURE TUBE. FULL DESCRIPTION ON REQUEST

A complete television receiver chassis made by a manufacturer whose name you will recognize. Not a kit, but a 16" TV set with all tubes, 8" speaker and 16" picture tube. Has 19 tubes, plus three rectifiers. Supplied with wood frame for wall or cabinet mounting. Size 19¼x23" wide and 21¼" deep. Price was $259.00. Now at McGee for $149.95. Stock No. 520EX. Shipping weight 80 lbs.

78 R.P.M. CHANGER SALE

CHOICE **$7.95**

We have a few hundred brand new 78 RPM record changers to close out and then there will be no more. All have standard crystal cartridges. Include postage for 13 lbs. Take your pick at $7.95 each. Stewart-Warner, General Instrument, or Detrola.

1950 MODEL TAPE RECORDER $79.95

Our brand new 1950 model portable tape recorder. Response, 60 to 8,000 CPS. With this you make and play-back top quality tape recordings. Tape speed, 7½ in. per second. New mechanism records 1 hour on 1200 ft. reel of tape. Fast rewind. Record 30 minutes, turn spool over and record second 30 minutes on 1200 ft. reel. Has an AC transformer type amplifier with 6" speaker. Inputs for mike and radio. External speaker jack. Price includes 30 minute reel of tape and mike. Hinged lid is removable. Case is attractive leatherette covered. Size 10x13x14". Shipping weight 29 lbs. Stock No. PLT-3. Net price $79.95.

V.M. 3 SPEED Record Changers

VM Model 406 deluxe 3 speed automatic record changer—plays them all—intermixes records of the same speed—equipped with a flip over crystal pickup with twin needles—a very sleek designed record changer—base size 12¼x13. Ship. weight 12 lbs. VM-406. Net $33.21.
Buy the VM-950 changer with or without base. Choice of G.E. VR or crystal cartridge. We think the VM-950 record changer is the finest in America. It automatically plays all records all speeds and all sizes; 12 10-in., 33⅓ or 78 rpm, 10 12-in., 33⅓ or 78 rpm and 12 and 10-in. records of the same speed intermixed. 12 7-in. 33⅓ or 12 7-in. 45 rpm. Automatically shuts off after the last record. Size 13 13/16x11⅞x7¼ in. high. Offered with crystal cartridge, G.E. VR cartridge, or either with a base. VM-950, 3 speed changer with standard output crystal cartridge and needles for 1 and 3 mil. (78 rpm, 33⅓, 45 rpm.) Net $28.35.
VM-950GE, 3 speed changer with the new RPX-050 magic button, all-in-one variable reluctance cartridge with stylus. Net $31.27.
VM-955, 3 speed changer with crystal cartridge on a base. Net $31.53.
VM-955GE, 3 speed changer with RPX-050 VR cartridge and stylus; with base. Net $33.59.

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MARS Station of the Month

MARS BEAMS WEEKLY BROADCASTS

MARS—Army Headquarters station, WAR, located at the Pentagon Building, Washington, D. C., broadcasts a weekly message each Tuesday at 0100Z and at 0400Z. (This is Monday at 8 p.m. and 11 p.m., Eastern Standard Time; Monday at 7 p.m. and 10 p.m., Central Standard Time; Monday at 6 p.m. and 9 p.m., Mountain Standard Time; and Monday at 5 p.m. and 8 p.m., Pacific Standard Time.)

Simultaneous broadcasts are made on frequencies 3497.5 kc., 6997.5 kc., 14,405 kc., and 20,994 kc. Each message is sent three times, once at 10 words per minute, once at 15 words per minute, and once at a higher rate of speed—usually 20 words per minute.

Designed especially to transmit quasi-official traffic and training information to MARS members, the broadcast offers an excellent opportunity to all amateurs in building up their code proficiency.

THE old days of pioneering in the Southwest are about over. And typical of the new era is a yearling MARS station at Fort Sill, Oklahoma. A5WAH/K5WAH, which made its initial contact at 0825 on 14 November 1949, has been named MARS Station of the Month by Captain E. L. Nielsen, Chief, MARS-Army, for its over-all excellence of operation, and for the good work in integrating amateur and military radio operations. Lt. Col. Robert W. Jackson (A5FCP/W5FCP) is station trustee.

No story of the Fort Sill amateur shack would be complete without the names of Captain George B. Cummings (A5MOA/W5MOA) the first trustee for A5WAH, and Sgt. Cecil C. Cash (A5PML/W5PML), the station's Chief Operator who did most of the construction work and equipment layout. The transmitter equipment consists of a *Hallicrafters* HT19, operated at approximately 200 watts input; a BC-610 on 20 meters; a BC-610 on 80 meters, both operated at 500 watts input and an RC 52 on 40 and 80 which runs at about 600 watts input. Receivers are a *National* NC 173, a *National* HRO, a *National* NC 100 and two *Hammarlund* "Super-Pro's."

When you stop drooling, let's take a look at the antenna equipment. There's a three-element beam on 10 and 20, located about 35 feet above the ground. Center-fed doublets are strung 40 to 90 feet above ground for 20, 40, and 80 meter work.

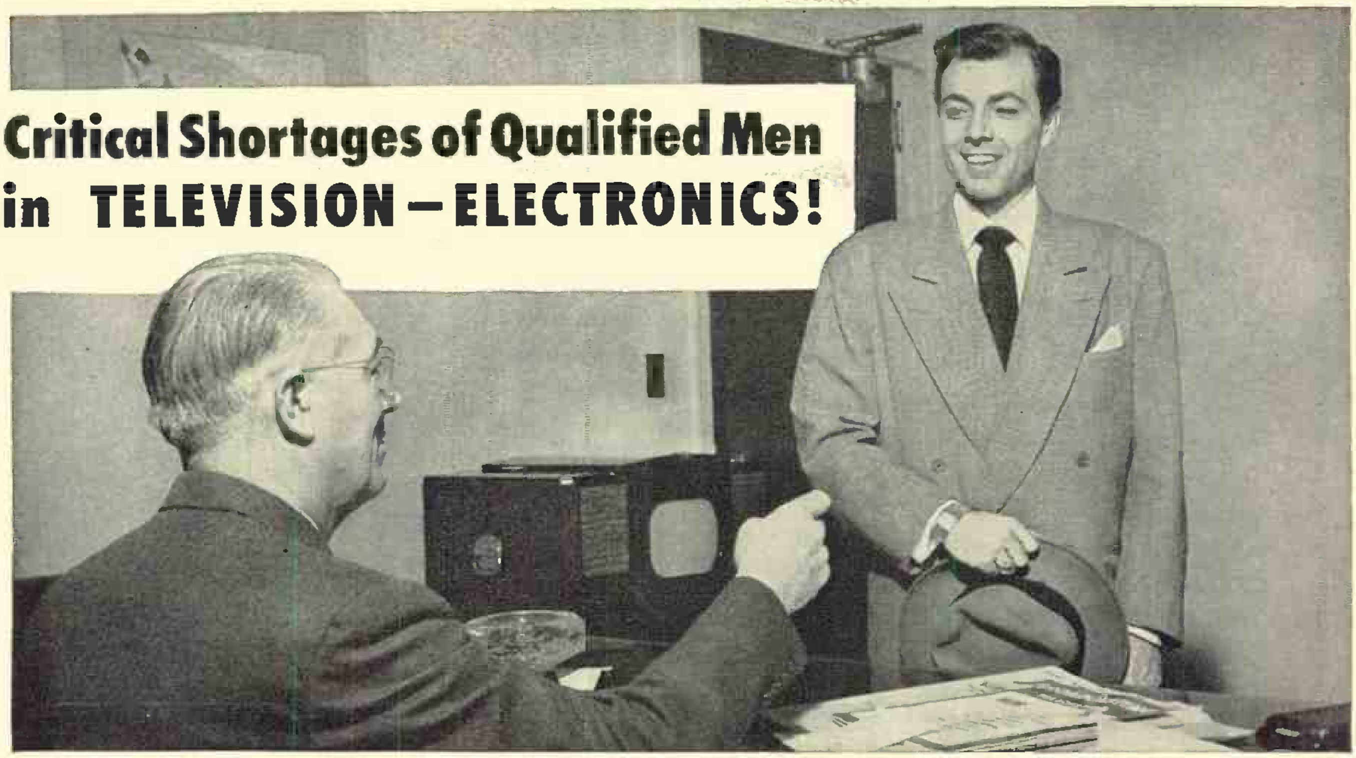
That's a "potful" of equipment—but the station does a "potful" of operating. Hardly had the station paint dried when A5WAH was appointed net control station for the Oklahoma State MARS net. The station served in this capacity until August, 1950 when the press of other military duties was too heavy.

K5WAH is a member of the OLZ (Oklahoma Traffic Net), which has about 30 members and meets daily except Sunday. K5WAH was instrumental in organizing the Armed Forces Net, and served as net control, with an average membership of 21 stations, meeting the 1300 hour daily schedule. In April and May, before the summer slump and the international situation slowed the boys down a bit, K5WAH made BPL in April with 650 points and in May with 717 points, with an average monthly traffic of 200 messages.

K5WAH operates all bands from 160 through 10 meters, averages 15 contacts a day. Because of personnel shortage the station is now on the air 0800-2200 on Mondays, 1200-1700 Tuesdays and Thursdays, 1200-2200 Wednesdays and Fridays. —30—

Col. C. H. Hatch (A5QVE), Fourth Army Signal Officer, and Lt. Col. R. W. Jackson (A5FCP), Fort Sill Post Signal Officer, look on as Sgt. C. C. Cash (A5PML) operates A5WAH.

Critical Shortages of Qualified Men in TELEVISION—ELECTRONICS!



Your Spare Time is Prepare Time! CREI Home Study can lead to quick promotion in essential industry or in uniform

"Technicians may soon be as scarce as certain tubes," says informed industry spokesman as growing military demands cut sharply into skilled personnel.

THE critical shortages aren't imaginary—they're serious. With demand for electronics equipment by the military increasing daily—and with qualified technicians wanted by industry to fill orders and maintain TV sets—now is certainly the time to get into the big-paying jobs in electronics. In this essential industry you're assured—*if qualified*—of a lifetime career at ever-increasing salary. If you're headed for the armed services your technical electronics ability will be immediately rewarded with supervisory work *at extra pay* in vital radar, navigation, or communications units.

CREI offers a home study program recognized by industry and the military as outstanding. *Proof:* Leading industrial firms like RCA-Victor, PAA, United Air Lines and many others have chosen CREI for technician training at company expense; during World War II CREI trained thousands for the Army, Navy, and Coast Guard—and provided texts for thousands more.

CREI, through home study, offers practical training that starts with basic principles and goes step-by-step through the more advanced subjects of TV and its related fields. Each student is grounded thoroughly in the fundamentals required for development work in TV, guided missiles, communications, and industrial electronics. You study Optics; Pulse Techniques; Deflection Circuits; RF, IF, AF and Video Amplifiers; FM; Receiving Antennas; Power Supplies; Cathode Ray, Iconoscope, Image Orthicon and Projection Tubes; UHF Techniques, TV Test Equipment, and many other subjects. You go on to specialized fields as soon as your capabilities permit.

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Technical Aspects of Naval Communications

(*Continued from page* 51)

economy, before a contract is placed, coordination to prevent undesirable duplication of effort is achieved. A proposed Research and Development project is forwarded to the Electronic Committee of the Research and Development Board for consideration. This committee comprises representatives of the three Services, as well as civilian members eminent in the electronics field. After similar development projects are scrutinized, and if no undesirable duplication is apparent, the Research and Development Board approves the project.

The specifications are then submitted to manufacturers for contract bids by the Bureau of Ships, and after the bid has been awarded, the research and development stage follows, under the close supervision of Navy engineers. The acceptance tests follow the development, and finally the service evaluation tests are conducted aboard a station or ship before the equipment is approved and purchased. In the case of shipboard equipment, the service tests are performed by the Commander, Operational Development Force who has available to him highly qualified technical personnel and various types of ships and aircraft for which the equipment is intended. The service evaluation tests consist of actually using the equipment under conditions which duplicate its ultimate employment, with naval personnel operating and maintaining it to make absolutely sure that it will fulfill the operational requirement, and meet the rigid physical standards imposed by the specifications. The foregoing procedure, while it is admittedly slow, assists greatly in providing for the U. S. Navy reliable, rugged, and compact communication equipment, as economically as possible, and with the least impact possible on research and manufacturing agencies. The communication equipment for the U. S. Navy falls generally into two groupings: (1) shore, and (2) ship.

Shore Station Equipment

Shore station communication equipment must possess all of the features of reliability, long life, stability, and low maintenance, the same as shipboard equipment. Certain features, such as ruggedness, small size, and weight are not so important. Shore stations exist to provide long distance communications in large volumes; hence, the equipment is large and powerful, and no limits are placed upon the size of the radiating system required for the job. Transmitters in the order of 500 kw. to 1000 kw. are used, together with huge amounts of terminal equipment for single sideband and electronic multiplexing. Very low frequency transmitters give the fleet world wide broadcast coverage. Transmitting, receiving, and control stations are separated by several miles, and thus must be linked together with landline or v.h.f. control links. Recent developments indicate a trend toward PTM (pulse time modulation) for replacement of the very-high frequency links. PTM offers more flexibility and more channels for the Navy's operational requirements.

Shipboard Equipment

Shipboard installations are restricted in size and weight, depending upon the type of vessel involved. Practically, this means that on some ships when a piece of equipment of any sort is placed in a ship the weight added must be compensated for; either by removing an equal weight, or if the equipment is installed above the water line, an equal weight must be inserted near the keel to preserve the stability. Similarly, space being at a premium in war vessels, consideration must be given the size of the equipment in order that other essential material may also be accommodated. This explains why those portions of Naval military characteristics and technical specifications which have to do with size and weight are most rigid and severe.

In addition to the size and weight factors, because of the extreme ranges of temperature, exposure to salt water spray, deterioration due to humidity and the wear and tear of a ship at sea to which the equipment is subjected, the problem of providing adequate equipment to meet the numerous operational needs is not an easy one.

The limited space above decks, for which requirements for guns, radars, signal searchlights, and other special electronic devices compete with increased numbers of communication antennas to meet expanding circuit requirements, all of which specify omnidirectional coverage, has placed increasing demands upon Navy Engineers for efficient antenna systems. Such research is a continuing project within the Navy, and of late years, considerable emphasis has been accorded it. Recently developed common antenna working systems show promise of producing some gratifying results.

In general, shipboard equipment is growing smaller, more compact, more stable, lighter, automatic, and rugged. It is hoped that miniaturization of components will reduce further their size and weight. On the other hand, the effort to meet the ever growing operational requirements and at the same time reduce the size and weight has introduced, in some cases, more complicated and complex equipment. This is a serious problem in view of the present shortage of Navy Electronic Technician Mates. Therefore, specifications are beginning to emphasize packaging of components for quick replacement to enable disabled equipment to remain on the air. The repair of the particular circuit can be accomplished at a later time. As a result of a standardization program, it is planned to replace the various

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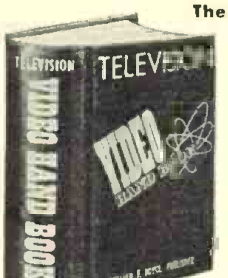

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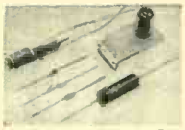
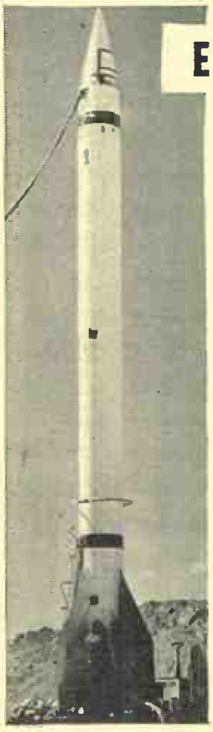
models of transmitters and receivers installed aboard our ships with an all-purpose series of transmitters and receivers. This modernization will assist to some extent in reducing the maintenance and spare parts provisions and stowage problems. The latter is one which has long plagued the logisticians. With numerous different types of equipments installed in ships, the provision and stowage of sufficient spare parts for self-sufficient operations presents many space and weight compensation problems. By standardization of equipments, components, and revising stowage methods aboard ships, a reduction of perhaps 50% in cubeage and weight per ship is anticipated.

In the development of any new equipment, the Naval Communication Service is guided largely by programs of systems-wise engineering. At the present time, there are three such programs that might be listed. They are: (1) ultra-high frequency conversion, (2) teletype, and (3) radiophoto-facsimile.

The ultra-high frequency band was chosen because of the possibility of obtaining more channels to provide for our tactical requirements. It is an all-purpose band and will be used by all three military services on air-to-air, air-to-ground, and ground-to ground circuits. Considerable difficulty has been experienced in developing equipment in this band, mainly because of frequency stability considerations; however, the demanding specifications have brought about successful research on new circuits, new techniques, and new automatic control devices and considerable progress has been made. For instance, the perfection of techniques to realize narrower channel bandwidths has produced nearly double the communication channels than was hoped for originally. Since this equipment must be installed aboard all types of ships and craft, as well as planes, attainment of small size and weight are being emphasized. This u.h.f. system will ultimately replace the very-high frequency system now in use.

Increasing traffic loads and high speed targets have resulted in more and more emphasis being placed upon the use of automatic equipment. The manual c.w. circuit is considered the "horse and buggy" type of communications and, like the horse and buggy, is highly reliable, but very slow. The teletypewriter program is an effort to shift naval communications from the manual method to the machine method, and has been successfully accomplished in the Navy Communication System (shore stations). A partial shift has been made in the fleet in that ship-shore teleprinter circuits exist for the use of those ships equipped with radio teletype equipment. It is hoped that the fleet broadcasts may soon be made by this method. Radio teletype equipment aboard ship is up against the same old problem of weight and space. Hence, new equipment is being developed that is





smaller, lighter, and more compact—a distinct advance.

In line with the trend toward automatics, the radiophoto-facsimile program is the latest additional service to be provided by the Naval Communication Service. The operational requirement for the transmission of maps, charts, and official documents has spurred on the development of radiophoto-facsimile equipment. Future developments indicate strongly that this equipment will become an integral part of shore station and shipboard installations.

Considerable thought has been given to multiplexing equipment for increasing the capacity of the existing communication circuits. The limited frequency spectrum available has encouraged this development.

Looking into the future, more and more attention will be paid to data transmission systems. In this atomic energy age, faster and faster methods of communications will be necessary to support military operation. Furthermore, with the U. S. Armed Services working as a team with allied forces, coordinated communications are a must. All equipment developments must continue to be done along joint specifications so that the Services can work easily into each others' systems. Military characteristics will insist that equipment be developed for joint use, that it be reliable, small and compact as possible with miniaturized components, stable, easily serviced, rugged, and easy to operate and that certain features be automatic. In this manner the U. S. Navy will continue to obtain the best equipment for war purposes that money can buy.

—30—

FOREIGN SET OWNERSHIP

ACCORDING to the most recently released data from the U. S. Department of Commerce, the Postmaster General of the Australian Post Office has asked for bids on equipment for a television station to be built in Sydney. Although bids were submitted two years ago, recent technical developments in both the United States and Britain make it advisable to secure up-to-date information.

The display of FM radios at the Dusseldorf (Germany) Radio Fair was reported to have attracted considerable public interest. Price reductions on these receivers proved to be somewhat of a stimulus as was the displaying of special FM converters which are now available for AM receivers.

The Netherlands is planning to provide television service to the public by means of six transmitters, the first of which will be put into operation early next year in Lopik. The Lopik transmitter is expected to serve 4 million people in The Hague, Amsterdam, and Rotterdam areas. Transmission will be on the 625 line standard.

Licensed television receivers in the United Kingdom totaled 382,348 on May 31, 1950. 109,852 sets were located in London. On January 31, 1950, the number of licensed receivers was 280,092 of which 85,991 were located in London.

—30—

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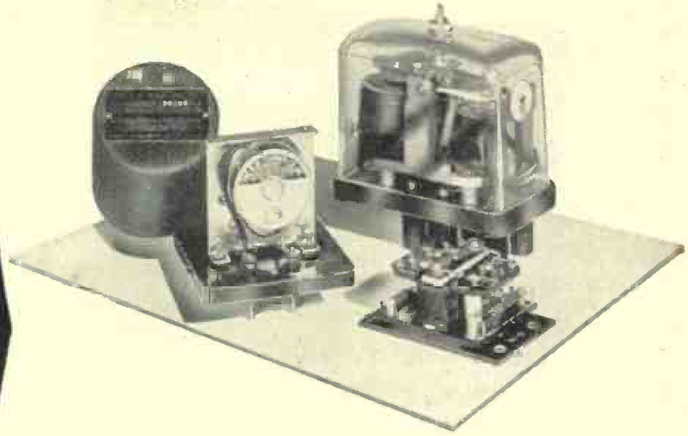

This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

STOCK NO.	VOLTAGE	OHMAGE	CONTACTS	MANUFACTURER & NUMBER	PRICE
R-503	12/32 VDC.	100	3A, 2C	G.E. Ant. Keying 500W 2C6530-653ARI	$ 2.25
R-749	600 VDC.	...	Max. 28 Amps.	Allen Bradley 810 Dashpot	5.95
R-804	550 VAC.	...	1B/38 Amps.	Culter Hammer C-261173A34 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	....	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.25
R-686	115 VAC.	...	2C	Leach 1157T-5/20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
R-246A	115 VAC.	...	1A	Cramer 2 Min. Aoj. Time Delay	8.95
R-611	24 VAC.	...	1A/30 Amps.	Durakool BF-63	4.25
R-283	12 VDC.	125	AC/10 Amps.	Onan Rev. Current 3H4512/R24	1.00
R-614	18/24 VDC.	60	1A/15 Amps.	Rev. Current Cutout 3H2339A/E1	3.50
R-262	....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
R-245	12 VDC.	25	4 In. Micalex Lever	....	.95
R-527	6/12 VDC.	50/50	In Series	2Z7668 For Scr-274N	.95
R-544	12/24 VDC.	60/60	1C	G.E. Push Button Remote Relay #CR2791-R-106C8	1.65
R-255	....	...	1A	G.E. Pressure Switch #2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	⅛" Stroke	Cannon Plunger Relay #13672	.95
R-651	24 VDC.	100	Solenoid Valve	....	2.50
R-295	12 VDC.	275	Annuncitar Drop	....	2.15
R-230	5/8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Wafer	Ratchet Relay From Scr-522	4.25
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A/5 Amps.	BK-13	1.45
R-620	6/12 VDC.	35	2C, 1A	Guardian BK-16	1.05
R-629	9/14 VDC.	40	1C/10 Amps.	Guardian BK-17A	1.25
R-778	8 VDC.	4500	1C/5 Amps.	Kurman BK-24	2.10
R-720	24 VDC.	50	2C, Ceramic	45A High Power	1.35
R-500	12 VDC.	10/10	2C/6 Amps.	Str. Dunn. Latch & Reset	2.85
R-816	12 VDC.	10/15	2C/6 Amps.	Guardian Latch & Reset	2.85
R-811	48 VDC.	8000	1C	Sigma 4R	1.65
R-524	24 VAC/DC.	...	....	Edwards Alarm Bell	.95
R-838	90/120 VDC.	925	2A	Allen Bradley-Bulletin #702 Motor Control	4.50
R-839	100/125 VDC.	1200	3A	Allen Bradley-Bulletin #200E Motor Control	4.50
R-840	115 VDC.	1200	2A	Allen Bradley-Bulletin #209 Size 1 Motor Control W/Type "N" Thermals	5.50
R-841	115 VDC.	1200	4A	Allen Bradley-Bulletin #709 Size 2 Motor Control W/Type "N" Thermals	25.00
R-842	115 VDC.	925	3A	Allen Bradley-Bulletin #709 Motor Control W/Type "N" Thermals	5.50
R-843	115 VDC.	1200	3A	Allen Bradley-Bulletin #200 Motor Control	4.50
R-844	115 VDC.	1200	3A, 1B	Allen Bradley-Bulletin #202 Motor Control	4.50
R-845	220 VAC.	Intermit.	3A	Allen Bradley-Bulletin #704 Motor Control	4.50
R-831	7.5/29 VDC.	6.5	1A/250A, 1000A Surge	Leach B-8	3.50
R-837	110 VAC.	...	2A/30 Amps.	Leach 6104	2.75
R-835	24 VDC.	2800	1A Dble. Brk./10 Amps.	Wheelock Signal, B1/39	1.95
R-836	220 VAC.	...	2A Ddle. Brk./10 Amps.	Wheelock Signal, A7/37	3.45
R-566	115 VAC.	(Coil only, Not a complete relay)		Leach #6104	.75
R-710	....	150-Ohms. Coil Only		Guardian #38187	.50

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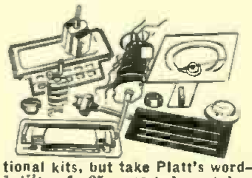

SPECIAL!! A BUNDLE OF CHRISTMAS KITS

Unfortunately space does not allow us to list all the individual parts of these sensational kits, but take Platt's word—they're value-packed!

- 1 Kit of 25 assorted metal and plastic ESCUTCHEON PLATES $2.49
- 1 Kit of 25 assorted DIAL FACES, finished in various stages and used on present high priced broadcast receivers. (Can be used with above kit) 2.79
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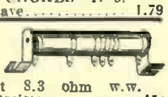
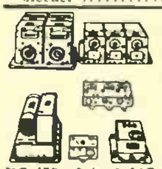
RESISTORS Wire Wound



14 ohms— 30 watt..19c
500 ohms— 25 watt..29c
5000 ohms—100 watt..79c
Flat 8.3 ohm w.w. Resistor 15c
5 tap Resistor, 750x23x23x7500x3000 ohms—200 watt bleeder .... .89c



SCR-27N COMMAND and ARC 5 EQUIPMENT

RECEIVERS

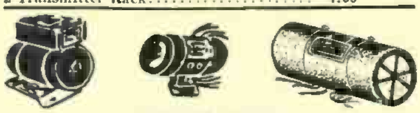
	USED	NEW
BC-453—190 to 550 KC	$12.95	
BC-454—3 to 6 MC.	5.95	$10.95
BC-455—6 to 9 MC.	6.95	10.95
R-23—ARC 5—190-550 KC		21.95

TRANSMITTERS

	USED	NEW
BC-457—4 to 5.3 MC.	5.95	
BC-458—5.3 to 7 MC.	5.95	8.95
BC-696—3 to 4 MC.	14.95	24.95
T-19—ARC 5—3 to 4 MC.		24.95
BC-459—7 to 9.1 MC.	12.95	24.95
T-22—ARC 5—7 to 9.1 MC.	12.95	24.95

ADDITIONAL EQUIPMENT

	USED	NEW
BC-456 Modulator	2.25	3.25
BC-450 Control Box (3 Receiver)	.98	1.95
BC-451 Control Box (Transmitter)	.89	1.49
BC-442 Relay Unit (ANT)	1.95	2.95
Plugs: PL-147, 148, 151, 152, 153, 154, 156—EACH	.75	
Flexible Shafting with gear to fit Receivers		1.69
3 Receiver Rack	2.25	
2 Transmitter Rack	1.69	



DYNAMOTORS

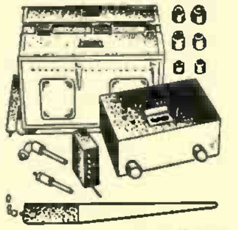
	USED	NEW
DM-33A—input 28V. output 540 VDC. 250 mills	$1.95	$ 2.95
DM-32A—input 28V. output 250 VDC. .06 amps	1.95	
DM-34—input 12V or 14V at 2.8 amps. output 220 V at 80 MA	8.95	
DM-25A—12 V, input 2.3 amps. 250V output at 50 MA. Ideal for use on command receivers for mobile use		4.95
DA-1A—input 28 VDC at 1.6 amps. output 230 VDC at 1 amp.		6.95
DY-12—for ART-13 Power Supply. 12V, 9.4 amps. 1 output 275V @ 110 MA, 2-500V @ 50 MA		6.95
DY-53A—24V input. 220 VDC. output at 80 MA		2.95
PE-125 Vibrator Power Supply. 12 or 24 VDC designed for BC-223 Transmitter, output 400V at 200 MA, 8V at 4.5 amps		17.95
PE-103A Dynamotor with power unit. Ideal for mobile use, input 6V at 21A, output 500V 1.6A or 12V at 11A, output 500V 1.6A. Used with SCR-284		24.95
BD-86—input 14V 2.2 amps. output 600V .3 amps. With fuse and Cond. Box on Mount		7.95

DYNAMOTORS (Cont'd)

	USED	NEW
DM-36 Dynamotor, input 24V to 28V 1.4A, output 220V at .08 amps. Complete with mounting base and Jones Plug	2.95	
PE-94—input 28V, output 14.5V at 4.9 amps, 150V at 10 MA, 300 V at 260 MA. Used with SCR-522	5.95	9.95
MP-28BA—A dynamotor power supply unit, input 25 to 28V 14.8 amps DC, output 540V 450 MA DC. With a transmitter modulation section using 1—6N7, 1—6F6 and a pair of 807 tubes in push-pull. Also includes modulation transformer. Used for Bendix TA-12		45.00

Multitester Foundation BIAS METER 1-97A

Contains a zero center 3½" round Marion voltmeter calibrated 0-100 volts each side. Movement is one mill each side of center. The unit is mounted in a steel box 7"x5"x4½" and contains 8 contact push buttons, line cord dual 100 MFD at 200 V DC condenser, a potentiometer 6 IRC 1% wire wound non-inductive resistors: one 400 ohm, two 2500 ohm, one 5000 ohm, one 10,000 ohm, one 15,000 ohm. Excellent for building a zero center multitester with ranges of 1, 10, 100, 1000 volt. COMPLETE BRAND NEW **$5.95**



RECONDITIONED SCR-522

With New Components

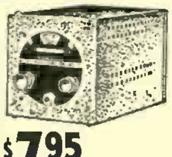
Very High Frequency TRANSMITTER-RECEIVER 100-156MC, 4 Channels. Crystal-Controlled, Amplitude Modulated Voice. Electrically Tested.

Complete as shown Only $84.50

BRAND NEW—$92.50
SCR-522C—Complete as above—Brand New $129.50

BEACON RECEIVER BC-1206-C

Manufactured by Setchell-Carlson



Frequency Range — 195 KC to 420 KC, IF Frequency—135 KC, Receiver Sensitivity — 3 Microvolts for 10 Milliwatts output. Output Impedance — 300 Ohms and 4000 Ohms to be selected internally. Power Output — 230 Milliwatts. Volume Control—RF Gain Control. Power Supply—24-28 Volts Aeroplane Battery. Current—.75 Amperes. BRAND NEW—ONLY **$7.95**

Mallory NF1-7 RADIO NOISE FILTER
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ARMY TEST UNIT 1-236

Meter is contained in a metal box 5⅛" long x 3¾" wide x 3¼" deep. Comes complete with test leads and instruction book. Can be used for testing between AC & DC measuring resistances of circuits, checking fuses, and testing capacitors. ONLY **$7.95**

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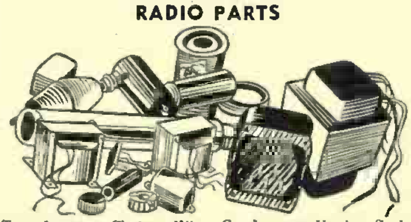
A 30 watt Transmitter, ideal for ship-to-shore or Ham Rig. Crystal or MO control on four preselected channels. 2000 to 5250 KC. Use of 3 plug-in coils, five tubes: 2—801 and 3—46, and TU 17-18-25 tuning units.

TRANSMITTER $25.95
TUBES 3.75
TUNING UNITS .... 2.25 ea.
PE-125 VIBRATOR POWER SUPPLY FOR BC-223 .... $18.95

20 POUNDS OF ASSORTED RADIO PARTS



Transformers, Chokes, Wire, Condensers, Knobs, Sockets, Switches, Dynamotor. ONLY **$3.39**

MINIMUM ORDER $2.00
Immediate Delivery—Send 25% deposit on C.O.D. orders. All shipments F.O.B., N.Y.C. (N.Y.C. residents add sales tax to your remittance.)

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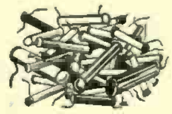

Non-insulated, various ohmages and wattages. SPECIAL **$1.97**

HEADSETS

- HS-33 low impedance with cord and plug, used, fine condition $0.79
- HS-23 high impedance, BRAND NEW with ear pads 2.75
- HS-33 low impedance, BRAND NEW with ear pads, cord and PL54 plug 2.75
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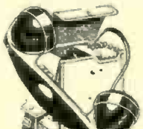
- HS-30 with ear plugs, low impedance, used, good condition .... .89

FIELD TELEPHONES



Army surplus, completely reconditioned and electrically tested, using 2 flashlight cells and a pair of interconnecting wires. GUARANTEED—like new. ONLY **$10.95**

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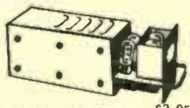
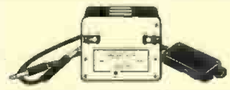


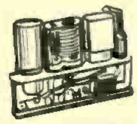
4 tube Amplifier used by U.S. Air Force. 115 V, input at 400 cyc.
With tubes—BRAND NEW $3.95
Without tubes—BRAND NEW 1.49

PRE-AMPLIFIER MODEL K-1



The K-1 is used to amplify output level for microphones and phonographs. Operates on 24-28 VDC, can be converted to 110 AC. Comes complete with PL 55 plug and 2 foot 119-B cord, 2 terminal blocks and instruction book. BRAND NEW .... SPECIAL **$3.95**

BC-746 TUNING UNIT



Plug-in transmitter tuning unit from Army Walkie-Talkie. Contains antenna and tank coils, tuning condenser, transmitting and receiving crystals. Ideal transmitter foundation. ONLY **$1.29**

BATHTUB CONDENSERS

- .5—.5 MFD—100 VDC (Top Terminals) 9c
- 20 MFD—350 VDC (Side Terminals) ..39c
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- .25 MFD—400 WVDC (Side Terminals) 19c
- .5 MFD—100 VDC—2.6 MFD—400 VDC (Side Terminals) 29c
- 2x1 MFD—600 VDC (Bottom Terminals) 39c
- 2x1 MFD—600 VDC (Side Terminals) 39c
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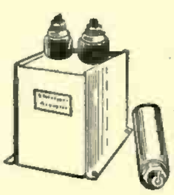
- 15x15 MFD—450x350 V. 59c
- 8x8x20 MFD—300x300x150 V. 59c
- 10x50 MFD—450x25 V. 39c
- 1000 MFD—15 V. 33c
- 3000 MFD—3 V. 48c
- 2000 MFD—15 V. 37c

OIL FILLED CONDENSERS



- 32 MFD—450 VDC, Mounted on Metal Plate $0.79
- .5 MFD — 750 VDC — 400 VAC .... .49
- 8x8x8 MFD—500 VDC .... .59
- 1 MFD—3000 VDC, Round Can .... .95
- 1 MFD—1000 VDC, Rect. Can .... .69
- 1 MFD — 600 VDC, Rect Can .... .49
- 2 MFD—600 VDC, Rect. Can .... .69
- 2 MFD—600 VDC, Round Can .... .69
- .25 MFD—3500 VDC, Rect. Can 1.29
- .25 MFD—6000 VDC, Rect. Can, G.E. 1.79
- 15 MFD—660 VAC—G.E., Large 1.29
- 2 MFD—4000 VDC, G.E., Large 4.39
- 30 MFD—90 V, 3 Phase, G.E., Large, 60 Cycles .. 1.39
- 1.25 MFD—220 VAC, Western Electric Motor Cond. .... .29

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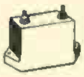
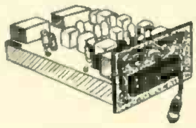
AT LOW, LOW PRICES!

TRANSMITTING MICA CONDENSERS



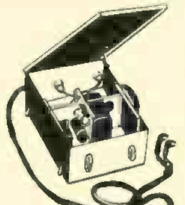
.00075	MFD—5000 V	.79c
.0015	MFD—5000 V	.89c
.09	MFD—1500 V	.79c

BC-620 RECEIVER-TRANSMITTER



2 crystal channels — 20 to 27.8 MC. FM-13 tubes. Metered. Plate and Filament. NEW **$24.95**

PE-97 POWER SUPPLY for BC-620



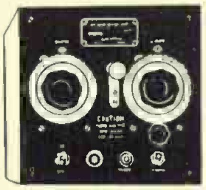
6 or 12 V vibrator type. NEW—less tubes, vibrator.

$3.95

TUBES—Brand New Standard Brands. Immediate Delivery

5BP4	$2.75	807	$1.65
3CP1	.59	955	.49
10Y	.39	12SH7	.49
79	.29	4AP10	2.50
801	.69	9004	.49

BC-1066 RADIO RECEIVER

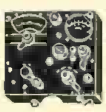


Receives radio frequency signals for checking frequency and operation of other radio equipment. Coverage is obtained by 2 bands, I and G. Battery operated. New with tubes...... **$8.95**

BC-433 RADIO COMPASS RECEIVER

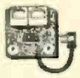
15 tubes, frequency range 200-1750 KC, 3 bands. EXCELLENT CONDITION..... **$29.95**

Control Box BC-434-A



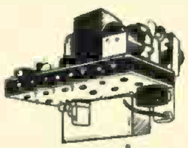
Used with Radio Compass receiver R5-ARN-7, Bendix ADF Equipment. Only **$1.95**

Control Box BC-648-A



Brand New. Includes 2 meters—0-5 milliamperes and 0-40 Volts. Made by Westinghouse. Excellent Value! Only........... **$3.29**

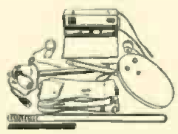
CHRISTMAS SPECIAL!
APN-2 COMPLETE AIRBORNE NAVIGATIONAL RADIO UNIT



Consists of transmitter, receiver and power supply. Frequency range of receiver: 214 and 234 MC. Maximum operating range: 100 miles. Power requirement: 115 VAC—400 cyc. Contains a considerable amount of excellent parts.

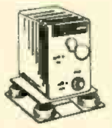
ONLY **$6.95** less tubes

MINE DETECTOR SET—SCR-625



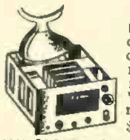
A portable device capable of detecting all types of metals. Hundreds of uses: Agricultural, mining, etc..NOW ONLY **$79.95**

RADIO RECEIVER BC-1023-A and MOUNTING FT-161



UHF aircraft receiver with frequency range from 62 to 80 MCS for receiving 75 MC marker beacon signals ....BRAND NEW! **$7.95**

MN-26 INSTALLATION



MN-26C Receiver — Remote control commercial type navigational. Indicates direction of any desired transmitting station. 3 bands — frequency range: 150 KC to 1500 KC; has 12—6 V type tubes. BRAND NEW (Original Cost $600.00).................. **$22.95**

MN-26C Receiver, used, excellent condition......$15.95
MN-26Y Receiver. Frequency to 7 MC. New..... 22.95

TYPE MN-20E ROTATABLE LOOP UNIT

8" diameter, used with MN-26 Compass and RA 10DB. Manufactured by Bendix. A TERRIFIC BUY! ONLY...................... **$11.95**

BC-221 FREQUENCY METER

This is a Christmas Special! QUANTITY IS LIMITED — so first come, first served. They are just like new, with original calibration charts. Range 125-20,000 KC with crystal check points in all ranges. Complete with crystal and tubes.

ONLY **$69.50**

WOOD CASES for 221 FREQUENCY METERS

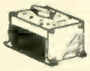
Brand New ....$3.95 Used $2.25

BC-461 CONTROL BOX

Used for RL-42 Ant. Reel. Has Veeder-Root counter with "0" reset adjustment and multi-switch to control RL-42 which is reversible.

ONLY **95c**

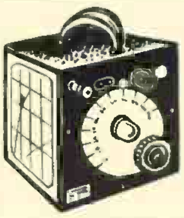
FL-8 RADIO FILTER



Can be converted for use with many types of transmitters and receivers. Complete write-up in May, 1950, Issue of CQ Magazine.

EXCELLENT CONDITION **$1.29**

BC-1255 MONITOR

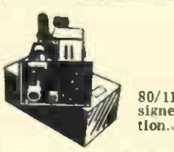


A battery-operated receiver, 75-150 MC range. Used as monitor in operation and calibration of radio transmitters. BRAND NEW............ **$14.95**

CONVERSION KIT E-3E

Contains one 20 ft. roll co-ax cable RG-8U. 2 rolls containing 75 ft. of aero glass-covered wire and assorted screws, nuts, switch plates, grommets, clips, etc. **$2.39**

T9/APQ-2 RADAR TRANSMITTER



80/115 V 400-260-26 VDC. Designed primarily for aircraft operation. Exceptional value. NEW **$42.50**

MINIMUM ORDER $2.00
Immediate Delivery—Send 25% deposit on C.O.D. orders. All shipments F.O.B., N.Y.C. (N.Y.C. residents add sales tax to your remittance.)

MICROPHONES

T-24-G, 200 ohms, single button, 8 ft. rubber cord with PL-106 Plug and JK 38 Jack. BRAND NEW $1.95

T-17-B. Hand-held carbon microphone for use in voice communication. Effectively covers the audio frequency range from 300 to 2600 CPS. 200 ohms, with press-to-talk switch, 5 ft. rubber cord and plug. NEW......$3.95

T-30 Microphone suitable for aircraft use. Responds to frequencies in the range of 400 CPS to 2000 CPS. Complete with cord and plug. Original Packing. NEW...................... 1.29

T-36-C Hand Carbon Microphone. 24 ft. cord. 3 contact amphenol plug...................... 2.95

T-44C Magnetic type mike with cord, plug and jack. Brand New...................... .69

GN-45 HAND GENERATOR

6 Volts, 3 Amps
500 Volts, 0.14 Amp

Used with Signal Corps Radio Set SCR-284. Has many applications. Brand New. Original Packing..........ONLY **$17.95**

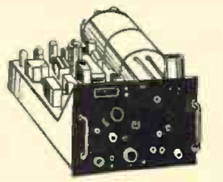
CORDS AND PLUGS

CD 508A Cord Assembly with SW 14-U Switch and 2 cord attachments with JK 48 Jack and PL 68 Plug. Value—$5.00. Our Special Low Price. Brand New.....59c

CD 307A with PL 55 and JK. New 79c

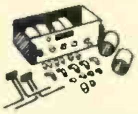
JK 26 Jack with cord, good condition	12c
JK 26 Jack only—Brand New	15c
PL 55 Plug—NEW	35c
PL 68 Plug—NEW	20c
Jones plug 8 contact male and female	25c
PL-Q-59	49c
PL-P-60	49c
PL-Q-61	49c
PL-Q-62	49c
PL-Q-77	69c
PL-Q-171	89c
PL-153-A	69c
PL-172	89c

T-85/APT-5 UHF TRANSMITTER



Frequency range 300-1500 MC. 20 watts output, band width 2.5-3 MC. Complete with 8 tubes and 110 V 60 cyc. fil. transformer. Calibrated in centimeters. New in original box with operating Instruction Manual.. **$79.50**

APN/1 RADIO ALTIMETERS



Christmas comes but once a year and so does a bargain like this. A complete NEW 14 tube Radio Altimeter. Contains 420 MC Transmitter and Receiver, Power Supply, Range Switches, Two Antennas, Meter Indicator. All Plugs and Instruction Manual. This unit makes an excellent amateur station as it is right in the band..............BRAND NEW—ONLY **$24.95**

LAST MINUTE CHRISTMAS SPECIALS!

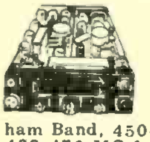
BC-348 Receiver—Excellent Condition	$129.50
BC-224 Receiver—Excellent Condition	99.50
BC-610 Radio Transmitter—Needs Repairs	375.00
BC-614 Speech Amplifier—Used with Hallicrafters BC-610 Transmitter	135.00
ARC-3 Transmitter—Brand New	325.00
R5/ARN7 Compass Receiver, complete, like new	125.00
PE-75 Gasoline Driven Power Unit, 2500 watts, Excellent Condition	169.00
SCR-284 Spare Parts Kit	39.95
DYNAMOTOR with base for ART-13	49.95

PLATT ELECTRONICS CORP.
DEPT. A, 489 BROOME ST., NEW YORK 13, N. Y.
PHONES: RE 2-8177 and WO 4-2915

BEST WISHES and BEST VALUES from NIAGARA

ONE OF AMERICA'S GREAT ELECTRONICS STORES

TRANSMITTER-RECEIVER



Navy Model ABA-1-BC-645
450 MC-15 TUBES,
Brand New

Can be easily converted for phone. or CW 2-way communication. Covering the following bands: 420-450 MC ham Band, 450-460 MC for fixed or mobile, 460-470 MC for citizens, 470-500 MC television experimental. Size 10½ x 13½ x 4¾. Contains 15 tubes: 4-7F7, 4-7H7, 2-7E6, 2-6F6, 2-955, 1-WE-316A door knob. Price, NEW and Boxed. Reduced to **$15.95**

TALK UP TO 10 MILES WITHOUT BATTERIES

R.C.A. SOUND POWER PHONES

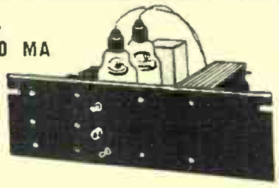
RCA No. M1-2475 Navy Type "Q." You can actually hold two-way conversations over wired circuits up to TEN MILES with these Sound Power phones. Any number of these units may be paralleled on same line without loss of power. Ample volume — excellent tone quality—rubber cushioned earphones, mouthpiece microphone attached. Massive construction, multiple adjustments, 22-ft. rubber cord, push-to-talk switch, navy waterproof plug. Ideal for TV antenna installations, fieldtests, hunting, mining, games, etc. Cat. No. N-300. Your cost, each unit, comprising 1 pair headphones, microphone, cord and plug as illustrated **$9.95**

Same as above with mile on chest plate. Type "O" RCA M1-2454B... **4.95**

274N and ARC-5 XMTRS and RECEIVERS

2.1-3	MC. Xmtr.	$14.95
3-4	MC. Xmtr.	19.95
4.5-3	MC. Xmtr.	12.95
5.3-7	MC. Xmtr.	12.95
7-9.1	MC. Xmtr.	24.95
190-550	KC. Rcvr.	14.95
550-2000	KC. Rcvr.	24.95
3-6	MC. Rcvr.	7.95
6-9.1	MC. Rcvr.	7.95
100-156	MC. Rcvr.	19.95

SPECIAL
1500 Volt—300 MA Power Supply Kit



Complete with punched chassis, 19½" rack panel, tubes, choke, transformers, hardware, etc.
WHAT A BUY! **$24.95**

TRANSFORMER BARGAINS!

Plate

750-0-750—300 MA.	$ 7.50
1025-0-1025—500 MA.	17.95
2500 V.—4 MA.	3.95

Filament

2.5V-5A, 7.5V-4A	$2.60
2.5V.-10A cased	4.95
5 V.C.T.-3A	1.35
5V-10A	1.85
5 V.C.T.-10.5A	2.15
5 V.C.T.-15A	5.95
6.3V-3A	1.29
6.3 V.C.T.-3.5A	1.49
Three 6.3 V.C.T.-4A each	1.80
6.3 V.C.T.-6A	1.85
6.4V-8A	2.05
7.5V-5A	2.49

Power

40-0-40—250 MA.—5V-3A	$1.25
55-0-55—250 MA.—5 V.C.T.-3A, 5 V.C.T.-3A	1.35
175-0-175—150 MA.—6.3V-6A	2.15
275-0-275—70 MA.—5V-5A, 2.5V-10.5A	3.00
325-0-325—40 MA.—5 V.C.T.-2A,2.5 V.C.T.-4A	2.25
325-0-325—70 MA.—6.3V-1.2A, 5V-3A	2.95
350-0-350—70 MA.—5V-3A, 6.3V-3A	3.05
350-0-350—100 MA.—6.3V-6A, 6.3V-2A	3.25

Modulation

807 to P.P. 6L6	$2.49
P.P. 807 to single 6L6, 4D32 (2400 ohms)	3.49
From 200,500 ohms to 5, 6, 7, 8, 9, 10K ohms at 150 MA.	4.49

Driver Xfmrs.

200, 10,000 ohm P. to single G.	$ .79
10,000 ohm P. to single G.	.89
P.P. 45, 2A3, etc. to P.P. 210, 801, etc.	1.95
P.P. 6L6, 2A3, etc. to P.P. grids	1.65

Output

P.P. par. 2A3, 45, etc. "AB" to 4, 8, 15, 500 ohms	$1.89
6V6 to 2, 4, 8 ohms	.69
P.P. par 6N7 Class "B" to 8000 ohms	1.49

Input

600 ohm C.T. to 300 ohm mike	$1.49

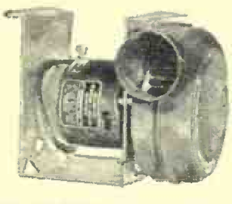
Mike to Line

From and to 50, 125, 200, 330, 500 Ohms	$2.49
30 ohm mike to 600 ohm C.T. Bal. line	1.65

Chokes

.875	HY.	2.5 Amps	$8.95
2.5	HY.	4 Amps.	8.95
2.5	HY.	130 MA.	1.10
4	HY.	40 MA.	.25
8	HY.	200 MA.	2.35
10	HY.	180 MA.	3.49
40	HY.	90 MA.	
10	HY.	200 MA.	2.49
12	HY.	150 MA.	1.75
15	HY.	125 MA.	1.60
15	HY.	200 MA.	2.65
20	HY.	125 MA.	1.75

BLOWERS



THREE TYPES ALL 110V. A.C. 60 CYCLE MOTORS. ALL BRAND NEW

TYPE A—Single section (illustrated above) approximately 100 Cubic Ft. Per Minute. 2½" intake, 2" outlet. 3200 R.P.M. 25 cycle motor measures 6" x 6½".
SPECIAL $9.95

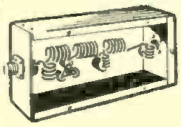
TYPE B—DUAL BLOWER—100 C.F.M. Per Section. Mounted side by side with 60 cycle motor in center. Otherwise same as TYPE "A."
SPECIAL $14.95

TYPE C—Single section (not illustrated). Somewhat smaller than TYPE "A." Approximately 50 C.F.M. 60 cy.
VERY SPECIAL $6.95

New Low Price
Niagara Famous High Pass Filter

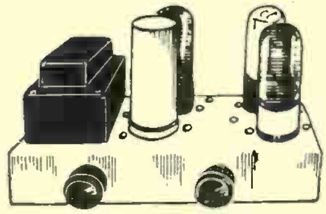
Banish Interference with Niagara's Hi-pass filter! Positive protection against interference from amateur transmitters, diathermy, and all other devices generating radio frequency interference below 40 MCS. Designed for 300 ohm leadin. No loss in brightness or clarity.
Wired and tested **$2.50**
Postpaid if entire amount is included with order.

LOW PASS FILTER



Don't be blamed for TVI! Tests have proven that Niagara's low pass filter attenuates all frequencies above 40 MC. May be used on all bands from 10 to 160 meters. Will easily handle a full kw. Matches 52-72 ohm line. Plus 25c shipping charges in U. S. A. **$4.99**

5 WATT AUDIO AMPLIFIER



Complete with speaker and 3 tubes. Hi-impedance output for XTAL mike or Phono-Pickup. Volume and tone controls. 5 W. amplif. with 5" speaker **$8.95**

Same as above with 8" speaker **9.95**

IMPORTANT NOTICE: Minimum Order $5. Quantity prices on request. All items in stock now—subject to prior sale—prices subject to change without notice. 20% Deposit with orders unless rated. All prices F.O.B. our N.Y.C. Warehouse.

Niagara Radio Supply Corp.

Phone
Digby 9-
1132-3-4

Dept. N-120 160 Greenwich Street, New York 6, N. Y.

What's New in Radio
(Continued from page 86)

equipment is the Model RC-12, three-speed portable phonograph with record changer.

The new unit plays all records, 33⅓, 45, and 78 r.p.m. in diameters up to 12". The 5-watt, full a.c. amplifier incorporates an inverse feedback circuit and an effective tone control. The set uses a 6" x 9" Alnico V PM speaker and a featherweight crystal pickup combined with a unique amplifier design to produce a rich tonal quality. The carrying case is of plywood construction covered with a washable fabricoid material. The unit weighs

just 31½ pounds and carries the *Underwriters'* seal.

Additional details on the Model RC-12 are available from the company at 6824 Lexington Ave., Hollywood 38, California.

INTERMODULATION METER

Measurements Corporation of Boonton, New Jersey has recently developed a compact, completely self-contained intermodulation meter which it is offering to the trade as the Model 31.

The new unit consists of two principal sections, a test signal generator and an analyzer. A built-in supply provides power for both units. The generator section produces two sinusoidal voltages, one on a low frequency and the other a high frequency which

are mixed in a 4:1 voltage ratio and applied to the apparatus under test.

The signal from the equipment being tested is then received by the analyzer section of the Model 31 to be filtered, amplified, demodulated, and metered. The meter is direct-reading in percentage of intermodulation and input volts.

The instrument is useful for evaluating the performance of audio systems, for the correct adjustment and maintenance of AM and FM receivers and transmitters, for checking linearity of film and disc recordings and reproductions, for checking phono pickups and recording styli, for adjusting bias in tape recordings, for quality control of all audio components and equipment, and for many other applications.

The Model 31 is 8"x19"x9" and may be mounted in a standard 19" relay rack.

LINE VOLTAGE REGULATOR

Clarostat Mfg. Co., Inc. of Dover, New Hampshire is now offering an automatic line voltage regulator for steadier television pictures irrespective of line voltage fluctuations.

Major Edwin H. Armstrong, George E. Burghard, Paul F. Godley, and Ernest V. Amy, shown below, were the recipients of an Armstrong Medallion and special citation at Greenwich, Conn. on Saturday, October 21, when a memorial was officially dedicated to Amateur Radio Station 1BCG. This station, located a few hundred yards from the site of the monument shown, was the first to transmit shortwave signals to Europe. Three other operators of 1BCG also were awarded medallions and citations but were not present at the ceremonies, Minton Cronkhite, John F. Grinan, and Walker P. Inman.

This new accessory is said to provide improved reception in rural districts or areas habitually experiencing line voltage fluctuations. With male and female *Edison* connections at either end, it plugs in between the TV set's attachment plug and the outlet.

Two models are available. The TV-A is rated at 300 watts and is designed for sets consuming from 200 to 300 watts. The TV-B is rated at 375 watts and is for sets using from 300 to 375 watts.

TRANSCRIPTION PLAYERS

Califone Corporation of 1041 N. Sycamore Ave., Hollywood, California, has recently announced the availability of its new transcription player models.

The 1951 line features the company's exclusive method of "Varipole" speed tuning which permits a gradual adjustment of turntable speed from 25% below normal to 10% above.

The entire line features lightweight portability, and three-speed playing of recordings or transcriptions up to 16" in diameter. For complete details on these units, write direct to the company.

TAPE RECORDING HEAD

A tape recording head engineered for mass production has been introduced by *Shure Brothers, Inc.* of 225 W. Huron Street, Chicago, Illinois.

Known as the Model TR5, the new head combines the functions of record, playback, and erase in a single unit. A special feature is the use of a deep-

drawn mu-metal shield for optimum hum reduction.

The TR5 has a unique design that insures production control of gap dimension and alignment. The tape head is also designed for ease in assembly to equipment.

The record and playback coil im-

ARROW has the VALUES!

MISCELLANEOUS SPECIALS!

	Used	New
ASB 7 Indicator Scope	12.95	——
MN 26 C	17.50	24.95
RA 10 DA Receiver	17.50	24.95
RT7/APN1 Transceiver	6.95	9.95
APN 1 Complete	——	24.50
BC 347 Interphone Amplifier	——	2.95
I-70 Tuning Meter	——	.89
BC 461 Veeder Root Counter	——	.59
BC 442 Less Condenser	1.49	1.95
APS 13 UHF Antenna, Pair	——	.98
FL 8 Filter	——	2.95
I-97 Bias Meter	3.95	4.95
RM 29 Remote Telephone Control	7.95	9.95
RL 42 Antenna Gearbox Motor and Reel	4.95	7.50
TS 10—Sound powered phones	6.50	——

BC 1066 B—150 to 225 MC Portable Receiver adaptable to many amateur uses. In Canvas Carrying Bag. Used $5.95

Tuning Units for **BC 375**—Presently most numbers are available in excellent condition with case at .... $2.95 ea.

BC 306—Antenna Tuning Unit for **BC 375**. Excellent condition .... $1.50 ea.

One Tube Interphone Amplifier—Small compact aluminum case fully enclosed. 2¼"x3¾"x5¾". Less Tube 79c

96Q1 Complete Autotune assembly with motor and frame as used in **ARC-1** Transmitter. New $35.00

BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery .... New $3.95

SCR 183 Complete .... New $49.50

220 MA Circuit Breaker .... New .59

Collins VFO Dial—5 calibrated ham bands from 3.2 Mc to 32 Mc; complete with pointer, gears, logging dial and flywheel. Scale 6" on 8" plate New .... each .95

C-18—Antenna coil assembly slug tuned used in BC 603 receiver. Frequency range 20-27.9 Mc.—fully shielded .... New. 10 for $1.95

I 82 F—Five Inch 360 degree compass indicator and Selsyn receiver .... New $4.95

A-81-2 Transmitter selsyn for I82 indicator ... $2.45 (Both I82F & Trans. Selsyn for $7.00)

MC 385A—Headset Adapter .... New 49c

Information and Prices on Request

BC 639 Receiver with **RA 42** Rectifier
RTA 1B Transceiver
TA 2J24 Transmitter and **MP 10G** Power Pack
SCR 269 Compass Installation
R 5/ARN 7 Compass Installation
MN 26 Compass Installation
I. L. S. Installation **(R 89-BC733)**
AN APRI Receiver and Tuning Units
ASB7 Complete Radar Installation

RT7/APN1 TRANSCEIVER UNIT—

Used as an altimeter, it may be converted for signaling control circuits, etc. Complete with 14 tubes and dynamotor they are in good used condition at the amazingly low price of **$6.95**

Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles FM. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½"x9"x4¼", provided with shoulder straps.

This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal **$89.50**
Battery charger is extra at $19.95

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 3½"x8"x15½", operating on 152 to 162 megacycles FM. It is six-volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit.
Brand new, ready to go **$129.50**
Extra 18" stub type antennae are available ... $2.95

HEADSETS—MIKES

HS-30 Hi Imp. Headsets	New	$1.50
	Used	.79
T-24 Hi Imp. Carbon Mike	New	1.19
T-30 Throat Mike	New	.98
T-45 (or Navy) Lip Mike	New	.98

RADIO EQUIPMENT

RC 100 B

This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

CABINET CH-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet **$34.95**

TRANSMITTER BC-769 is designed to transmit RF pulsed signals at 470 megacycles with the use of the two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines **$19.95**

KEYING UNIT BC-770 furnishes the pulse of the transmitter **$14.95**

RECEIVER BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation **$19.95**

RECTIFIER RA-52 produces the high voltage. An O-15 kilowatt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an O-20 milliammeter is connected to the ground return to measure the average current drawn **$74.50**

AIR COMPRESSOR M-349 together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 cycles **$42.50**

OVEN M-348 is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110 V AC 60 cycles. **$29.50**

FREQUENCY METER BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source **$49.50**

TECHNICAL MANUAL TM11-1113B covering entire equipment .... **$ 5.00**

COMPLETE UNITS are available at amazing low price ... WRITE TODAY!

TUBE SPECIALS!

211	$0.39	803	$2.89	832A	$7.95
307A	5.50	805	3.29	837	1.19
703A	1.89	807	1.89	841	.49
723A/B	12.95	813	6.95	860	4.95
724B	1.89	832	2.95	864	.24

RC 150 EQUIPMENT

Receiver BC 1161 A	New	$29.95
Transmitter BC 1160 A	New	29.95
Control unit BC 1162 A New but less tubes		14.95
Signal Generator I 198 A	New	24.95

COMMAND (SCR 274 N) EQUIPMENT

	Used	New
BC-453	$12.95	——
BC-454	5.95	——
BC-455	7.95	$9.95
BC-456	——	2.95
BC-457	5.95	——
BC-458	5.95	8.95
BC-696	14.95	24.95
BC-450—3 Receiver Remote Control	.89	1.95
BC-442	——	2.95
3 Receiver Rack	1.95	——
2 Transmitter Rack	1.50	——

Complete Command set as removed from aircraft—3 receivers—2 transmitters—Relay unit—control boxes—mounting racks—plugs—modulator and dynamotors—crated Set. **$34.50**

SURPRISE PACKAGE

20 lbs. Ass't radio parts. A $25.00 value for only **$1.95**

AS-138/ARN—10 inch streamline loop as used with direction finding receivers. Fixed position, it is ideal for planes, boats, automobiles. New **$1.95**

1D6/APN4 Scope unit complete with 5CP1 cathode ray tube and shield and all parts except smaller tubes and crystal. Used .... **$9.95 ea.**

MONTHLY SPECIAL
FLAP PITCH MOTOR

24 VDC. will operate on AC—3300 or 11,000 R.P.M. Complete with gear box and limit switches .. ea. **$2.49**

CONDENSERS

	Each
1 mfd. 6000 VDC. OIL FILLED	$1.98
.00025 mfd. 25000 VDC. OIL FILLED	2.95
1 mfd. 600 VDC. OIL FILLED	.24
	5 for 1.00
50 mmfd—5KV—5 Amp. Vacuum Cond	1.19

IS-185 Weston Voltmeter Model 433—0 to 150 VAC 25 to 2400 cycles. New **$24.95**

BC-604 Transmitter FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition **$19.95**
Crystals—Set of 80 .... **19.95**

BC 603

Receiver—Good. Used **$24.95**

Complete **SCR-508** Installation available—price and information upon request.

BC 620

Receiver-Transmitter—2 crystal channels—20 to 27.8 MC FM—13 tubes. Metered, Plate and Filament .... Used $9.95
PE 97 or **PE 117** or **PE 120** Power Supply for above 6-12 volt vibrator type.
Used less tubes, vib. & con $2.95
Used, complete $6.95
FT 250 Mount for both BC 620 and PE 97 New $1.50

BC 223

Brand new Transmitter with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace; but less tubes at new low price of **$29.95**
Set of 5 tubes $3.95
Tuning units are available separately at .. Ea. $2.50
PE 125—12-volt Vibrator Pack .... New $12.95
Used $8.95

BC 906—Frequency Meter

Range 150-225 MC with modification possible for lower frequencies of TV, etc. Contains 0-500 DC microammeter and uses Battery pack of 1.5 V and 45 VDC.
Like New—Less Batteries **$10.95**

HERMETICALLY SEALED CHOKES

10 H.	100 M.A.	59c
59 H.	100 M.A.	95c
3.7 H.	145 M.A.	59c
10 H.	20 M.A.	39c

All shipments FOB warehouse. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

ARROW SALES, Inc.

Dept. N
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

pedance is 1650 ohms at 1000 c.p.s. while the erase coil impedance is 1000 ohms at 40 kc. The output level of the unit is 5 db. above 1 millivolt at 1000 c.p.s. at a tape speed of 3.75" per second. The over-all dimensions are .685" maximum height, 1.240" wide, and 1.031" deep.

NEW COMBINATION

Voice and Vision, Inc., 314 N. Michigan Avenue, Chicago 1, Illinois is now offering a custom AM-FM-phono com-

bination as one of the instruments in its "Professional Series."

The duo-chassis design has separate high-fidelity amplifier, 17 tubes including two rectifiers, and a 3-gang tuning condenser. An automatic frequency control eliminates station drift. Input channels for television are provided. There are continuously variable separate bass and treble controls, easily adjustable to reproduce sound from 20-20,000 c.p.s. undistorted. Flywheel tuning assures simple station adjustment.

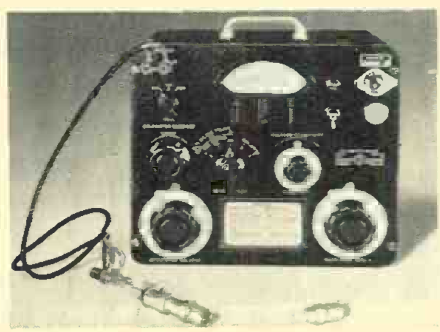
This new set will be available in a variety of custom cabinets.

For complete details on the new "Professional Series," write for the company's new brochure.

BOLOMETER BRIDGE

General Radio Company of 275 Massachusetts Avenue, Cambridge 39, Massachusetts has designed a new bolometer bridge which provides maximum flexibility of application.

The new Type 1651-A can be easily adapted to a variety of power measurement problems. It can be used, not



only with the *General Radio* bolometers, but also with those of other manufacture which have resistances between 25 ohms and 400 ohms. Measurements can be made either by a direct reading or a substitution method. The current range is 0 to

1000 KC crystal BT cut	$3.95
3" scope shield	1.29
2 speed dial drive for ¼" shaft ratios 5:1 1 to 1	.39
ATC 100 mmfd air trimmer screwdriver shaft	.29
—10 +5 Weston modulation meter Weston 301	8.95
J37 key	.69
500 watt 12.5 ohm power rheostat	3.49

R·H·S
SPECIALS OF THE MONTH

50 mmfd 5 KV vacuum condenser	$1.49
2v. 6v. 12v vibrators any type	.98
Rotary switch Mycalex. 2 deck SP3T	.39
1 mfd 5000v oil condenser	2.98
2 mfd 3000v oil condenser	3.25
3 mfd 4000v oil condenser	3.95
24 mfd 1500v DC 3KV flash. Excellent for speed lamp	3.95

TUBES!! BRAND NEW! STANDARD BRANDS! NO SECONDS! COMPARE! TUBES!!

OA3/VR75	$1.29
OB3/VR90	1.29
OC3/VR105	1.05
OD3/VR150	.89
1B22	2.95
1B23	8.75
1B24	4.95
1B26	2.95
1B27	24.50
1B29	2.75
1B32	1.79
1B36	24.96
1B38	32.50
1N21 Xtal	.79
1N21A Xtal	1.89
1N21B Xtal	3.25
1N22 Xtal	1.35
1N23 Xtal	1.25
1N23A Xtal	1.75
1N23B Xtal	3.95
1N27	1.69
1N34	.95
1N34A	.85
1P23	3.49
1P24	.79
1P36	2.69
1S21	3.79
2AP1	4.95
2AP5	4.95
2C21/RK33	.35
2C22/7193	.19
2C26A	.25
2C34/RK34	.39
2C39	24.50
2C40	2.75
2C43	14.95
2C44	1.49
2C46	7.50
2C51	5.75
2D21	1.25
2E22	1.19
2E24	4.69
2E26	3.69
2E30	2.29
2J21A	9.95
2J22	8.45
2J26	6.50
2J27	10.95
2J30	39.50
2J31	8.49
2J32	12.95
2J33	39.50
2J34	39.50
2J36	97.50
2J37	12.75
2J38	9.95
2J39	19.95
2J40	24.50
2J46	49.50
2J48	15.75
2J49	39.50
2J50	22.50
2J54B	22.95
2J55	89.50
2J61	49.50
2J62	49.50
2K25	19.75
2K28	24.95
2K29	24.50
3AP1	4.59
3B22/EL1C	2.39
3B23/RK22	4.85
3B24	1.95
3B24W	2.89
3B25	4.65
3B26	3.95
3B27	1.95
3B28	7.95
3BP1	2.59
3C22	59.50
3C23	6.95
3C24/24G	.89

3C31/C1B	$3.49
3C45	12.75
3CP1	1.39
3CP1-S1	2.25
3DP1	3.10
3DP1A	3.95
3DP1-S2A	4.75
3D21A	1.98
3E29	12.95
3FP7	1.65
3GP1	4.75
3HP7	2.89
4-65A	14.21
4-125A	26.95
4-250A	29.95
4AP10	4.95
4B22/EL5B	9.95
4B24/EL3C	5.95
4B25/6CF	7.50
4B26/2000	4.95
4B28	2.95
4B32	9.95
4C27/CV92	49.50
4C35	27.50
4D22	9.95
4D32	12.95
4E27/257B	17.95
5AP1	3.69
5AP4	3.69
5BP1	2.29
5BP4	2.39
5CP1	2.95
5CP7	3.49
5C22	49.55
5D21	24.50
5FP7	1.19
5GP1	4.95
5JP1	24.45
5JP2	8.95
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5LP1	11.95
5NP1	2.49
6C21	22.50
6F4	5.79
6J4	4.95
7BP7	4.49
9GP7	8.95
9JP1	5.95
9LP1	19.95
9LP7	3.49
10BP4	18.95
7DP4	17.95
10	.25
12DP7	12.25
12GP7	12.75
12HP7	12.75
12LP4	22.50
15E	1.19
15R	.49
16AP4	42.50
16CP4	42.50
19T8	1.29
23D4	.45
28D7	.29
30 SPEC.	.39
35TG	4.95
45 SPEC.	.25
53A	5.95
75TL	5.95
100R	.89
100TH	8.95
121A	2.65
203A	5.95
204A	49.50
211	.39
212E	49.50
215A	.19

217C	$6.75
227A/5C27	2.49
249C	2.95
250R	5.95
250TH	18.95
250TL	18.95
274A	5.50
274B	1.95
276A	6.95
293A	2.98
204A	1.95
300B	9.95
304TH	3.65
304TL	2.95
305A	24.95
307A/RK75	6.95
310A	6.95
316A	.65
323A/B	24.50
327A/5C37	2.49
328A	12.95
331A	12.95
350A	2.65
350B	1.75
368AS	2.39
371A	.59
371B	.65
388A	1.75
393A	5.95
394A	3.95
417A	8.95
434A	2.95
446A	1.25
446B	1.79
450TH	39.50
450TL	44.50
527	9.75
559	1.39
562	97.50
573A	14.95
701A	2.95
702A	2.69
703A	2.39
704A	1.05
705A	.89
706BY	24.95
706CY	16.95
706FY	42.50
706GY	42.50
707B	14.95
708A	3.59
709A	3.95
710A/8011	.85
713A	.79
714AY	3.52
715A	6.49
715B	6.85
715C	24.50
717A	.69
721A	2.25
722A	2.95
723A	6.75
723A/B	12.95
724B	2.95
725A	6.45
726A	4.95
726B	29.50
726C	49.50
730A	8.95
750TL	79.50
800	1.69
801A	.25
802	4.10
803	2.10
804	9.95
805	3.49
806	29.95
807	1.98
808	1.95
809	2.25
810	9.95

811	$2.49
812	2.85
812H	6.90
813	8.95
814	2.25
815	2.25
816	1.19
826	.98
828	12.75
829	7.45
829B	12.95
830B	3.95
832	4.95
832A	7.95
833A	37.50
836A	1.25
837	1.35
838	2.35
841	.33
843	.27
845	3.75
849	29.50
851	13.95
852	6.25
860	6.95
861	10.95
864	.29
865	1.45
866A	1.15
866JR	1.15
869B	26.50
872A	1.25
874	.89
876	.35
878	1.69
884	1.49
885	1.39
902	5.95
905	2.59
908	7.95
918	1.49
919	1.95
923	.72
927	1.09
930	.89
931A	3.59
954	.29
955	.35
956	.35
957	.35
958	.35
959	.49
991/NE16	.32
1603	1.98
1613	1.25
1614	1.95
1616	.75
1619	.29
1622	1.49
1624	1.25
1625	.35
1626	.35
1629	.25
1630	.98
1631	.85
1632	.79
1633	.69
1634	.75
1636	3.25
1638	.65
1644	.98
1654	2.39
1665	1.25
1851	.89
1960	.79
1961	4.99
2050	1.25
2051	.65
8005	5.95
8011	1.75
8012	3.95
8013	2.95

8014	$24.50
8020	.89
8025	5.95
9001	.85
9002	.65
9003	.85
9004	.45
9005	2.35
9006	.29
C1JA	9.95
C5B	9.95
C6A	7.95
C6J	4.45
C100D	1.49
CK502AX	2.95
CK503AX	2.95
CK505AX	2.25
CK506AX	2.25
CK507AX	2.25
CK512AX	2.25
CK517AX	8.45
CK1005	.35
CK1006	.95
E1148	.35
EF50	.69
F123A	8.75
F127A	22.50
F128A	89.50
F606	37.60
F660	79.50
F862A	397.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	12.95
FG81A	3.29
FG105	8.95
FG172	29.50
FG146	8.95
FG434A	2.69
FG451	.89
FG502A	1.85
GL562	97.50
GL592	14.95
HF125	14.95
HF300	19.95
HY114B	.79
HY115	.79
HY615	.29
KC4	37.50
KU610	6.95
ML101	49.50
REL21	1.95
RK20	9.95
RK25	4.19
RK33	.24
RK34	.39
RK48A	14.95
RK59	1.49
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.39
RX120	8.95
V70D	6.95
VR78	.29
VR91	1.10
VR92	.69
VT127A	3.95
VT158	14.95
VU29	2.95
VU111	.49
WL468	5.95
WL530	12.75
WL531	1.75
WL532	1.89
WL578	.89
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50

0A2
0A4G
0B2
0Z4
01A
1A3
1A4P
1A5GT
1A6
1A7GT
1AB5
1B3/8016
1B4
1B5/25S
1B7GT
1C5GT
1C6
1C7G
1D5GP
1D7G
1D8GT
1E5GT
1E7G
1F4
1F5G
1G4GT
1G6GT
1H4G
1H5GT
1H6GT
1J6GT
1L4
1LA4
1LA6
1LB4
1LC5
1LC6
1LD5
1LE3
1LG5
1LH4
1LN5
1N5GT
1P5GT
1Q5GT
1R4
1R5
1S4
1S5
1T4
1T5GT
1U4
1V
2A3
2A4G
2A5
2A6
2A7
2B7
2V3G
2X2
2X2A
3A4
3A5
3A8
3B7/1291
3D6/1299
3LF4
3Q4
3Q5GT
3S4
3V4
5R4GY
5T4
5U4G
5V4G
5W4
5X4G
5Y3GT
5Y4G
5Z3

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

5Z4
6A3
6A4LA
6A6
6A7
6A8
6AB7
6AC5GT
6AC7
6AD7G
6AE6G
6AF6G
6AG5
6AG7
6AH6
6AJ5
6AK5
6AK6
6AL5
6AQ5
6AQ6
6AR5
6AT6
6AU6
6AV6
6B4G
6B6G
6B7
6B8G
6BA6
6BE6
6BF6
6BG6G
6BH6
6BJ6
6C4
6C5
6C6
6C8G
6D6
6D8G
6E5
6F5
6F6
6F6GT
6F7
6F8G
6G6G
6H6
6H6GT
6J5
6J5GT
6J6
6J7
6J7GT
6K5GT
6K6GT
6K7
6K8
6L5G
6L6
6L6G
6L6GA
6L7
6L7G
6N7
6Q7
6R7
6S7G
6S8GT
6SA7
6SC7
6SD7GT
6SF5
6SF5GT
6SF7
6SG7
6SH7
6SJ7
6SK7
6SL7GT

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

6SN7GT
6SQ7
6SR7GT
6SS7
6ST7
6SU7GTY
6SV7
6T7G
6T8
6U5G
6U6GT
6U7G
6V6
6V6GT
6W4
6W7G
6X4
6X5GT
6Y6G
6Y7G
6Z7G
6ZY5G
7A4/XXL
7A5
7A6
7A7
7A8
7AG7
7B4
7B5
7B6
7B7
7C4
7C5
7C6
7C7
7E5
7E6
7E7
7F7
7H7
7K7
7L7
7N7
7Q7
7R7
7S7
7V7
7W7
7X7
7Y4
7Z4
12A
12A6
12A7
12A8GT
12AH7GT
12AL5
12AT6
12AT7
12AU6
12AU7
12AV6
12BA6
12BE6
12C8
12F5GT
12H6
12J5GT
12J7GT
12K7GT
12K8
12Q7
12SA7GT
12SC7
12SF5
12SF7
12SG7
12SH7

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

12SJ7
12SK7
12SL7
12SN7
12SQ7
12SR7
12Z3
14A4
14A7
14B6
14F7
14F8
14H7
14J7
14N7
14Q7
14R7
19
24A
25L6GT
25Z5
25Z6GT
26
27
28D7
30
31
32
32L7GT
33
34
35/51
35A5
35B5
35C5
35L6GT
35W4
35Y4
35Z3
35Z4
35Z5
36
37
38
39/44
41
42
43
45
45Z3
45Z5
46
47
48
49
50A5
50B5
50C5
50L6GT
50Y6
53
56
57
58
59
70L7
71A
75
76
77
78
80
82
83
83V
84/6Z4
85
89Y
117L7/M7
117N7
117P7
117Z3
117Z6

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps.	$ 2.49
20E1	2.4 Amps.	3.49
20F1	6.4 Amps.	4.95
20K1	13.0 Amps.	8.95
20J1	17.5 Amps.	11.95
20K2	26.0 Amps.	17.95
20K3	39.0 Amps.	24.95
20K4	52.0 Amps.	29.95
20K5	65.0 Amps.	35.95
0-40v AC	Current	0-34v DC
40D1	.6 Amps.	$ 2.95
40E1	1.2 Amps.	3.89
40F1	3.2 Amps.	5.25
40K1	6.0 Amps.	9.95
40J1	9.0 Amps.	12.95
40K2	12.0 Amps.	18.95
40J2	18.0 Amps.	22.45
40K4	24.0 Amps.	32.50
40K5	30.0 Amps.	34.95
40J4	36.0 Amps.	39.50
0-120v AC	Current	0-100v DC
40D1A	.6 Amps.	$ 7.85
40E1A	1.2 Amps.	10.76
40F1A	3.2 Amps.	16.65
40K1A	6.0 Amps.	24.75
40J1A	9.0 Amps.	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps.	$ 1.89
10E1	2.4 Amps.	2.25
10F1	6.4 Amps.	3.87
10K1	12.0 Amps.	4.95
10J1	16.0 Amps.	7.95
10K2	24.0 Amps.	10.75
10K3	36.0 Amps.	14.75
10K4	48.0 Amps.	17.75
10K5	60.0 Amps.	19.95
10K6	72.0 Amps.	25.57
10K7	84.0 Amps.	27.95
10J6	96.0 Amps.	32.50
10K10	120.0 Amps.	42.50

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TRANSFORMERS—115V 60 CY
HI-VOLTAGE INSULATION

6250v or 3850v or 2600v @ .056 arms	$13.95
2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A	4.95
2500v @ 15 MA	3.49
1600v @ 4 MA; 350-0-350v @ 150 MA; 6.3v @ 9A	4.45
1540v @ 5 MA; 340-0340v @ 300 MA	4.35
1120-0-1120v @ 500 MA; 12v CT @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32v @ 25 MA; 115/230 Pri	16.95
925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	5.55
700-0-700v @ 300 MA	7.55
500-0-500v @ 175 MA	4.55
430-0-430v @ 340 MA; 6.3v CT @ 6.3A; 5v @ 6A	4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Duel Pri	4.97
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	4.35
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	5.35
500-385-0-385v @ 200 MA; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A	4.75
325-0-325v @ 12 MA; 255-0-255v @ 240 MA	4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	3.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A	2.97
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230	3.85
18 or 36v @ 15A..$8.75 13.5v CT @ 3.25A	2.17
12.6v CT @ 10A; 11v CT @ 6.5A	6.35
3x10.3v CT @ 7A..$6.95 6.3v @ 1A	.77
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A	3.50
6.4v @ 10A; 6.3v @ .6A	2.77
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	.17
6.3v @ 1A; 2.5v @ 2A..$2.29 4-0-4v @ 1A	.87
6.3v CT @ 3.5A; 2x2.5v CT @ 3A	2.97
5v CT @ 20A; 10 KV INS	8.95
.6v @ 15A RMS	1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA	$ 5.35
3x5v @ 6A; 4v @ .25A	2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A	2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri	3.95
Step Up/Down 110/220, 500 watt	10.95
Step Up/Down 110/220, 220/440 600 watt	14.95

EQUIPMENT SPECIALS

APN-1 Altimeter Xceiver	Like New	$ 7.95
ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	14.95
AN/CRW-2 UHF Receiver	New	5.95
BC357 Beacon Receiver	Good	3.45
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC458 Transmitter	New	8.95
BC602A Control Box/SCR522	Used	.39
BC778 Gibson Girl	Good	3.95
BC958-121 Xmitter 100-156 MC	New	39.50
BC1016 Tape Recorder	New	459.50
BC1206A Beacon Receiver	Good	4.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Out	Good	4.95
EE8 Foundation Unit	Good	4.95
MN26C Compass Receiver	Good	24.95
M116 Dynamic Chest Mike	New	3.95
PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE104 Vibrator Supply	Excellent	24.95
R89/ARN5 Receiver	New	9.95
R89/ARN5 Receiver Less Tubes, Covers	Good	4.95
SCR518 Altimeter Complete	New	39.95
T17 Carbon Mike New 1.98	Used	1.29
TU25 Tuning Unit/BC223	New	1.79

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$1.98
.05 HY @ 15A	7.95
.065 HY @ 2.5A	2.49
.1 HY @ 5A	6.95
2 HY @ 175 MA	1.49
3 HY @ 50 MA	.39
3/30 HY @ 250 MA	3.65
5 HY @ 70 MA/.2 HY 350 MA Duel	2.39
5.3 HY @ 775 MA	9.95
10 HY @ 55 MA	.89
10 HY @ 100 MA	1.49
10 HY @ 200 MA	$2.15
10/20 HY @ 85 MA	1.49
13 HY @ 130 MA	1.55
13 HY @ 250 MA	2.95
14/3.5 HY @ 40/400 MA	6.95
15 HY @ 25 MA	.59
15 HY @ 70 MA	1.15
26.5 HY 125 MA	1.98
200 HY @ 10 MA	2.95
325 HY @ 2 MA	2.95
600 HY @ 1 MA	2.95

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PHONE DIGBY 9-0347

WRITE FOR QUANTITY PRICES

Prices subject to change without notice. F.O.B. NYC, minimum order $10.00. 20% deposit required. All merchandise guaranteed.

100 ma. and the power range is 0 to 500 mw. The bridge operates from the 60 cycle power line.

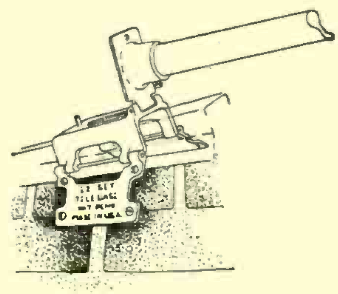
Matching transformers and other accessory equipment can be assembled from the company's Type 874 coaxial elements so that the purchase of specialized tuning and matching assemblies is not required.

TV MAST BASE

A new type of television mast base has been recently introduced by the *Gamble Machine Works* of Carpentersville, Illinois.

The "E-Z set tele base" is fabricated of a new lightweight alloy, *Almag*-35. The base can be installed on any type of roof and its rigid construction is said to eliminate vibration and the danger of collapse and roof leakage. The unit can be installed directly over the peak, throwing the weight of the installation at the point of greatest strength.

One of the unique features of the new base is the hinged socket arrangement on the top which permits the installation of the completed antenna and mast unit in a horizontal position in the base, which has previously been affixed to the roof. With the antenna and mast seated in the base socket the hinged arrangement permits raising



the entire unit and then locking it into position with a simple bolt. The antenna can be lowered for repairs at any time without disturbing the permanent installation of the unit proper.

Complete information on the new mast base is available from the company.

—30—

AM-NBFM Transmitter

(*Continued from page* 62)

wavemeter for the initial tuning of this transmitter. With the wavemeter set to the desired frequency and held near L_3 (Fig. 3) (bearing in mind that the second 6AG5 doubles) C_{20} (Fig. 3) is rotated until an indication is noted. The setting of C_{20} (Fig. 3) is noted and is returned to this reading whenever operation is desired in this band. Proceeding to L_1 (Fig. 4) the same method establishes the setting of C_1 (Fig. 4). With these settings logged it is a simple matter to change the two coils and go from band to band. S_1 (Fig. 3) is thrown *only* for operation on 80 and 40 and on these bands the first 6AG5 is then out of the circuit.

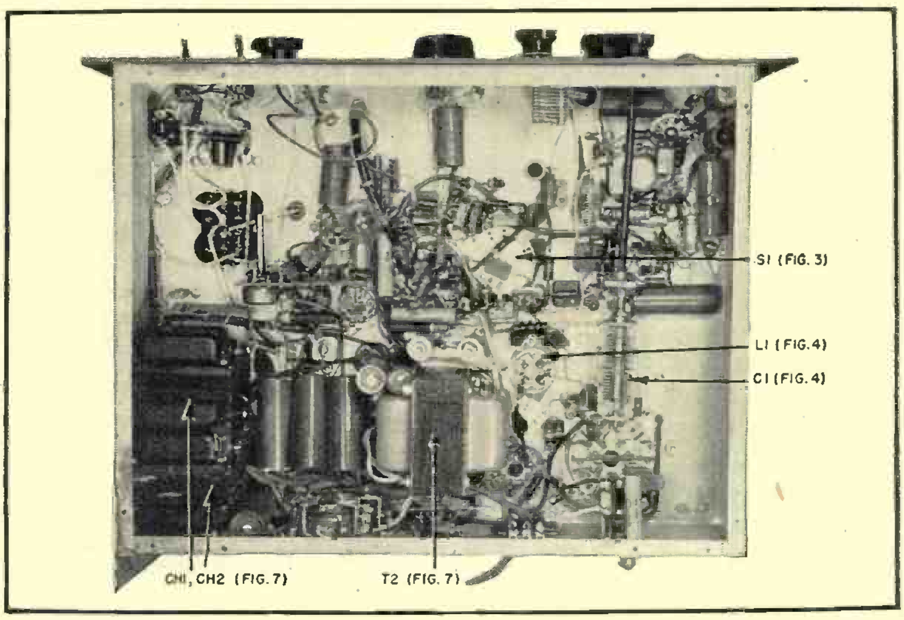
On phone the reports have shown that the NBFM circuit provides exceptional clarity on practically all popular types of amateur receivers where either slope detection or discriminators were being used. AM operation is excellent with good communications quality being obtained.

On c.w., this transmitter accounted for a large portion of the contacts made by W5MPZ/5 during the 1949 Field Day when it was operated continuously on 14 mc. c.w. Such operation speaks for itself.

Simplicity of band changing, combined with the ease of operation, the phone systems, and the c.w. monitor make this transmitter a versatile, efficient unit that has more than held its own against the "Sunday Kilowatters" and the multi-element boys.

—30—

Fig. 8. Under chassis view. Careful chassis layout will reduce construction difficulties.



Spot Radio News

(*Continued from page* 18)

devoted so much of their efforts to the compatibility part of their systems that they never succeeded in producing satisfactory color."

As cited previously all of the Commissioners did not agree that the mechanical system should be the chosen one. And when the second report was released, continued evidence of revolt within the ranks appeared, with seething dissenting opinions from the pens of Commissioners George Sterling and Frieda Hennock. Declared Madame Commissioner: "In the light of the progress made in the development since the start of the proceeding, I think it essential to defer the final decision in this matter until June 30, 1951. . . . It is of vital importance to the future of television that we make every effort to gain the time necessary for further experimentation leading to the perfection of a compatible color television system. . . . It is important to repeat the conviction, expressed in my separate views in the first report, that there is a moral obligation on this Commission to insure that a reasonable amount of valuable programming service will continue to be rendered to present set owners, both day and night, for a transitional period; e.g., three to five years, without the necessity for making any expenditure to change their sets."

Sterling, also quite critical of his fellow Commissioners, pointed out that a cooling-off period of at least two days should have been provided after the bracket deadline, so the industry could have thrashed out its differences and perhaps come up with a series of helpful answers. The shortsighted action, closing the door on future developments, will in his opinion, seriously impede color progress. He felt, also, that the decision now to insist on chassis changes, when industry is becoming more and more involved in emergency activities and shortages are beginning to mount, was a faulty one which could raise havoc. He particularly struck out at the views that the public would accept smaller screens, when the trend was toward larger and larger picture tubes. Such thinking, he implied, was inconsistent with the bigger tube programs, regardless of the attractiveness of colored reproduction.

In Sterling's report there were references to the bags of mail from industry, the bulk of which carried angry denunciations of the wheel ruling. In a letter from one manufacturer, the FCC was told that the program, if carried out . . . "will cause irreparable injury to broadcasters, manufacturers, and present set owners." Another set maker said that the increased list price, required by the addition of the switch and other components, is . . . "a severe penalty for the public to pay . . . for a feature which may never be used." From another chassis producer came the comments that it could not conform with the conversion request since, first, no *CBS* color signals are available for engineering tests, and second, certain technical difficulties have been encountered in obtaining pictures of geometric linearity and brightness on higher frequencies, as well as reduced scanning efficiency due to the return time of the horizontal sweep. In the opinion of one of the leading set makers in the country, not over 5 percent of the ten-million sets which will be in service before the year is out, will ever be made compatible with the *Columbia* system. Still another large video receiver producer declared that they regarded the decision scientifically unsound and against the public interest. "No incompatible system is good enough for the American public," said this manufacturer, who added that the hundreds of millions of dollars that present set owners would have to spend and that future set owners would have to pay to obtain . . . "a degraded picture with an incompatible system reduces . . . the order to an absurdity."

One manufacturer, who said that he would make available adapters and converters for the disk system, declared that apparently their intentions were misinterpreted and hastened to release a statement which said, in part: "We are neither in agreement with nor do we condone the ill-considered decision of the FCC. . . . The decision, however, has been made. It probably will not, and we hope that it does not, remain. . . . It is our earnest hope that the present non-compatible system . . . will be replaced by a compatible system before it is necessary to market these devices."

Prior to the decisions there were rumblings that lawsuits would be filed, should the Commission adopt the wheel scanner. Two such suits appeared on the judicial calendar within a week after the second report appeared, one from a proponent and another from a set maker in New York City. Both complaints, filed in the U. S. District Court in Chicago, declared in part that industry, broadcaster, and set owner stands to be seriously affected by the field-sequential order. One complaint charged the order was contrary to public interest, was arbitrary and capricious, exceeded the authority of the Commission, and was not supported by the evidence. Continuing, this suit which attempted to restrain the Commission from enforcing its order, stated that . . . "Although the Commission has no jurisdiction over television manufacturers, the Commission sought to require that such manufacturers agree with the Commission to build all their black and white receivers according to the specifications laid down by the Commission. These specifications required extensive alterations in present production model receivers. The Commission stated to the television set manufacturers that if they did not agree so to build their sets the Commission would forthwith and finally adopt the *CBS* color system."

Within twenty-four hours after the suits were filed, FCC issued a blunt statement which declared that they would vigorously oppose the issuance of any injunctive relief. Then, referring to a portion of the complaint which inferred that the Commission had been unduly influenced in its decision by an employee of the Commission who had patented a device usable in connection with the *CBS* system, the government specialists pointed out that their position in this matter was clearly detailed in the record.

During the hearings Harry Plotkin, FCC counsel, told those in the session room that Ed Chapin had constructed in the lab a receiver which featured automatic adaptation from one set of scanning records to another, and that such a set would be demonstrated in a room nearby. As soon as the circuit of the change and a description of it were received in evidence, and tagged with a legal exhibit identity, counsel for the dot-sequential proponent rose to say that he understood that . . . "this development of Mr. Chapin's constitutes what might be considered an improvement in the particular system being proposed by *CBS* in these proceedings." He then added that in this case the Commission might be considered as serving in a judicial capacity . . . "because it may have to choose between contesting proponents here, and when the Commission comes forward with a development which seems to be an improvement in the system proposed by one of the litigants, it sounds a little bit like a person in a judicial capacity assisting one of the parties in the contest. . . . I just want to make that statement and say that we take exception to putting this development into these proceedings, because we think it is inconsistent with the judicial position which the Commission should take in the proceedings."

Chairman Coy took one steely look at the attorney and said that Mr. Chapin is the head of the lab and not a member of the Commission, and in no way . . . "in position to determine the vote of a single member of the Commission; nor is any other member of the staff of the Commission." Declaring that the members are perfectly competent, the chairman added that they have . . . "the ability to determine between contesting forces." And then Coy remarked that he resented . . . "the suggestion very much that the Commission is influenced in its determination by the work of a single member of its staff or all of its staff when it comes to making a decision on the record." The chairman concluded this portion of his reply with the statement: "If there is anything else to be said on this, let's get it off our chest now." The attorney for the contestant arose again and repeated that he still thought the procedure a little bit out of order, a comment that riled Coy and prompted him to say that the Commission had asked for equipment from others so that they might have an opportunity to work on it. "I suspect," said Coy, "that some of our people have capabilities of effecting some improvement in that system and that we may, when and if we get hold of that equipment, file a patent on an improvement on that equipment for the benefit of the Government of the United States." Coy then pointed out to the attorney that . . . "you will recall privately that I have had something to say to you about equipment and have had some argument with you whether it is proper for us to have the equipment. We have not yet received the equipment. When we receive the equipment, we will have the same opportunity to work on the equipment as we do on *CBS* equipment." This brought forth a reply that . . . "We will welcome that, and as soon as we can get the equipment to you, we will."

In a parting blast, before the group left to look at the disputed receiver, Coy said: "Is there anybody else who has questions. I am perfectly willing to answer questions on this as chairman of the Commission, and I do not feel any one of us considers it improper for us to have taken such action, and want to add further, if you do not know it, that I have already signed the letters to patent the equipment that you are going to see."

In an attempt to clarify the operation of its system, *CBS* reviewed the basic features for the press. In their method, colors are changed after each vertical scanning period or field. There are 144 fields per second, and as in black and white, two-to-one interlacing is employed. The number of lines per frame is 405, or 205.5 per field (262.5 in black and white). Thus, the total number of lines per second, or horizontal line frequency, is 72 times 405 or 29,160, which is slightly less than twice the black and white horizontal line frequency, which is 30 times 525 or 15,750.

The colors are transmitted in the following sequence: red, blue and green. Each color lasts for 1/144th of a second, and the color sequence repeats itself after 1/48th of a second. This period is called a colorframe interval. Since only one-half the number lines will have been scanned in all colors in 1/48th of a second, twice this period, or 1/24th of a second is required for all lines to be scanned in all colors. This period of 1/24th of a second is called a color-picture interval.

The color disk rotates in front of the receiver tube at a rate of 1440 r.p.m. When six color filters are employed, two sets of red, blue and green filters are used. The over-all diameter of the color disk is determined by the size of the picture tube used. It will be slightly more than twice the diameter of the tube.

At the transmitter, a color filter disk, fully enclosed, rotates in front of the pickup tube and contains a series of color filters. If the camera disk has twelve filters or four red, four blue and four green, the disk rotates at 720 r.p.m. Every 1/144th of a second the camera scans electronically the image to be transmitted from top to bottom, while one of the colors in the filter disk, permits, let us say, only the red components of the scene to be picked up. The next 1/144th of a second, the blue filter is between the lens and the camera tube, and only blue components of the scene are scanned. The same sequence occurs to the green components. The vertical scanning rate of 1/144th of a second is synchronized with the disk rotation, and in addition, an extra pulse is inserted in the transmitted signal every third field, or every 1/48th of a second. This impulse permits the receiver disk to be phased automatically, if so desired.

As this column was being readied for the mailbag, about a half-dozen manufacturers had indicated that they would make adapters, converters, and switch models. A few others declared that they might follow along, but most indicated that they would not be able to produce *CBS* pickup chassis for quite awhile, with many saying that they just wouldn't make such sets at all. The year '51 should provide an intriguing answer to this tantalizing situation. . . . . L.W.

Planning Communications
(*Continued from page 37*)

and radio relay, and then as emergency supplements to the wire and radio relay;

4. For emergency use within the Continental United States in case of disruption of wire or radio relay circuits.

The *Theater network* is the network which provides the circuits from the Theater Command down to the senior commanders of tactical ground, air, and naval units. This network functions under the control of the Theater Commander and serves as the vital link between the global network and the tactical networks.

The *combat or tactical networks* are the parts of the communications system by which the commanders of tactical units control and direct their commands. In the field army we envision two general types of combat networks, one down to approximately regimental level, which is more or less of an administrative type of network; and the other at approximately the regimental level and below, which is a fire and maneuver type network at all times directly under the control of the combat commander. *No combat commander is placed in the position where he is dependent on someone outside his command for his unit communications.*

Principles of integration, however, are applied to the combat network. The concept envisages, for example, that each switchboard serving a command (battalion or higher) may have a radio set connected to it. This radio station can be operated so that it will be possible:

1. To talk over a wire or radio channel, from any telephone connected to the switchboard, to another switchboard, and to any user connected thereto;

2. From any telephone user's position, to call a mobile or fixed radio station at any point within range of the calling radio-switchboard;

3. From a mobile or fixed radio installation, to cause a signal to appear at a called radio-switchboard, bringing the operator on the line and thus enabling the calling radio station to communicate with anyone connected to the communications system.

The general idea is to avoid using such huge amounts of field wire as were used in Europe during the last war; to augment and replace cable and wire to a much greater extent with radio.

That, briefly, is what the Signal Corps means by an integrated system of communications—in terms of planning. The concept must come first, of course, but to carry it out we must have the equipment which, because of its versatility, makes integration possible. Elsewhere in this issue (page 38) are outlined some of the *engineering* aspects of integrated communications. —30—

International Short-Wave
(*Continued from page* 54)

national broadcasts is made through publications, advertisments in foreign newspapers, distribution of program schedules, and so on. "Our weekly programs are published in all Danish-American newspapers in the United States and Canada and in Danish papers elsewhere abroad."

During the fiscal year April 1, 1948-March 31, 1949, transmission hours totaled 5295 with an average of 14½ hours per day. Percentages of the various broadcasts were—music, 44.6; talks and discussions, 8.2; instruction, 11.5; news service, 16.1; church services and morning prayers, 4.6; recitation, 4.2; drama, 2.3; running commentaries, relays of meetings, and so on, 4.3, and features (montages, and so on), 4.2.

Our best wishes go to the Danish State Radio for a long and successful career!

* * *

Club Notes

USA—QRA for the *United 49'ers Radio Society* is 28 Eisenhower Drive, New Britain, Connecticut; issues a nice monthly bulletin.

* * *

This Month's Schedules

(*NOTE:* In the interim from the time this was compiled until you read it, some stations will have reverted to winter schedules; in such cases, some schedules will be *one hour later* than listed herein.—KRB)

Albania—Scutari, 8.200, heard afternoons (EST) in Britain; bad CWQRM; signs off 1530 with Albanian National Anthem. (Pearce)

Angola—CR6RN, 9.469, Louanda, noted 0135 in Portuguese; weak. (Cox, Dela.)

Argentina—LRT, 11.84, Tucuman, noted signing off 2300, good level. (Russell, Calif.)

Australia—At the time this was compiled, *Radio Australia* was using VLC4, 15.32, to North America 0700-1115, and was *testing* at 0715-0845 on parallel VLA8, 11.81; it is likely that by now will be using 11.81 regularly at least during the East Coast beam 0700-0900.

Belgian Congo—OTM2, 9.400, Leopoldville, noted with good signal afternoons to closedown 1606 with Belgian National Anthem. (Ferguson, N. C.) OTM1, 6.295, Leopoldville, heard opening 0000 with drums followed by news in French; weak level; parallel OTM2, 9.400; latter heard also around 1450-1500 or later. (Cox, Dela.) OTC3, 11.645, now runs 1600-2030 (parallel OTC2, 9.767). (Barry, Ill.)

Brazil—ZYK3, 9.565, Recife, has *English* program ("Brazil Calling") now around 2000-2038; asks for reports. (Ferguson, N. C.) The Brazilian outlet on 9.505 now is believed to be *Radio Record,* Sao Paulo. (Stark, Texas, others)

British Honduras—ZIK2, 10.598, Be-

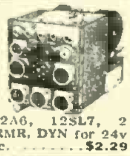
BATHTUB CAPACITORS

MFD	VOLT	TYPE	PRICE EACH	10 FOR
.5	600	2ST	$ .25	$2.40
.5	400	2BT	.23	2.20
.5	600	2TT	.25	2.40
3X.1	600	3TT	.45	4.35
3X.1	600	3ST	.45	4.35
2X.1	400	3ST	.26	2.50
2X.1	600	3ST	.28	2.65
2X.1	600	3BT	.28	2.65
2X.1	400	2TT	.26	2.50
2X.1	200	2ST	.23	2.20
2X.1	600	2BT	.26	2.50
2X.1	600	3TT	.26	2.50
.1-.1-.025	400	3ST	.28	2.65
.1	600	2BT	.22	2.10
.1	600	1ST	.22	2.10
.1	600	2TT	.22	2.10
.1	600	2ST	.22	2.10
.13	600	2ST	.25	2.40
2X.25	600	3ST	.30	2.85
.05	600	2TT	.21	2.00
1	100	2TT	.23	2.20
20	50	2ST	.26	2.50

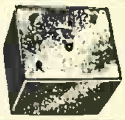
GIBSON GIRL

The Emergency Radio Transmitter. Send S O S signals automatically on 500KC. 150-mile range. No batteries required. Has hand-driven generator, tubes, wire. New. It's only........$3.95

RL9 or RL7



Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Compl. w/12A6, 12SL7, 2 Chokes, 1XFRMR, DYN for 24v operation, etc. $2.29



400 MA Choke 12 HY 002 H.V. INSUL. HERM. Sealed.

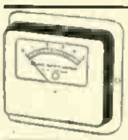
$3.75 ea.

0-30V DC Meter Westing. Type AX Aircraft type. Price $2.49

Multimeter Mvmt. 0-100 Meg. 0-600 / 50 / 14VDC (0-5 Ma Basic) 3" Rd Metal Sim to Sipson #23 ....$3.95
100-0-100 Microamp 4½" Bake. Same as Model 801 (Weston). Mfg. by Sun Elect & Beede Elect. Model 4AW271. Price ea. $8.75
0-1MA 3½" Rd. DeJure Mod 8-310. Price ea.........$4.75
0-1MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP259. Price ea.......$3.95
0-10MA 3½" Rd. DeJure Mod S-310. Price ea. $4.65
0-10MA 3½" Rd. Same as above. Mfg. Sun Mfg. Mod 3AP236. Price ea.....$3.95

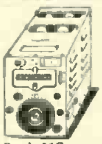
Special Oil Condensers

6 MFD 330VAC 1000VDC $1.95
2 MFD 600VDC 49c
14 MFD 330VAC 1000VDC $3.95



METERS

0-5MA SQ 2" Metal Case or 0-10 volt movement readrite meter 98c



BC 696

Transmitters 40 Watt Output These Famous V.F.O. Drivers Available

3–4 MC $6.95
Used. Good condition.

Heineman Ckt Bkrs for AC-DC operation.
AM1510M 7 AMP
1614 80 AMP
1614 50 AMP
U90 100 AMP
Price ea. $1.10
P-0322 Dual 10 Amp.
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Voltage Stabilizer VR3 95-130V 2.4A 60cy 1d out 115V 120W 100% Raytheon w/Ext. BX Box. Sockets, Cable. Used but good. Price $19.95

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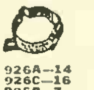
WOW! What Savings!



Birtcher Tube Clamps

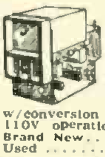
926A—14 926—C15
926C—16 926—C13
9268—7
929—1

11c ea.
100 for $10.50
1000 for 10c ea.

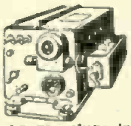
9268—16
926A—14
926A

T.V. Transformer, 110v 60 cy 7" or 9" scope, 3000v/5 MA, 720 vct/200 MA, 6.4 / 8.7 A, 6.4/ .6A, 5/3A, 1.25/.3A.
New $3.95

BC 605 INTERPHONE AMPLIFIER



Easily converted to an ideal intercommunications set for office—home — or factory. Complete w/conversion diagram for 110V operation.
Brand New......$4.49
Used $3.95



Aircraft Rec. #429 for Mobile or Aircraft Covers from 201 Kc up by interchange plug in tuning units includes one Dual Tuning Unit: 200 KC, 400 KC, & 2.5 Mc-4.7 Mc. Less tubes. Rec. Only a few left...........$3.95 ea.

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Regular Budd Boxed
80 MTR 500 watt
160 MTR 500 watt
40 MTR 150 watt
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$1.49 ea.

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HS23 Used Good 8000 Ω Imp. $2.49
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HS30B Replace Elements ....60c ea.
Rubber Earplugs for HS30 ....10 for 25c
Matching XFRMR C410 Less Cords 59c
T45 Lip Mikes 98c
T30 Throat Mike.....39c
CD508T30 Ext. Cords w/ Switch Sw141 Complete $1.25
Gas Mask Mike Elements 49c
Cords 3 Cond. Color coded approx. 42"...15c ea.
Hdband HBI 25c
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Tuning Units for BC375 & 191 Diag. for Conver to VHF Freq. Meter in Oct. 1950.
TU5 1500— 3000KC..
TU6 3000— 4500KC..
TU7 4500— 6200KC..
TU8 6200— 7700KC..
TU9 7700—10000KC..
TU26 200— 500KC..
Price $2.49 ea.

1619—1619—1619

Octal Base Pentode A versatile High Performance Tube
New 35c
5 for $1.50

Voltage Regulator VH623 95-130V 1.75A 60cy 1d CU 115V 150W 100%. Slightly used. Excellent. Price $19.95

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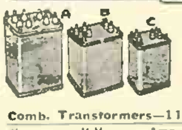

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These XFRMRS are Army Spec. All Underrated.

Comb. Transformers—115V/50-60 cps Input

Item	H.V.	Amp.	Filaments	Price
CT-861	2100VCT	.175	7.5VCT/4A, 2.5V/10A	$7.29
CT-142	645VCT	.060	5V/2A, 6.3V/1.2A	4.25
CT-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-076	600V	.100	2 x 12.6V/1	1.95
CT-626	1500V	.160	2.5/12. 30/.100	9.95
CT-15A	350VCT	.070	6.3/.6. 6.3/1.8 3 lbs.	2.95
CT-071	110V	.200	33/.200, 5V/10. 2.5/10	4.95
CT-378	2300V	4 MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A. 2.5VCT/7A	3.25
CT-91A	726V	.100	5V/3A, 6.3/3.5	3.25
CT-080	700VCT	.205	5V/3, 5V/2A	3.95
CT-441	50V	.200	5V/2.4. 5V/1.2	2.29
CT-408	350VCT	.026 MA	5V/3A	2.75
CT-26B	1100VCT	400 MA	6.3V/1.6	6.95
CT-931	585VCT	.086	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002 MA	2.5V/2.1A. 2.5V/1.75A	4.95
CT-137	350VCT	.026 MA	5V/3A	2.75
CT-102	1080VCT	.055	25V/3A, 6.3V/1.8A, 6.3V/1.2A	5.95
CT-866	330V	.065	6.3V/1.2, 6.3V/600 MA	1.75
CT-319	330VCT	.085	5V/2, 6.3/7.5, 6.3/3	3.25
CT-526	510VCT	.025	12.5/.900 MA, 6.3/.5A	1.95

Filament Transformers—115V/50-60 cps Input

Item	Rating	Each
FT-852	23V .353A	$1.79
FT-30B	58V/2.2A	2.25
FT-599	78V/.300, 6.3V/2A	1.95
FT-719	1.3V/6A	.79
FT-029	13.5V/1.11A	.79
FT-074	2.5V/10A. 6.3/.9A	1.79
FT-23-1	6.3V/3A	1.10
FT-367	5VCT/3A, 58VCT/40A	1.10
FT-346	5VCT/13/5, 5VCT/6.75, 5VCT/6.75	5.95
FT-781	866 Trans. 2 x 2.5/5A	2.25
FT-36-4	6.3/2, 6.3/4.5	1.49
FT-511	3.4V/300A. 7½H x 10" x 5"/2W	14.95
FTG-31	2.5V/2.5. 7V/7A (Tape @ 2.5V/2.5A). 16 lbs	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-391	6.4V/3A	1.10
FT-736	2 x 6.3VCT/3.2-1.2A	1.49
FT-461	2 x 6.3VCT/1A	1.10
FT-899	2x5 V/5.5A 29000 Rms	12.95
FT-418	6.3VCT/1A, 6.3VCT/7A	1.95
FT-735	6.3VCT/5A, 6.3VCT/1A	1.79
FT-101	6V/.25A	.79
FT-738	6.3VCT/1A. 5V/2A	1.69
FT-774	6.3V/16A	.79

Plate Transformers—115V/50-60 cps Input

Item	Rating	Each
PT-976	Auto: 120VCT/10 MA	$ .69
PT-31A	2 x 300V/5 MA	.79
PT-46A	4080VCT N.L. 3⅝ to 1 8" H x 6" W x 7" L 20 lbs	29.95
PT-033	4150V/400 MA 11½ x 9¼ W x 9" D 70 lbs	49.95
PT-75-2	3780/3446/3112VCT/77 MA	10.95
PT-28-1	4600VCT/.077	12.95
PT-403	Auto: 70V/1A	2.29
PT-160	1120VCT/770 MA, 590VCT/82 MA, 25 lbs	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT*848	3140VCT/750 MA for BC545, BC1069A	69.95
PT-139	42V/46V/50V/55V/15.2A 7⅜x7" W x 6¾" H	10.95
PT-637	400V/20 MA	.98
PT-589	9V/1.6A	.49
PT-31A	2 x 300V/5 MA	.79
PT-976	120VCT/10 MA	.79
PT-67-1	62V/3.5A	2.95
PT-12A	280VCT1.2A	2.95
PT-104	690V/450 MA	4.95
PT-054	980V/450 MA	5.25
PT-997	78V/.00754 KVA ...... AUTO	1.49

SPECIAL TYPES

Item	Pri.	Output	Price
STF-946	210/220/230	2.5V/4A 3½" H x 2¼" x 2¼" D	$1.29
STF-443	220/440	11VCT 125A 6½" L x 6¾" x 8" 15 lbs	15.95
STF-638	230	5V/9A 5½" H x 4½" x 3¼"	1.25
STF-05A	115/230	2 x 5V/7.5 7" H x 7" x 5" D	4.25
STF-682	220	30-25-20V/1 MA	.69
STF-968	230	2.5V/6.5A	1.10
STF-405	230/115	5V 12/9A	2.95
STF-370	220/440	3 x 2.5V/5A, 2.5V/15A, 5½ x 5 x 4½	5.25
STF-619	110/220	2.5V/500A, 7 x 5¼ x 5	19.95
STF-11A	220	2 x 40V/.05/2 x 5V/6A, 12.6/1A	2.95
STF-631	230	2 x 5V/27A 2 x 5V/9A, 10¾/4H x 5 x 7 30 lbs	24.95
STF-608	220	24V/600, 5V/3A, 2 x 6.3V/1A	2.25
STF-45A	43/78/90 115/180/230	2 x 2.5/6.5, 6.3V/4 7 Few	3.25
STF-306	100/120 200/240	5VCT 10 amp 20000 VCT	3.95

PL TRANSFORMER

Item	Pri.	Output	Price
STP-945	210/20 30	1100VCT/300 5¼ x 4 x 3½	$5.95
STP-444	230/460	230/105/115/125 15 lbs. 5¼ x 6 x 4½	14.95
STP-613	230V	2 x 230/.05	1.29
STP-823	137V	222VCT/300 MA	2.95
STP-780	82V	4000V/.002	1.29
STP-08B	50V	2 x 750V/1 MA	.98
STP-311	30/35 40	95 NL-50VFL .1 Amp	.59
		COMB.	
STC-627	230V	1500/160, 110V/.200, 3.3V/.200, 5V/10, 2.5-1.4/10	$5.95
STC-611	230V	200V/200, 4 x 6.3V/.9	2.95
STC-16A	220V	260V/.03, 100V/1, 6.3V/4.2	2.95
STC-607	220V	700VCT/75 MA, 40VCT/.100, 15/10/15V/100 MA	3.95
STC-612	230V	400V/.30, 190/.30, 2 x 5V/2.5 w/2-866 Socket	3.95
STC-622	230V	250V/100, 2 x 5V/2-9 2-4 Png. Sockets	4.25
STC-047	200V	700V/80 MA, 110/.80 MA, 24V/80 MA, 2 x 6.3/.3-1A, 5V/3. 5V/5A, 2.7/5A	4.95

TUNING UNITS FOR BC 223 XMITTR

TU17A 2000-3000Kc....................$2.75
TU18 3000-4500Kc....................2.25
TU25 3500-5200Kc....................2.25

ARC 5 MODULATOR

MD7 / ARC5 Plate Modulator w / dynamotor complete w/Tubes 1—12J5, 2—1625, 1—VR50. Good cond.
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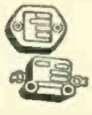
ARC-5 Mod. XFMR P-P 807 to P-P or PAR 807's #9446 $1.65

6V Input Dynamotor Output 150V/75MA or 12V Input. 500V/50MA Out. $3.49



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2500 V Test

Mfd.	Price
.00001	$0.35
.000025	.35
.00003	.35
.00005	.35
.000075	.35
.0001	.35
.00015	.35
.00025	.35
.0003	.35
.0004	.35
.0005	.40
.00075	.40
.00085	.40
.001	.50
.0015	.50
.0016	.50
.0017	.55
.002	.65
.0023	.65
.003	.75
.004	.95
.005	.95
.006	.98
.0063	.98
.0069	.98
.007	.98
.0075	.98
.0076	.98
.008	1.05
.01	1.25
.015	1.25
.02	1.30
.025	1.30
.027	1.35
.03	1.45

5000 V Test

Mfd.	Price
.0015	1.75
.002	2.00

Solar XQ Solder Lugs 2500 V Test

Mfd.	Price
.01	1.25
.015	1.30
.02	1.50
.04	1.75
.001	.60
.0015	.60
.002	.75
.0022	.75
.0023	.75
.0024	.75
.0025	.75
.0027	.80
.003	.80
.004	.85
.005	.90
.0056	.95
.006	.95
.0063	.95
.0075	1.00
.0076	1.00
.008	1.05
.0085	1.20
.0005	.60
.00085	.70
.00015	.60

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Gas Phototube having SI response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data.
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R5/ARN7 Compass Rec ADF Rec 100-1750 Kc. in 4 bands 5 gang Tuning Capacitor w/15 Tubes. Phone for price.

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Used to extend range of field telephones, teleg. & 20 cyc. ringing possible over lines complete w/3Q5 tube & phone. Featherweight. Price $9.95

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AM-32/PRS1 less batt w/carry case for Mine Detector AN/PRSI. Price ea. $7.95

Horsie Talkie BC745 Xmtr Rcvr 3-6Mc w/1TU Less Pwr Supply..$11.95

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LM Freq. Meter. No calibration Book used. Fair As Is. Less Xtal.
Special $22.50

TVI Line Filter 110VAC 1 Amp Reject Range .15-150 MC Chassis Mt. Herm sealed 1⅛"x1¼"x2". Price 69c

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Avail. in Stock. Dual XMTTR & Dual Rec. Triple Rack Mounts MT63—MT 65-MT71 Bent & Banged Up. Sold As Is. No Refund. Repairable $1.00 ea.

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Tinn #1, 3, 4, 6, 7A, Lock Type Rubber 6c ea. 10 for 55c.

Line FILTER, GE 100 Amp Filter w/2x5Mfd 50V oil cond. Operates on 110V AC DC......$1.98

Aircraft Radio Transmitter CRV 52233, 28VDC ATB Equip. RCA less T. U. As Is $25.95

R-9A APN4 Loran Rec Power Supply 400 cy 3IFS Quad. Tuned switches, connectors, etc. N. G. As Is. Less tubes.$14.95

ID6 APN4 Scope 5" Loran. Full of Resis. Micas Basic Assy for Scope. N. G. As Is. Less Tubes. $12.95

BC433 Mod or unmod CW Reception 200-1750KC in 3 bands 14 or 24V & 115V AC ADF. Radio Compass As Is. Less Tubes.
Poor Condition ...$11.95

BC929A 3BP1 Scope Indicator containing Ant.. Switch & Motor w/Tubes 2—6H6GT, 2—6SN7, 1—6H6, 1—6X5, 1—3BP1, 1—2X2, P/o SCR 729 & APN2. New $25.95
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BC434 CONTROL BOX

Remote Control for 433 Radio Compass contains 0-5MA Meter, Dial Control $3.95

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12"/30cm AT5/ARR1 Convertible Citizen's Band Threaded Coax Term Insulated Silv Pl Cont w/waterproof gask flange & hardware for MOBILE mtg BRAND NEW 39c; 4/$1.00
PL259 for Above....29c
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lize, noted Sundays around 1410-1501. (Ferguson, N. C.) Weekdays may be on the air as early as 1300.

British New Guinea—Reports for VLT5, VLT7 now should be sent *direct* to Australian Broadcasting Commission, Port Moresby, British New Guinea. (Starry, Pa., via NNRC)

Canada—CBNX, 5.970, St. John's, Newfoundland, heard 1545. CBRX, 6.160, Vancouver, British Columbia, noted with popular music 0050; QRM'd by Munich, weak. CKFX, 6.080, Vancouver, noted signing off 0205 after news. CJCX, 6.010, Sydney, Nova Scotia, heard with news 1300, weak but clear signal. (Cox, Dela.)

Canary Islands—Tenerife, approximately 7.515, noted 1615 to after 1700. (Pearce, England)

Cape Verde Island—Praia's CR4AA is now on approximately 5.895. (Pearce, England) Can be heard some days in eastern U. S. to closing 1700 when signs with "A Portuguesa."

Ceylon—*Radio Ceylon* seems to have added a "commercial service"; noted in South Africa with powerful signal on 21.62 around 0000-0200 with variety of musical programs, also "Voice of Prophecy"; plays requests at times. (Hannaford)

Chile—CE920, 9.200, Punta Arenas, heard well *after* 1800. (Sutton, Ohio) CE1180, 12.005, Santiago, noted from tuning 2015. (Ferguson, N. C.) CE625, 6.250, Santiago, excellent 2245; signs off 2310. (Russell, Calif.)

China—When this was compiled, *Radio Peking* was being heard mornings on (measured) 11.865 (claims 11.69) in parallel with 15.054V (claims 15.060); news was still at 0830 but by now may be changed to 0930. (Ferguson, N. C., others) I was still hearing the 10.260 outlet mornings but at 0830 carries separate (Chinese) program.

A station on approximately 6.040 is heard at times at 1000 in parallel with *Radio Peking;* fine signal; also noted from 0400. (Balbi, Calif.)

Colombia—*"Emisoras Unidas,"* Barranquilla, is broadcasting on 4.785 in Spanish 0600-2300. (Copenhagen DX broadcast)

Costa Rica—San Jose is noted on (announced) 11.970 mornings to *after* 0900 and evenings until *after* 2130; at times has *English* program at 2100-2130, including about five minutes of news at end of the period. (Stark, Texas)

Cuba—COBZ, 9.525.6, heard 1810 with *English* grammar lesson in progress. (Oskay, N. J.) COCQ, 8.825, Havana, excellent evenings; signs off 0030. (Russell, Calif.) COCH, 9.437, 5 kw., is scheduled in Spanish 0700-2400 daily. (Kroll, N. Y.)

Curacao—PJC2, 5.010, Willemstad, has *English on Mondays only* 2000-2015. (Ferguson, N. C.)

Cyprus—Limassol noted recently 2325 on 6.17, 6.13, 9.65, with Arabic chanting. (Bellington, N. Y.)

Czechoslovakia—Prague, 11.84, noted signing on 1315 with horn notes. (Leary, Ind.) Noted recently on 9.55 with news 1530. (Mulvey, Conn.) An-

Long a valued contributor to the ISW Department, Roland S. Peddle is shown at his Listening Post in St. John's, Newfoundland. He has recently become a radio ham.

nounces *English* for 1715 on 9.550, 11.840. (Pearce, England)

Dominican Republic—When this was compiled, HI2L, "La Voz del Tropicos," Ciudad Trujillo, was using 3.240 (moved from 3.290); heard evenings; power is 500 watts. (Cox, Dela.)

Eire (Ireland)—Dublin, 17.84, is heard occasionally with news and market reports 1230-1245V. (Cox, Dela.)

El Salvador—YSO, 7.315,6, heard again after absence; noted 1905 with announcements in Spanish by man. (Oskay, N. J.) Heard in Delaware at 2140. (Cox)

French Equatorial Africa—Frequency of *Radio Brazzaville* has been shifted from 9.952 to 9.9685. (Oskay, N. J.) Noted on 6.025 with world news 0015. (Cox, Dela.)

French Morocco—*Radio Maroc*, Rabat, is radiating on 6.005 with 2.5 kw.; programs in French are broadcast 0145-0300, 0800-0930, 1515-1800; in Spanish, 0700-0730, 1300-1430. (Radio Sweden)

Germany—Reception reports on *Radio Free Europe*, 6.130, can be addressed to 350 Fifth Avenue, Room 311, New York, N. Y., USA. Is heard on 6.130 from 1200. (Pearce, England)

Nordwest Deutscher Rundfunk has replaced the s.w. transmitter at Elmshorn by a *new* 20 kw. transmitter at Norden-Osterloog/Ostfriesland; frequency remains 7.290 and schedule is unchanged—2300-0500, 0600-1900; reception reports requested. (Radio Sweden)

Greece—Athens, 9.607, heard with interval signal 2358, signs on 2359 with musical number, pips 2400, then identification by woman announcer; fair signal at start. (Cox, Dela.)

Larissa, 6.754, heard 0030 in native; weak with QSB. (Cox, Dela.) Pearce, England, lists this one currently on 6.745, says appears to have *English only* on Thursdays at 1530 although has claimed to have that language also on Mondays at 1530.

The Greek Armed Forces Radio Station, Athens, on 6.340, broadcasts an experimental program in *English* daily 2315-2330 and 1615-1630; reports are welcome to Armed Forces Radio Station, No. 3, Zalocosta St., Athens, Greece. (Radio Sweden) Khania, 10.050, Crete, opens regularly 0530. (Bluman, Israel)

Haiti—A station noted on 6.166 evenings is believed to be 4VCM. (Stark, Texas) This station in Port-au-Prince is listed on 6.167 with 100 watts, as Magloire Broadcasting Circuit. *Radio Denmark* lists schedule as 0600-1000, 1200-1500, 1700-2300.

Holland—PCJ, Hilversum, is sending out a new card (with map of Holland on it). (Pearce, England)

Honduras—HROW, 6.02, Tegucigalpa, *"Radio Monserat,"* excellent evenings; *no English noted;* signs off 0000. (Russell, Calif.)

Hungary—Budapest now appears to be using 6.248 and 9.834 for news 1600 and 1810 for Europe, but still is reported on 11.910 and 9.834 to North America at 1930 and 2300.

Indo-China—Radio France Asie ("The Voice of France in the Far East"), Saigon, is using its old 11.78 frequency for news 0900; reported on 11.83 yet for *English* ending around 0510; has been testing on 9.495 (claimed 9.524) around 0520-0550. Balbi, Calif., says that announces on 11.78 at 1000 that is parallel on 6.165 and m.w. 1055 kc. Russell, Calif., reports the 11.78 channel closes 1030 with playing of "La Marseillaise." Noted on this channel 1000 by Pearce, England. Neeley, Calif., reports the 6.165 channel is excellent mornings. Probably uses 11.78 or 11.83 for its "morning" program around 1800-2000 although has not been reported as heard in the U. S. recently at that time; may have moved to the 31-m. outlet for that beam?

The outlet on 6.19 still announces as *Radio Dalat*. (Balbi, Calif.)

Iran—EPB, 15.100, Teheran, noted to closing 1600. (Pearce, England) Should have five minutes of news 1500-1505.

Israel—Kol-Israel now has news 1515 on 9.000 and 6.830, and at 0700 on 6.830; the World Zionist Broadcast in *English* is daily 1700-1745 now on 9.000. (Pearce, England, Fargo, Ga., others)

Italy—Rome, measured 15.1194, noted with news 0600-0615. (Oskay, N. J.)

Jamaica—Radio Jamaica, 4.950, closes daily 2300; appears to have dropped its 3.48 channel entirely. (Russell, Calif., Bellington, N. Y., others) Verified via airmail in 10 days from Jamaica Broadcasting Co., Ltd., Broadcasting House, 32 Lyndhurst Road, Cross Roads, Jamaica, B.W.I. (Russell, Calif.)

Japan—JKM, 4.95, noted back again; good signal; now signs off 1030 as do *all* other Tokyo transmitters, including JKL. (Balbi, Calif.) JKH, 7.257, noted in Japanese 0600. (Cox, Dela.) JBD3, 15.225, and JBD4, 15.235, Tokyo, heard 2330-0000 with program for domestic listeners and Japanese in the Far East; verified in 15 days via airmail from Nippon Hoso Kyokai (NHK), Broadcasting Corporation of Japan, Radio Tokyo Bldg., Tokyo Cen-

(*Continued on page* 147)

Audio Developments

(*Continued from page* 45)

equalizing action with the preamplifier, others merely compensate for the magnetic response characteristic in their preamplifiers, while still others assume a flat input. For this reason it is important to fully understand the operation of the various elements that make up the audio system. Otherwise it would be impossible to intelligently build a complete audio system unless all components are manufactured by the same company.

Amplifiers

The trend in amplifier (and preamplifier) design is to concentrate on reducing distortion and, after that is accomplished, obtain the widest possible frequency response. This is a departure from the thinking and philosophy in design of a few years ago, where the emphasis has always been to obtain a wide frequency response. Tests have shown that a wide frequency range amplifier which does not have good distortion and tonal balance characteristics is not pleasing to the ear.

Another new factor that has been emphasized is that intermodulation products sound most displeasing to the ear because they have no direct harmonic relationship with the frequencies producing them. Most sounds in musical instruments are rich in harmonic content and harmonics generated by non-linearities in an amplifier merely alter the amplitude of existing harmonics. It usually takes a very critical ear to detect a small amount of harmonic distortion.

Intermodulation distortion, on the other hand, will introduce frequencies which are not harmonically related. For example, if the input to an amplifier is 1000 and 49 cycles (most musical sounds have multi-frequencies), then a non-linearity will cause the following frequencies to appear: 1000, 49, 2000, 98, 1049, 951, etc. It is the presence of the 1049 and 951 cycle components that displeases the ear most.

For this reason manufacturers concentrate on minimizing intermodulation products and the intermodulation distortion method of testing and rating is being widely used not only by the amplifier companies but also by the recording companies and broadcasters.

Good tonal balance is another feature that is found in many new amplifiers. Tonal balance is the introduction of enough "treble" or "bass" into the response characteristic to be most pleasing to the ear. In more expensive units, tone controls are provided to permit the user to adjust the response to his own liking. In less expensive amplifiers the manufacturer has a rising low and/or high frequency characteristic which he finds presents the best sound.

Of course other factors such as low noise level and wide frequency response are also important. However,

"Premier" Prices on TUBES and PARTS

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17BP4A	$31.95
0Z4	.83
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1A5GT	.90
1A6	1.60
1A7GT	1.00
1B3GT/8016	1.33
1C5GT	1.10
1C6	1.60
1C7G	1.60
1D5GP	1.95
1D7G	1.60
1D8GT	1.95
1F4	1.33
1F5G	1.33
1G4GT	1.33
1G6GT	1.33
1H6G	1.60
1J5G	1.33
1J6G	1.60
1J6GT	1.60
1LA4	1.33
1LC5	1.33
1N5GT	1.00
1P5GT	1.33
1Q5GT	1.33
1R5	1.00
1S5	.90
1T4	1.00
1T5GT	1.33
1U4	1.00
1U5	.90
1V	1.10
1X2	1.33
2A3	1.60
2A5	1.10
2A7	1.33
2E5	1.33
3A8GT	2.40
3B7/1291	1.33
3C6	1.60
3E6	1.33
3LF4	1.33
3Q4	1.10
3Q5GT	1.20
3S4	1.00
3V4	1.00
5T4	1.95
5U4G	.83
5V4G	1.20
5W4	.83
5W4GT	.83
5X4G	.90
5Y3GT	.68
5Y4G	.75
5Z3	.90
5Z4	1.33
6A4	1.60
6A3	1.60
6A7	1.00
6A8GT	1.00
6AB4	1.00
6AB7	1.60
6AC5GT	1.45
6AC7	1.45
6AG5	1.33
6AG7	1.60
6AH6	1.95
6AK5	1.95
6AK6	1.20
6AL5	1.00
6AL7GT	1.33
6AQ5	1.00
6AQ6	.90
6AQ7GT	1.20
6AR5	1.33
6AS5	1.00
6AT6	.75
6AU5GT	1.33
6AU6	1.00
6AV6	.75
6AX5GT	.68
6B4G	1.60
6B5	1.60
6B8GT	1.60
6BA6	.90
6BA7	1.20
6BC5	1.00
6BC7	1.10
6BE6	.90
6BF5	1.10
6BF6	.83
6BG6G	2.40
6BH6	1.00
6BJ6	1.00
6BN6	1.60
6BQ6GT	1.60
6C4	.83
6C5GT	.83
6C6	1.00
6CB6	1.00
6D6	1.00
6CD6G	3.00
6D8G	1.60
6F5GT	.83
6F6GT	.83
6F8G	1.60
6G6G	1.33
6H4GT	1.33
6H6	.83
6H6GT	.83
6J5GT	.75
6J6	1.45
6J7G	1.00

6J8G	$1.60
6K5GT	1.20
6K6GT	.83
6K7G	.83
6K7GT	.83
6K8	1.20
6K8GT	1.20
6L5G	1.33
6L6	1.78
6L6G	1.78
6L6GA	1.78
6N6G	1.95
6P5GT	1.20
6Q7	1.00
6Q7GT	.90
6R7GT	1.33
6S4	.90
6S7GT	1.60
6S8GT	1.33
6SA7	1.00
6SA7GT	1.00
6SC7	1.00
6SD7GT	1.45
6SF5	.83
6SF5GT	.90
6SF7	1.00
6SG7	1.00
6SH7	1.10
6SH7GT	1.10
6SJ7	.90
6SJ7GT	.90
6SK7GT	1.00
6SL7GT	1.45
6SN7GT	1.10
6SQ7	.75
6SQ7GT	.83
6SR7GT	.90
6SS7	.90
6T7G	1.60
6T8	1.45
6U5	1.00
6U6GT	1.00
6U7G	.90
6V6GT	1.00
6V7G	.90
6W4GT	.90
6W6GT	.90
6X4	.75
6X5GT	.75
6Y6G	1.20
6Y7G	1.60
7A4	1.00
7A5	1.10
7A6	.90
7A7	.90
7A8	.90
7AF7	.90
7B4	.90
7B5	.90
7B6	.90
7B7	.90
7B8	.90
7C4	1.60
7C5	.90
7C6	.90
7C7	.90
7E5	1.33
7E6	1.10
7E7	1.33
7F7	1.10
7F8	1.33
7G7	1.33
7H7	1.00
7J7	1.33
7K7	1.33
7L7	1.33
7N7	1.10
7Q7	.90
7R7	1.10
7S7	1.33
7V7	1.33
7W7	1.33
7X7	1.33
7Y4	.90
7Z4	.90
10	1.80
12A	.68
12A6	1.45
12A7	1.60
12A8GT	1.00
12AT6	.75
12AT7	1.45
12AU6	1.00
12AU7	1.20
12AV6	.75
12AV7	1.60
12AX7	1.20
12BA6	.90
12BA7	1.20
12BE6	.90
12BF6	.83
12F5GT	.90
12H6	.90
12J5GT	.75
12K7GT	.83
12Q7GT	.90
12S8GT	1.33
12SA7	1.00
12SA7GT	1.00
12SC7	1.10
12SF5GT	1.00
12SF7	1.00
12SG7	1.00

12SH7	$1.10
12SH7GT	1.10
12SJ7	.90
12SJ7GT	.90
12SK7	.90
12SK7GT	1.00
12SL7GT	1.20
12SN7GT	1.10
12SQ7	.75
12SQ7GT	.83
12SR7	1.10
12SR7GT	1.10
12Z3	1.33
14A7	1.10
14AF7	1.20
14B6	1.10
14B8	1.10
14E6	1.10
14E7	1.33
14F7	1.10
14F8	1.33
14H7	1.20
14J7	1.33
14N7	1.33
14Q7	1.10
14X7	1.33
14Y4	1.20
19BG6G	3.00
19T8	1.45
20	1.95
22	1.60
24A	1.10
25A7GT	3.00
25AC5GT	1.45
25BQ6GT	1.60
25C6G	1.45
25D8	1.95
25L6GT	.90
25W4GT	1.00
25Y5	1.45
25Z5	.83
25Z6GT	.75
26	.90
27	.75
30	1.00
31	1.33
32L7GT	1.60
33	1.60
35/51	1.00
35B5	1.00
35C5	1.00
35L6GT	.90
35W4	.63
35Y4	.90
35Z3	.90
35Z4GT	.75
35Z5GT	.75
35Z6G	1.33
36	1.33
39/44	1.33
41	.83
42	.83
43	.83
45	.83
45Z5GT	.90
46	1.33
47	1.20
50	1.95
50A5	1.10
50B5	1.00
50C5	1.00
50C6G	1.45
50L6GT	.83
50X6	1.10
50Y6GT	.90
55	1.10
56	.90
57	1.00
58	1.00
59	1.78
70L7GT	1.95
71A	1.00
75	.83
76	.83
77	.83
78	.83
79	1.33
80	.68
81	1.95
82	1.33
83	1.33
84	.90
85	1.10
89Y	1.10
117L/M7GT	1.95
117N7GT	1.95
117P7GT	1.95
117Z3	.75
117Z6GT	1.20
VR150	.50
482B	.30
483	.30
199V	.30
807	1.50
813	6.75
1619	.10
1622	1.75
2050	2.25
2051	1.75
7193	.18
9001	.36

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10-10—450 V .... ea. 52c
20-20—450 V .... ea. 59c
10-10-10-20—450V-150-25 V .... ea. 59c
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8-8—150 V .... ea. 23c
10—150 V .... ea. 23c
10-10—150 V .... ea. 29c
10-10-10—150 V .... ea. 35c
15—150 V .... ea. 25c
20—150 V .... ea. 30c
30—150 V .... ea. 35c
40—150 V .... ea. 35c
15-15—150 V .... ea. 35c
20-10—150 V .... ea. 35c
20-20—150 V .... ea. 35c
30-20—150 V .... ea. 47c
30-30—150 V .... ea. 47c
35-35—150 V .... ea. 47c
40-20—150 V .... ea. 47c
40-40—150 V .... ea. 47c

40-40—150 V 20-25 V .... ea. 47c
50-30—150 V .... ea. 47c
20-16-16—350 V Sprague type .... ea. 47c
25-25—150 V-200-10 V .... ea. 47c
15-15-40-20—150 V-25 V .... ea. 35c
20-20—150 V-25 V .... ea. 47c
30-30-200—150 V-10 V .... ea. 47c
20-16-16—150 V .... ea. 47c

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½ meg., 1 meg., 1/10 meg. or 2 meg., long shaft, less switch	19c	23c
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Midget 455 Kc .... ea. 47c

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.002	6c
.005	6c
.01	8c
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these factors are well known to most audio men and require no further discussion. One point that may be new to some readers is that it is possible to minimize the noise appearing in old records by use of special noise suppressing circuits.

Speakers

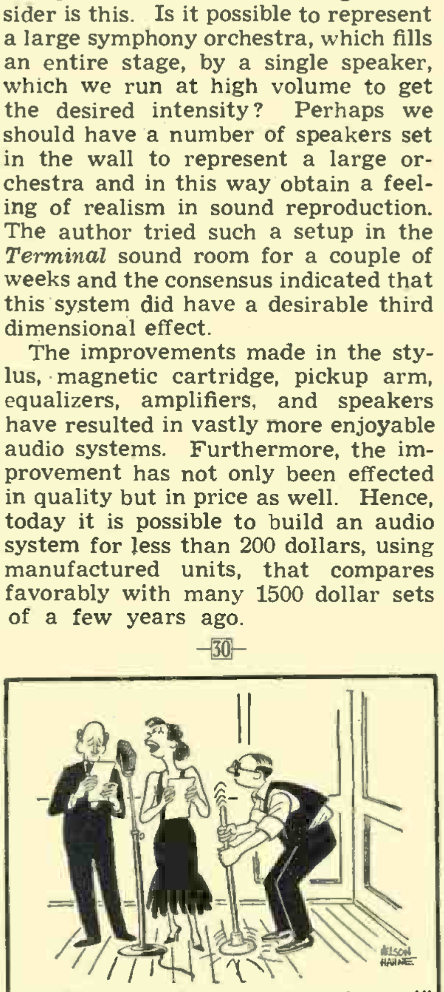
The quality of speakers is being constantly improved. However, at the present time, they appear to be the limiting factor in the audio system. High quality speakers are still essentially dual units, a woofer and tweeter combination. Sometimes they are placed concentrically, while other manufacturers prefer to supply them as two separate units. The placement of the speaker in the cabinet or baffle is quite important and beginners should not attempt to design their own bass reflex cabinets. The use of an infinite baffle by placing the speaker in the wall or large closet has proven very satisfactory in many instances.

A corner-horn speaker has recently appeared on the market and seems to have some advantages. It utilizes the walls of the room as part of the acoustical system and gives the impression that the speaker is extremely large. Excellent dispersion of sound has been effected without breakup of high and low frequencies, even though there are two separate speakers.

A point that the reader might consider is this. Is it possible to represent a large symphony orchestra, which fills an entire stage, by a single speaker, which we run at high volume to get the desired intensity? Perhaps we should have a number of speakers set in the wall to represent a large orchestra and in this way obtain a feeling of realism in sound reproduction. The author tried such a setup in the *Terminal* sound room for a couple of weeks and the consensus indicated that this system did have a desirable third dimensional effect.

The improvements made in the stylus, magnetic cartridge, pickup arm, equalizers, amplifiers, and speakers have resulted in vastly more enjoyable audio systems. Furthermore, the improvement has not only been effected in quality but in price as well. Hence, today it is possible to build an audio system for less than 200 dollars, using manufactured units, that compares favorably with many 1500 dollar sets of a few years ago.

—30—



"Oh, kiss me again, and again, and again!"

Naval Communications
(*Continued from page* 49)

a cluster of special non-directional electric lamps, located near the ends of the yardarm.

Additional devices used in visual communications are pyrotechnics and panels. Pyrotechnics are merely fireworks of various types with special meanings assigned to each type or combination. The meanings may change, but usually deal with distress or emergency identification. Another kind of pyrotechnic is the smoke grenade, used to mark locations in the water. Panels are strips of material laid out on the ground to give instructions and information to aircraft. The position of the panels in relation to one another determines the meaning of the message.

Sound

Sound in communication is employed in underwater signaling devices. These devices can be used over short distances to communicate with submarines or surface vessels that carry similar echo-ranging equipment. Messages are sent by telegraph key. Underwater sound transmissions are slow, the range extremely limited, and security from interception poor. Reliability of communication is subject to variations in the temperature of the water, the salt content, the depth, and other conditions that affect the movement of underwater sound waves.

Wire Systems

Wire communication systems employed by the Navy include cables, landwire telegraph, telephone, and teletype. The Naval Communication Service does not own or operate cables. Therefore, when such facilities are required, the cables of commercial companies or foreign governments must be utilized. Landwire telegraph—the sending of Morse Code over wire—is now almost completely replaced by the faster and more efficient teletype. The telephone, being convenient and speedy, is, of course, especially suitable for administrative traffic at naval bases and shore stations.

The most widely used wire system for communication between stations ashore is teletype. The teletypewriter, broadly speaking, is little more than an electrically operated typewriter. Teletype may be defined as "typewriting at a distance." It is the most rapid and accurate system of recorded wire communication. Normal speed of transmission is in the vicinity of 60 words-per-minute, but much higher speeds are possible.

By operating a keyboard similar to that of a typewriter, signals are produced that print characters in page form, or on a tape. These characters appear at both the sending and receiving stations. One teletypewriter transmitting signals will actuate all receiving machines connected to the teletype system. For example, an op-

erator transmitting from New York to Boston has his message repeated, letter by letter, in Boston as soon as it is formed in New York. The same occurs at all receiving stations tied into the network.

One form of teletype operation is called "simplex." This provides transmission in a single direction at a time. Simultaneous flow of traffic in both directions is provided by a second method, "duplex." By employing separate wires, carrying incoming and outgoing signals, duplex can carry nearly twice as much traffic as simplex.

Special transmission devices, known as tape relay equipment, enable messages to be relayed from one point to another with a minimum of delay. A combination of transmitter-distributor, perforator, and printer gives the operator the choice of messages printed on a page, perforated on tape, or both. An incoming message may be received in page form for the record, and punched on tape by the perforator at the same time. The tape can be used for further relay by feeding it into the appropriate circuit transmitter-distributor.

Teletypewriter System

Prior to 1940, Naval Communications within the continental limits of the United States consisted of point-to-point radio circuits and one landline Morse telegraph circuit. Messages which could not be handled by the Navy's facilities were routed via commercial communication companies. In July 1940, a commercial teletypewriter network was developed to serve selected Naval activities. This became known as the TWX System. The Navy was charged at toll call rates, so much for the first three minutes, and additional charges for overtime. As the volume of messages increased, the cost of communication soared. It became mandatory in the interests of economy that a private teletypewriter service be installed for the Navy, to supplement TWX, and to serve activities which were handling large numbers of messages.

In May 1941, the first private Navy teletypewriter circuit was inaugurated between Washington and New London. This became the nucleus of the present extensive U. S. Naval Teletypewriter System, which is commonly called the NTX System. Primary relay stations are located in five communication centers, at Washington, San Francisco, Honolulu, Guam, and Balboa. The various Naval Districts tie into these primary stations either by landwire or by radioteletype. Each continental Naval District has a major relay station and is connected to Washington or San Francisco by direct wire circuits. Western districts channel traffic to San Francisco, eastern districts to Washington. San Francisco and Washington are connected by landline teletype. Ships at sea and major relay stations outside the continental limits feed into the primary stations by radioteletype. To provide complete

NTX coverage, minor and tributary stations are set up at activities within Naval Districts and at outside points, when the traffic load warrants. TWX (commercial) is still used where NTX coverage is not justified.

The NTX and TWX systems link district and sea frontier headquarters, naval bases, ordnance plants, manufacturers, supply depots, and the countless other naval shore establishments which supply and maintain the fleet.

Radioteletype

Navy Radioteletype, which applies the teletype to radio transmission and reception, is given the abbreviated title RATT. Prior to the development of RATT, teletype needed wire to connect it with communication points. Contact with ships at sea was limited to radiotelephone or radiotelegraph. At the present time, many warships have radioteletype equipment; in the future, radioteletype will handle the bulk of communication traffic for all ships in the Navy. A milestone in the history of radioteletype is the sending of messages to and from aircraft in flight. This was made possible by development of smaller and lighter equipment.

Radioteletype is simply an ordinary teletypewriter installation connected by means of a converter to the radio transmitting and receiving equipment. When receiving, the converter changes radio impulses into a form of electrical energy which actuates the teletype. When transmitting, the procedure is reversed. Teletype is so flexible that wire and radio systems can be combined as desired. This makes it possible for Naval Communications to span great areas of the globe with a network using Teletype alone.

Radiotelephone

Although radioteletype and radiotelegraph are the primary radio systems used in the Navy for long-distance work and for recorded communications, radiotelephone, or voice radio, is also extensively used. Its important advantages are speed and ease of operation and adaptability to lightweight portable equipment.

Voice radio is particularly valuable for comparatively short-range communication by aircraft and surface ships. When a number of ships are in company and time is a primary consideration, voice radio often steps in to replace visual methods. It is used for walkie-talkie, for communications between aircraft units, and in control tower operations. Ship-to-shore as well as tactical ship-to-ship communications are greatly aided by its use. Small craft, such as district craft, depend entirely on radiotelephone for radio communication.

Facsimile-Radiophoto

Facsimile, or radiophoto, performs the transmission of pictorial or graphic information by wire or radio and reproduction of the material in its original form at the receiving station. Navy radiophoto facilities, operating as a function of the Naval Communication Service, are maintained at Washington, San Francisco, Pearl Harbor, and Guam. A basic operation of these units is the daily exchange of weather maps. They also provide a rapid method of delivering photographs, blueprints, and other material not suitable for transmission by other standard means of communication. The Navy is a participant in the joint national facsimile weather map network, which covers the entire United States and connects major air stations and weather centrals. This network is composed of facilities of the U. S. Air Force, Navy, Weather Bureau, and a few commercial stations. Mobile radiophoto units provide for operation aboard ship or at outlying points, as necessary to meet special requirements.

Radiophoto transmission is an important supplement to rapid communications, providing a previously unavailable method of handling pictorial—graphic intelligence. In comparing radiophoto with other advanced communication systems, radioteletype may be likened to typewriting, radiophoto to the printing press, and television to the motion picture.

Navy Communication System

It is clear from the preceding discussion that Naval Communications provides all types of facilities, from the most simple to the highly complex. These versatile facilities enable local commands to carry out in the most efficient manner whatever is the job of the moment. In any military organization, however, there must be overall control and a means for getting the word to all elements of the forces wherever located. Effective control of our widespread naval forces is made possible by the Navy Communication System, which is an integrated network providing basic communication coverage on a world-wide scale.

The chief components of the Navy Communication System ashore are the Primary Communication Centers at Washington, San Francisco, Honolulu, Balboa, and Guam. These are the "big five" of the system. The key station of the entire Navy Communication System is, of course, Washington. From this point, radio circuits and landlines tie together the entire Navy, making it possible for the fleet to perform its tasks as a single unit. From the radio standpoint, "Radio Washington" consists of several elements: a central communication office located in the Navy Department; a high power transmitting station at Annapolis, Maryland; a receiving and monitoring station at Cheltenham, Maryland; and a radio link transmitter and receiver station at Arlington, Virginia.

To get messages to all units of the Navy, a system of "broadcasts" is used. The word "broadcast" was introduced to communications by the Navy. This term is appropriate because messages are cast in all directions. Fleet Broadcast schedules are the primary means of delivering traffic to the fleet. The five major stations transmit by this method on predesignated frequencies and schedules, appropriate to reach all points. Messages normally are transmitted "blind," that is, the ships do not use their transmitters to acknowledge receipt of the traffic. This insures security and safety, since any "enemy" is deprived of the opportunity to use direction finding equipment in detecting the location of fleet units. In addition to the primary broadcasts, which require very high power equipment, secondary stations are set up at appropriate points to provide local coverage for small units operating in a local area. In addition to these two types of broadcasts, there are a number of local, low-power transmitting facilities operated in various areas to disseminate hydrographic and weather information, and time signals.

Earlier descriptions of the Navy's vast teletype and radioteletype point-to-point circuits told how continental shore stations are linked to overseas points and to ships at sea. This comprehensive high-speed system handles huge volumes of traffic. Manual radiotelegraph also is used by ships to contact shore stations, when other facilities are not available.

The efficient and smooth operation of Naval Communications requires careful planning. Ashore, each Naval District has its own communication organization, supervised by the District Communication Officer. This officer draws up a communication plan that provides for complete communications with ships, aircraft, and all naval stations within his district. This plan also furnishes direct channels to the Navy Department, to other Naval Districts, and to the communication facilities of other military services. District plans take special note of measures to be taken in case of local emergencies, such as storms, floods, fires, and hurricanes, when normal communication circuits may be disrupted. Emergency planning makes particular provision for the utilization of the extensive Naval Reserve Communication System. There are over 850 radio stations located at Naval Reserve activities throughout the United States. Established primarily for the training of communications personnel, and located in practically every major city and in hundreds of small communities, these stations constitute a valuable communication potential in emergencies.

The seagoing counterpart of District Communication Plans are Fleet Communication Plans. These plans prescribe radio and visual procedures to be used by ships, and are drawn up to meet any situations that may arise.

To achieve better service, preparedness, and greater economy, Naval Communications planning involves full coordination with the Army and the Air Force. Joint use of facilities, whenever practicable, results in economy of men, material, and radio frequencies. Employment of standard operative procedures and equipment by the three services, further assists continu-

ing efforts toward maximum integration of military communications.

Aviation Communications

A close parallel can be drawn between the communication service required to support the operations of naval aircraft and that required by surface craft operations. In addition to the communication channels of tactical command, point-to-point flight operations require continuous circuits, fixed or mobile, between the point of departure and destination; continuous air-surface communication enroute; and reliable aids to navigation.

Similar functional communications apply to ships and aircraft, since both are mobile naval units with responsibility to operational commanders, with comparable ranges of operation, and need for full operating area coverage. Both have need for fixed circuits to provide command and supporting functions. Air-ground channels parallel ship-shore channel functions, with added air-surface ship channels being provided in the case of air operations with the fleet. Worthy of note is the mutual interdependence between installations provided for communication and for navigational purposes, voice transmissions being normally made over most radio aids to navigation, and normal radio channels being used on occasion for direction-finding purposes.

The preponderance of aeronautical communication is accomplished by voice radio, operated by the pilot, except when planes are at such distances from base as to necessitate radiotelegraph transmissions. Flashing light signals are useful between aircraft and surface craft under conditions where the use of radio is undesirable or impossible.

Communication Personnel

No matter how excellent the communication system, its effectiveness is no greater than the people who man it. That is why, in Naval Communications as in every other field, personnel is the most important factor. The Navy, in maintaining its Naval Communication Service, has a continuing need for both operational and technical personnel. The manual radiotelegraph operator, the wireline expert, the electronics technician, each finds an important job awaiting him.

The Future

In the past twenty years, tremendous strides have been made in the technological fields of communications. With faster ships, faster airplanes, and increased tempo in all fields, no communications organization can rest on its laurels. Continuing research has a prime objective of devising faster and more reliable means of communications. Naval Communications in the future, as in the past, will be quick to recognize new systems and techniques and to apply them wherever feasible, at all times working toward more reliable, secure, rapid and flexible communications. —30—

RADIO-TV Service Industry News

AS REPORTED BY THE
TELEVISION TECHNICIANS LECTURE BUREAU

A new series devoted to the service industry. Answers to your many problems will be covered.

THE early enigma of television was the riddle of television service. Would the radio service industry eventually take over and handle television servicing? Or would it demand an entirely new type of service business expressly designed to handle the peculiar requirements of this new medium of entertainment in a manner that would keep the public happy with their sight and sound receivers?

Those were the questions of three years ago. What is the over-all television servicing situation today?

While it is still too early to say that a definite business pattern for rendering successful and satisfactory television service has been established, the trends that will eventually determine the character of that pattern become clearer every day. It is obvious that this is one service industry whose future will be largely molded by the users of its products. John Q. Public has clearly demonstrated that he wants reliable, efficient television service—not cheap service—and he is showing that he will play an important role in the creation of the kind of television servicing industry that he will support. He is throwing his weight around in quarters where it receives immediate attention by the pressures he is already applying through the Better Business Bureaus in practically every city where telecasting stations are located.

It is obvious that the acceptable audio deficiencies of AM radio that kept the public apathetic about the quality of service on aural receivers cannot and will not be tolerated in TV receivers. The ears of the general public were never critical about sound reproduction. But the eyes are sticklers for picture perfection. When a set is adjusted or repaired the picture must be good—or else.

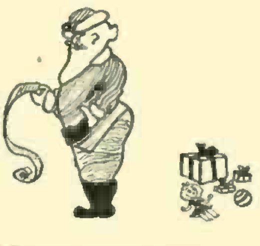
This one factor alone, with the picture tube as a vigilant detective revealing servicing inefficiencies, will stimulate a capable, efficient, business-like service dealership and provide an effective deterrent against the ruinous price competition of neighborhood screwdriver mechanics and "electronic do-gooders."

We have already seen that when a family becomes television conscious the family life is readjusted to the schedule of video programs. And the

Ed Noll's discussion of antenna types is of special interest to this attentive audience in Reading, Pa., most of whom are service shop operators who have an antenna problem to solve on every television receiver installation. The equipment visible on the lecturer's table was used in the television servicing demonstration that was given as a part of the "Radio-TV Service Industry Day" program. The complete schedule of lectures and demonstrations was presented in Reading by the Television Technicians Lecture Bureau under the sponsorship of the George D. Barbey Co. stores in that area.

Happy Holidays To You

From Buffalo Radio Supply



KITS & ASSORTMENTS

Silver & Mica Condensers	100 for	$4.95
Ceramicon Condensers	15 for	.95
Resistors ½ & 1W	100 for	2.95
Wire wound resistors including adjustable and tapped	12 for	1.00
Rotary Switches	6 for	1.75
Grid & Pl. Tube Caps Asst.	35 for	1.00
Coil Forms Asst.	50 for	1.00
Knobs Asst.	30 for	1.00
Fuses Asst.	100 for	1.95
Spaghetti Sleeving Asst.	75 for	1.00
Solder Lugs	300 for	1.00

DELUXE AC-DC RADIO KIT

High quality standard production line RADIO in kit form with complete instructions. No other advertised kit, regardless of price, offers these features. 2 Iron Core I.F. transformers. Polethylene insulated edgewise-wound antenna loop. 2 gang condenser. Tubes include 12AT6, 12BA6, 12BE6, 50B5, and 35W4. Receives Broadcast Band from 550 to 1700 KC. Kit is $8.75 or 2 for $17.00. Assembled, wired and tested, $12.95 or 2 for $25.00.

Transvision 7" television kits complete with everything but cabinet, regular wholesale price, $149.50. Your special bargain price.......$69.95

A BETTER RAT TRAP
(Or From Blind Mice to Electric Eyes)

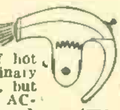
We offer a limited quantity of sensitive photocell amplifiers complete with tubes, including the photocell. These were part of an ingenious rat trap manufactured by the Kryptar Optical Company of Rochester, N. Y. for use in flour and feed mills, etc., all over the world, in killing rats. This was done when the rodents interrupted a light beam, setting off a mechanism which electrocuted them. These amplifiers are useful for traffic counting, checking units in a production line, for opening garage doors, for burglar alarms, for smoke detectors on chimneys or fire alarms, for turning on street lights at dusk; and many other applications.
Super Special, completely wired—$9.95. Kit Form—$6.95.

MICA CONDENSERS

100 assorted mica condensers, special $3.95.

CHRISTMAS GIFT SUGGESTIONS

HEAT GUN



Streamlined pistol grip heat gun in vivid red housing, that delivers a powerful 20 Cubic Ft. per minute blast of hot air at 160° Fahrenheit. Ordinary blowers have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that produces a hurricane of either hot or cold air. Perfect for blowing out dirt or dust, drying out ignition systems, warming up carburetors, drying paint, thawing out radiators, etc. Warning:—Keep this away from your wife, or she will be using it to dry her hair because it will do it in half the time of her ordinary hair dryer, to say nothing of her using it to dry stockings or clothing, or defrost the refrigerator instantly. Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

Drillmaster Electric Drill

A Terrific Christmas Gift. (But our stock won't last until Christmas.)

Pistol Grip electric drill, ideal for hobbyists. Complete with sander, buffer, grinding wheels, etc. $9.95

Admiral Record Changers in metal cabinet. Play 12-10" or 10-12" records. Latest high output featherweight Shure Crystal cartridge. Free removable permanent needle. Original factory carton. Worth double our price of $19.95 complete.

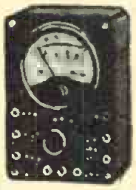
Mike with Push-to-Talk Switch $0.98

War Surplus Headphones $1.50 per pair
Guaranteed in Good Condition

SENSATIONAL VALUE IN AC-DC POCKET TESTER

This analyzer, featuring a sensitive repulsion type meter housed in a bakelite case, represents the culmination of 15 years' achievement in the instrument field by a large company specializing in electronic test equipment.

Specifications of the AC-DC Model Volt-Ohm-Milliammeter:
AC Volts—0.25, 50, 125, 250
DC Volts—0.25, 50, 125, 250
Milliamperes AC—0 to 50
DC Milliamperes—0 to 50



Ohms Full Scale—100,000
Ohms Center Scale—2400
Capacity—.05 to 15 Mfd.
Total Price, prepaid anywhere in the USA—$7.00. Similar DC Meter, lacking the AC operated ranges of above, $5.50 prepaid.

Super Special Condenser Bargains

40, 20, 20 MFD—150W condensers with common negative—55c or 10 for $5.00.

20, 20 MFD—150W, plug in condensers, 40c or 10 for $3.50.

8 MFD 475 W.V. Tubulars 35c or 10 for $2.90.
16 MFD 475 W.V. Tubulars 55c or 10 for $3.90.
8+8 475 W.V. Tubulars 60c or 10 for $4.20.
8 MFD 475 W.V. Screw neck cans 65c or 10 for $5.50.

16 MFD 350 W.V. Screw neck cans 65c or 10 for $5.50.
10 MFD 450 W.V. Twist Lug 35c or 10 for $2.90.
10+10 MFD 450 W.V. Twist Lug 60c or 10 for $4.20.
10+15 MFD 450 W.V. Twist Lug 70c or 10 for $6.00.
20+20 MFD 450 W.V. Twist Lug 80c or 10 for $7.00.

Multi-Range Model 458 AC-DC Volt-Ohm-Milliammeter with Output Ranges

Specifications:
Volts DC: 0-5/10/50/100/500/2000-1000 Ohms per volt
Volts AC: 0-125/25/125/150/250/1250
Milliamperes DC: 0-1/10/100
Milliamperes AC: 0-2.5/25/250
Ohms Full Scale: 1000/200,000/2,000,000
Ohms Center Scale: 50/2250/22,500
Output: −5 to +55 Decibels

This versatile instrument has a large 5½" rectangular meter with two-tone aluminum scale, set at a 45° angle, to facilitate greater reading ease. Welded steel case, finished in brown wrinkle. All multipliers are bridge selected within one percent. Furnished with test leads. Shipping weight 8 lbs. Special $26.00.

WE CAN MAKE IMMEDIATE DELIVERY ON THE FOLLOWING TUBE TYPES IN REASONABLE QUANTITIES

2A5	$1.10	6J5	$0.90	12AT6	$0.90
2X2	1.50	6J6	1.74	12SL7	1.40
5V4	1.44	6K6	.99	26	.80
5Y3	.75	6K7	.99	27	.80
5Z3	1.08	6L6	1.60	32L7	1.50
6AC7	1.74	6R7	1.59	50	1.25
6AJ5	2.34	6SA7	.99	56	.85
6AK5	2.34	6SC7	1.20	76	.89
6AK6	1.44	6SD7	1.40	77	.89
6B7	1.50	6SF5	.90	78	.80
6C4	.80	6SK7	.80	80	.69
6C6	1.20	6SQ7	.75	84	.90
6D6	.99	10 or 210		85	1.05
6F7	1.73		1.25	117L7	2.34

Many of the above are JAN tubes. Manufacturers quantities on some of the above. No price reduction while present shortage lasts.

HOME WORKSHOP AT BARGAIN PRICE. Accurate and precise 2 speed guaranteed hobby lathe, the essential machine for the home workshop. Sturdy enough for light production work or factory standby service. Supplied with 56" of belting for connecting to any available electric motor or power take-off. Also included in this unbelievable offer are such accessories as a ¼" drill chuck with specially hardened tool steel jaws, a 4" electric furnace high speed grinding wheel, a cotton buffing wheel and a large supply of buffing compound, and a 4" steel wire scratch brush. Your cost $6.00. Sole export agent. Distributor inquiries invited.

"THE BIGGEST SHOW ON EARTH"

9-foot by 7-foot picture
Compact—Self Contained—Portable
For Theaters—Auditoriums—Churches—Institutions—Hospitals
Imagine Clear, Bright, Steady TV with figures on the screen—

AS LARGE AS LIFE!!!

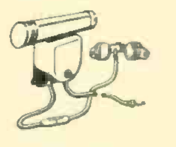
Picture can be regulated in size from 6 to 63 square feet.
Colonial Vision Master projection model TV has 39 tubes, is complete with all accessories, including movie screen, and is fully guaranteed.

Regular price $2195.00
Special Net—$795.00

Bright Star "Flashlights of Tomorrow"

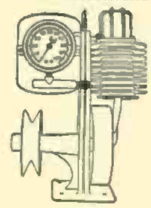
6 beautiful unbreakable plastic 2 cell flashlights on colorful display card with 12 free batteries. Flashlights alone worth $9.00. Your cost for this bargain $4.95.

Musical Instrument or Contact Microphones



Assembly complete with two Microphones. On-Off Switch, Amplifying Transformer, Batteries, Battery Case and Connector to attach to any radio: AC, DC, or battery portable. Tremendous amplification up to the full volume output of the radio or sound system used. Perfect for watch or clock repair diagnosis, diesel engine injector adjustment, gasoline engine trouble shooting, or for use on any musical instrument with dance band or orchestra. Worth $30.00. Your cost $4.95.

COMPRESSED AIR INSTANTLY ANYWHERE



Portable Air Compressor and storage tank. Ruggedly built. Best Materials. Lifetime lubricated ball-bearing on connecting rod and oil-impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors.
PATENTED unique air intake system increases efficiency tremendously so that air output is much greater than that from larger compressors powered by heavier motors. Delivers approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 00 lb. truck tire in less than one minute. Complete with 100 lb. gauge. Finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paint, lacquer, disinfectant, insecticide, annealing or brazing with natural gas, inflating tires, etc. Price $14.50 postage prepaid anywhere in the U. S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose, only $7.75 with pint container, also prepaid.

TRANSFORMERS

AUTO-TRANSFORMER—Steps up 110v, or steps down 220v to 110v—$2.95.

FIL. TRANSF.: 6.3v, 1 Amp—$1.00; Universal Output Trans. 8 Watt—89c; 18 Watt—$1.29; 30 Watt—$1.69. **AUDIO TRANSFORMER**: S. Plate to S. Grid. 3:1—79c; S. Plate to P.P. Grids—79c; Heavy Duty Class AB or B. P.P. inputs—$1.49; Midget Output for AC-DC sets—69c; **MIKE TRANSFORMER** for T-17 Shure microphone, similar to UTC ouncer type—$2.00. Stancor SB or DB mike to line or grid—$1.95.

POWER TRANSFORMERS—Half-shell type, 110V, 60 cy. Centertapped HV winding. Specify either 2.5 or 6.3V filament when ordering.

For 4-5 tube sets—650V, 40MA, 5V & 2.5 or 6.3V	$1.75
For 5-6 tube sets—650V, 45MA, 5V & 2.5 or 6.3V	1.90
For 6-7 tube sets—675V, 50MA, 5V & 2.5 or 6.3V	2.35
For 7-8 tube sets—700V, 70MA, 5V & 6.3 or two 2.5V	3.00
For 7-8 tube sets—700V, 70MA, 5V & 6.3 (25 Cycles)	4.50
For 8-9 tube sets—700V, 90MA, 5V-3A, 2.5V-3.5A, 2.5-10.5A	3.50
For 9-11 tube sets—700V, 5V & 6.3V-4A	3.50
For 9-15 tube sets—600V, 150MA, 5V&6.3V	4.00

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. RN-12, BUFFALO 3, N.Y.

trends indicate that video families will have the telephone number of their TV service dealer or contractor at the top of their "emergency call" lists. The governing factor in their selection of a television technician will not be price. It will be based on the speed, quality, and efficiency of the services rendered.

An analysis of hundreds of complaints about video service shows that such complaints don't arise because the customer feels that he was overcharged but because he feels that the technician failed to adjust or repair the receiver satisfactorily.

Public consciousness of the need for reliable television service is reflected in an excellent article in the October issue of *"BETTER HOMES AND GARDENS"* magazine under the title, "Look Out for Television Tinkerers." This article points up the important policing function that could be performed by a national organization of independent service contractors and service dealers patterned after the successful contractor organizations now operating in Chicago, Philadelphia, Boston, Los Angeles, and many other Cities. Members of these organizations adhere to a very strict code of ethics in the conduct of their businesses. Customer satisfaction with the members' services has been so satisfactory that in several cities the Better Business Bureaus have turned to these organizations to check user complaints and to help weed out the racketeers in television servicing.

The importance of a "good general press" to well-managed, honestly-operated service businesses was quickly and dramatically demonstrated as soon as this issue of *"BETTER HOMES AND GARDENS"* reached its readers.

The telephone of Paul V. Forte, executive secretary of the *Television Contractors Association* of Philadelphia,—one of the organizations named in the article—was kept busy by television owners requesting the name of some member of *TCA* who could fix their receivers. In every case, these people had been "stuck" by some so-called television service company, usually selected at random from the telephone directory by the customer.

Typical of the "gypery" that was being practiced was the experience described by one customer who phoned for a *TCA* contractor. She had picked the name of a television service company from the telephone directory and phoned to ask whether they could send a man out to adjust her receiver on one channel that was giving her trouble. The service company informed her that there would be a five dollar service charge for the call and she said that was all right. The next day a technician called at her home, switched the receiver to several channels and observed it briefly on the defective channel. Then he turned off the set. "The trouble is in your antenna," he said. "We don't work on antennas so you will have to call an installation company." He wouldn't

Al Saunders explains use of a high voltage measuring device to W. R. Brown, chairman of Electronics Technicians Association of Toledo, Ohio, and several other service shop operators of that city. Mr. Saunders has pioneered many ideas for improving the efficiency of television servicing and is explaining these new methods to technicians attending his Television Technicians Lecture Bureau speeches.

recommend an installation company, collected his five dollar "service charge" and left.

These service racketeers can be weeded out through the combined efforts of the competent independent service dealers and contractors in cooperation with other segments of the radio-television industry. However, the independent service contractor or dealer must be willing to relinquish some of his "rugged individualism" in working in an association for the improvement of his business.

Since the successful operation of a television service business depends more on the management ability of the owner rather than on his individual technical knowledge or skills, there is a decided movement among competent television service dealers and contractors in all sections of the country to join in a concerted effort to improve the efficiency and effectiveness of independent TV service.

Aside from the inherently dishonest men who jumped into the television service contracting business to pick some "fast money" without any thought of building a business or rendering honest service for the contract dollars they received, most failures in the television servicing business are caused by mismanagement or by a complete lack of management ability on the part of the owner. The major factors in mismanagement leading to failure fall into three categories:

1. Over-expansion. Requirements for capital investment in trucks, installation equipment and supplies, shop equipment and replacement parts were met by using the contract monies that should have been escrowed for payroll and supply needs in fulfilling the 12-month terms of the contract agreements. These organizations ran into financial difficulties almost immediately when their volume of new contracts tapered off.

Many operators, particularly experienced radio service dealers, whose organizations rapidly mushroomed to an unwieldy size, saved their businesses by curtailing their operations and accepting only enough service and installation business to keep a smaller organization busy. Optimum size of any individual organization from the standpoint of personnel employed is determined by several factors. The first factor is the ability of the owner as an employer, manager, and executive. The second is the density of the population in the area where the business is located. And the third is the capital available for investment in capital and working equipment.

2. Inability to organize office and operating routine to provide for the efficient scheduling of the time of field and shop personnel is another contributing factor to failure in a television service business. Lost time is definitely lost money in any service business because the major product it sells is *TIME*.

3. And an unfailing red light against successful operation of a TV service business is the failure to set up an accounting to furnish the manager with accurate figures on his costs of operation. Lack of essential information on operating costs has long been the bane of radio service and the cause of most of its profitless pricing. But where the radio service operator might continue in business and eke out an existence despite his unsound pricing methods, it will soon put the television service operator out of business because of the broader scope of his commitments. As one television contractor expressed it—"When I found at the end of my first year in TV service that it had cost me $11,000 to handle $10,000 worth of service business I realized that I had to have accurate cost accounting records or I'd soon be out of business."

Whether the 12-month service contract is good or bad for the independent service contractor has long been a prime subject of discussion at meetings of television service contractors. They agree unanimously that the 12-month contract that calls for unlimited service is not sound; that it is not good business to commit your organization to supply an unknown amount of service over a long period of time for a fixed fee. Some contractors, however, look with favor on the limited service type of contract which provides for a maximum of six calls over the 12-month period and for which the standard charge in most cities has been $30.00. But at the present time with the certain prospect of rising wages, increased costs of transportation, parts, etc., any long-term service commitment at a fixed price is economically unsafe.

The majority of contractors are now accepting only the 90-day service policies and they carefully avoid any commitments on the "one-year parts warranty" agreements that a number of receiver manufacturers have forced upon their distributor and dealer organizations as "tie-in" sales. These one-year parts warranty agreements have cost the independent service industry many thousands of dollars because of the restrictions and red-tape involved in getting replacements under the warranty agreements from some of the distributors and manufacturers. In order to protect themselves, service contractors now charge the customer for the replacement parts used to repair a set and then give him a "due bill" for the parts from the set distributor. When the distributor supplies the parts replaced under the warranty agreement the service contractor refunds the charges to the set user.

While attention has been focused on the booming business of television installation and service, the production and sale of AM radio receivers has zoomed upward again to record heights. It would pass all previous records during this year if the necessary parts, tubes, and production facilities were available. Eight and one-quarter million AM radios were produced during the first eight months of 1950 and it is expected that the year's output will reach 12½ million.

Add to this record production of AM sets the many thousands of wire and tape recorders that the general public has purchased during the past three years and the countless number of automatic record changers of various speeds and it spells out a market for radio and electronic service that will keep many thousands of competent radio service shops profitably—or at least busily—occupied for many years to come.

Surveys that have been conducted in various parts of the country show that an immense volume of service business on AM radios, record players, and recorders is available to service dealers who solicit this business aggressively. As an example, the market for replacement phono cartridges is tremendous. Although most dealers recommend the replacement of the phono cartridge when record players or automatic changers are in their shops for service, very few dealers have ever employed a studied plan for soliciting this profitable plus-business.

Several simple, inexpensive service-sales promotional campaigns have been found successful. And they bring in more service work than the replacement cartridge business. Space does not permit a complete discussion of these excellent sales-service promotional campaigns in this article but the details of how to conduct them will be sent to any radio or TV service dealer who writes to RADIO & TELEVISION NEWS (Dept. SR-3), 185 No. Wabash Ave., Chicago 1, Ill. —30—

Video Response
(*Continued from page* 58)

oughly for shorts, bad connections, and other mechanical defects. To make sure that the defect is in the video amplifier connect the vertical scope leads to the second detector load resistor and observe if a picture signal appears there. If it does, then the defect must be somewhere in the video stages. The next step is to check the operating voltages of each amplifier tube.

In the case of insufficient video gain the most likely suspect is the tube itself or a peaking coil. If a peaking coil opens then the high value damping resistor on which it is usually wound will reduce the gain of the video amplifier substantially. For example, if L_2 in Fig. 5 should open then the 22,000 ohm resistor would block most of the picture signal from the picture tube grid. This appears as a light gray image with poor frequency response and low contrast.

Other and more difficult service troubles include flat pictures, smeared or fuzzy images, and pictures blurred on very strong stations. Flat pictures are invariably due to poor high frequency compensation unless the i.f. amplifiers are misaligned. Occasionally wrong value peaking coils are found or the wax has melted, causing the coil to slip off its form and cause partial shorting. In such an instance the technician may not be able to identify the coil as to its inductance value. Exact replacement coils should be obtained from the set manufacturer if at all possible to avoid errors.

Smeared and fuzzy images are due to loss of low frequency components or overpeaking on the high side of the response curve. Overpeaking can be due to an open damping resistor or regeneration in the video amplifier section. To remedy the latter it is often sufficient to bend coils and condensers away from each other, especially to keep the grid and plate coils well separated. Loss of low frequencies is usually due to a defective coupling condenser or, if used, a defective part in the low frequency boosting network.

When pictures appear blurred only on very strong signals the defect may be in the i.f. section. The last i.f. amplifier stage may be overloaded and cause clipping of the video signal. If the signal from the second detector is observed on the oscilloscope and found to be free from distortion on both weak and strong channels, then the video stages may be at fault. Some low cost receivers use a direct connection from the detector to the grid of the video amplifier and let the diode load resistor double as grid return. On very strong signals the negative voltage across this resistor may exceed the grid bias cut-off value and cause clipping. Unless this condition is very bad, only a portion of the synchronizing pulses will be clipped, but sometimes the level of the picture signals is also affected. The remedy is to either reduce the value of this resistor or to replace it with two series resistors and connect the grid to the center of this voltage divider. Excessive clipping can also occur in a two-stage amplifier when a coupling condenser becomes leaky and causes the grid to draw current. Whenever either of these defects are found, checking the peaking coils and coupling condensers is the fastest method of locating the trouble.

The operation of video amplifiers, its desirable and undesirable aspects, as well as how to control them, form an integral part of the technical knowledge required for profitable television servicing. It will be worthwhile for the technician to acquaint himself with the appearance of frequency response curves, sweep methods, and the many different peaking systems found in modern television sets. Once the principles of the video amplifier are understood it will be easy to adjust, repair, and improve these circuits. And, after all, the final quality of the picture depends on the proper operation of the video amplifier.

—30—

Multimeter
(*Continued from page* 55)

cellent 0-250 d.c. millivolt range. On the Model 260, the millivolt values are read directly from the 250 volt d.c. scale, while the 100 microampere range is being used. The resistance of the resulting millivoltmeter is 2500 ohms in the Model 260. The scale may be read down to 5 millivolts, and 2½ mv. may be estimated.

R. F. Voltmeter

The addition of an external 1N34 germanium crystal diode converts the 100 microampere d.c. scale of the multimeter into a satisfactory radio-frequency voltmeter useful to 100 megacycles. The r.f. voltmeter may be used in signal tracing, transmitter adjustments, and sundry experimental work.

Two r.f. voltmeter circuits are shown in Fig. 3. The series type (Fig. 3A) gives highest sensitivity but can be used only when the circuit under test is continuous and will complete the circuit from the crystal anode to the meter "Common" terminal. Furthermore, no d.c. voltage may be present in the circuit under test, otherwise the crystal and meter may be damaged.

The shunt-type circuit (Fig. 3B) contains an input condenser which blocks the crystal and meter from any d.c. component in the circuit under test.

Since there is some variation in electrical characteristics of crystals, a voltage calibration must be made for an individual r.f. voltmeter. This calibration may be made conveniently at 60 cycles, the a.c. voltage ranges of the multimeter being used to check

POWER TRANSFORMER BARGAIN

740 Volts CT @ 185 MA 6.3V @ 4A, 5 Volts @ 3A 110 V 60 cy. primary.

$3.49

PEAK ELECTRONICS CO. COMPONENTS

PHONE CORTLAND 7-6443 7-6486

SELECTED AND GUARANTEED SURPLUS AT A FRACTION OF ORIGINAL COST.
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PANEL METER BARGAIN

0-500 microamps 2" Simpson Bakelite case, volt scale.

$2.95

PANEL METERS

GE—General Electric
WH—Westinghouse
W—Weston S—Simpson
SU—Sun *—Special Sale
SQ—Square Case

2" Meters

0-500 VA, WH*	$3.25
0-5 MA, GRUEN	1.95
0-5 MA, S, SQ*	2.45
0-5 MA, GE*	1.95
0-20 MA, S*	1.75
0-25 MA, SU*	1.75
0-50 MA, SU*, SQ	1.95
0-50 MA, GE	2.45
0-2 AMP RF, S, SQ	1.95
0-4 AMP RF, GE	1.95
0-9 AMP RF, WH	1.95
0-250 MA AC, GE	2.95
0-20 VOLT DC, W	2.45
0-30 AMP DC, GE	1.95
—10 +6DB, W	4.95

6" Meters

0-1.5 AMP DC, GE	$ 6.95
0-300 VAC, GE	7.95
0-30 MA, DC, GE	6.95
0-12 KVDC, GE	12.95

3" Meters

0-20 UA, W*	$12.50
40-0-40 UA, W*	7.95
50-0-50 UA, GE	8.95
0-75 UA, GE	9.95
0-1 MA, S*	4.50
0-2 MA, WH, S	3.95
0-5 MA, GE, SQ	3.95
0-10 MA, WH*	2.95
0-20 MA, S, WH	3.95
0-20 MA, GE, SQ	3.95
0-30 MA, GE, SQ	3.95
0-80 MA, WE	2.95
0-100 MA, GE, SQ	3.95
0-200 MA, GE, SQ	3.95
0-300 MA, GE, SQ	3.95
0-2 AMP, GE, SQ	3.95
0-2 AMP, WH	3.95
0-15 VOLT AC, GE	3.95
0-30 VOLT DC, DA	2.75
0-800 VDC, GE, SQ	4.50
0-3KV DC, GE, SQ	7.95

CERAMICONS

MMF: 1.5, 3, 8, 10, 20, 22, 120, 500 .... .05 ea.

SILVER MICA CAPACITORS

MMF: 10, 50, 60, 340, 750, 780, 1000 .... .09 ea.

METER MULTIPLIERS

2 Meg 1/5 of 1% Cage Enclosed 2 KV $3.95
2 Meg 1/2 of 1% Tubular 2 KV 1.95
4 Meg 1/2 of 1% Tubular 4 KV 3.75

PANEL METER KIT

Here's what you get:
- 2" Sq. bakelite cased meter. Gov't. Surplus
- Scales for all the following ranges: 0-50 ma, 0-100 ma, 0-200 ma, 0-500 ma.
- Pre-calculated shunt sizes for all ranges.
- Complete instructions.

Only $2.50 ea. .... 3 for $6.75

CHOKE BARGAINS

O-Open Frame		C-Cased	
6 Hy, 50 MA, O	$0.39	6 Hy, 400 MA, C	$3.69
6 Hy, 80 MA, O	.69	4 Hy, 450 MA, C	3.95
8 Hy, 175 MA, C	1.49	5 Hy, 170 MA, C	1.25

RAYTHEON SWINGING CHOKE

2 to 12 Henrys, 1 Amp to 100 Ma. 15 Ohms DC fully cased. High voltage insulation, ceramic insulators. Very conservatively rated. Weight 60 Lbs. .... $14.95 ea.

HIGH WATTAGE ANTENNA RELAY

110/220 volt 60 cycle Solenoid. D.P.D.T. Heavy duty paralleled contacts rated 5000 Volts @ 15 Amps. Sturdy Construction. Isolantite insulation.
As above but DPST $12.50
As above but SPDT 12.50

GUARDIAN LATCHING RELAY

SPDT, 110 V 60 cy Coil, 15 Amp Contacts $1.95

SENSITIVE RELAY

2000 ohm coil, SPDT, breaks at 3 MA, plugs into 5 prong socket .... $.99 ea.

POWER TRANSFORMERS

Fully Cased. Pri. 110 Volts 60 cy.

1110 volts CT 60 MA, 920 volts CT 160 MA, 6.3V, 18A, 6.3V, 2.25V, 5V2A, 5V2A	4.95 ea.
300 volts CT 300 MA, 2.5V7A, 2.5V7A, 0.3V, 1.5A	2.75
1050 Volts @ 20 MA, 20V, 4A, 2.5V, 5A	2.75
940 Volts CT 425 MA, 65V BIAS	7.95
880 Volts CT 100 MA, 6.3V4A, 5V 3A	2.49
4400 V @ 4.5 MA, 5V 3A, 15 KV INS	4.95
550 Volts CT 125 MA, 5V @ 2A, 6.3V 4A	1.95
Vibrator Trans. 6V In, 300V @ 100MA Out	2.95

FILAMENT TRANSFORMERS

110 V 60 CY Primaries—Full Casings

6.3V 12 AMPS	$1.95	2.5V 20A, 2.5V 20A	$6.95
2.5V 10A, HV INS.	3.95	2.5 VCT 3A	.75

WIRE WOUND RESISTORS

5 watt ohms: 25-50-200-2500 .... $ .09 ea.
10 watt ohms: 25-40-84-400-1325-2K-4K .... .15 ea.
20 watt ohms: 50-70-100-300-750-1K-1.5K 2.5K-2.7K-5K-16K-20K .... .20 ea.

30 WATT WIRE WOUND RESISTORS

Ohms: 100-2500-3k-4500-5300-18k .... 8 for .99

ADJUSTABLE SLIDER RESISTORS

20 Watt: 1, 5, 50 Ohms	.25
50 Watt: 100, 500 Ohms	.35
75 Watt: 100, 150, 200 Ohms	.39
100 Watt: 20, 50, 75, 100, 500 Ohms	.49

MISCELLANEOUS BARGAINS

7 mfd 330 VAC Oil Cond	$ .69
25 ohm 675 watt Rheostat	2.95
50 meg 35 watt Resistor	.99
250 mmf Midget Var, Ceramic Ins	.69
15 mmf Midget Var, Ceramic Ins	.39
4PST Lever Switch	.89
Ceramic RF Switch SP 11 Pos	.89
4PDT Relay, 4500 Ohm DC Coil	1.95

PIGTAIL MICAS

MMF: 5, 20, 50, 60, 100, 250, 300, 400, 500, 750, 800, 1000, 2000, 3000, 4,000, 5,000, 6000, 10000 .... $0.09 ea.

SOLA CONSTANT VOLTAGE TRANSFORMER

2 KVA, 17.4 Amps. Input 95-135 Volts, 60 cy., 1 Phase. Constant Output 115 Volts. Type 4. 31⅛" L., 9½" H., 7⅞" W. .... $137.00 ea.

WESTON PORTABLE AC VOLTMETER

Model 433. 0-150 Volts AC. 25 to 2400 cycles. ¾%. mirrored hand calibrated scale. Bakelite case with leather handle $27.50

HIGH CURRENT MICAS

Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	KV DC	Price Each
08	60	4	$27.50
.1	70	4	29.50
.05	60	5	24.50
.037	45	6	26.50
.02	40	9	29.50
.0075	39	15	24.50

TYPE G1

CAP MFD	Amps 1 Mc	KV DC	Price Each
.00024	4	6	$ 3.95
.009	40	15	29.50
.01	43	15	29.50
.002	21	20	27.50
.0031	26	20	29.50
.001	18	25	26.50
.0005	9	30	26.50
TYPE G2			
.01	25	7	6.95

BAKELITE CASED MICAS

MFD	VDC	Price	MFD	VDC	Price
.001	600	$ .18	.005	2500	$ .55
.002	600	.24	.002	2500	.45
.01	600	.26	.004	2500	.50
.02	600	.26	.005	3 KV	1.00
.027	600	.26	.0001	5 KV	.70
.01	1 KV	.45	.00045	5 KV	1.10
.002	1200	.35	.001	5 KV	1.60
.024	1500	.65	.0015	5 KV	1.60
.033	1500	.75	.003	5 KV	1.90
.02	2 KV	.90	.005	5 KV	2.50
			.0003	8 KV	2.50
			.0005	8 KV	2.90

OIL CONDENSERS

56 mfd 220 vac	$3.95	10 mfd 2000 vdc	$4.95
4 mfd 600 vdc	.59	2 mfd 4000 vdc	4.90
6 mfd 600 vdc	.79	1 mfd 5000 vdc	4.50
8/8 mfd 600 vdc	1.39	.1/.1 mfd 7000 vdc	2.25
10 mfd 600 vdc	1.29	.05 7000 vdc	.85
6 mfd 1500 vdc	2.95	.1 7500 vdc	1.25
10 mfd 1500 vdc	3.75	2 mfd 6000 vdc	9.95
2 mfd 2000 vdc	2.25	2 mfd 7500 vdc	12.75
8 mfd 2000 vdc	3.95	.65 mfd 12,500 vdc	12.95

PRECISION 1% W. W. RESISTORS

Ohms: 2K, 5K, 8500, 50K .... .19 ea.

100 WATT NON-INDUCTIVE RESISTORS

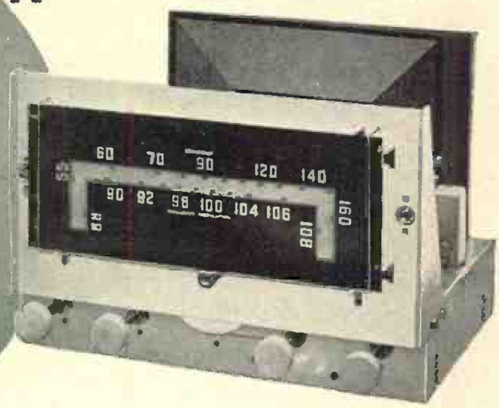
Ohms: 250, 500, 12,500 .... $0.75

NEW! the MEISSNER 9A

AM-FM TUNER CHASSIS COMPLETE WITH AUDIO

AMERICA'S GREATEST RADIO VALUE!

MEISSNER takes great pride in announcing their new 9A AM-FM chassis complete with Audio. The 9A brings real "Custom" quality reception into the low price field! ¶ A complete AM-FM unit — the 9A is a tuner, amplifier and power supply — everything you need for a deluxe custom installation or for converting older radios. ¶ Nine tubes, including rectifier, give the 9A ample power while a high degree of stability and selectivity is attained through superior MEISSNER circuit design and the use of high quality components. ¶ MEISSNER engineers stress that only a high quality speaker is capable of reproducing the wide range fidelity and tonal richness inherent in the 9A. ¶ See this fine instrument at your dealers now. Examine the workmanship — hear the glorious richness of its tone! Compare the MEISSNER 9A with units selling for twice its price. You will agree, it's MEISSNER — For Magnificent Reception!



Here's the outstanding 9A — complete with tubes, power supply, built-in antenna, escutcheon, knobs, etc.

features that place the 9A in a class by itself

- High Selectivity and Sensitivity
- Full Audio Fidelity
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MEISSNER FOR MAGNIFICENT RECEPTION

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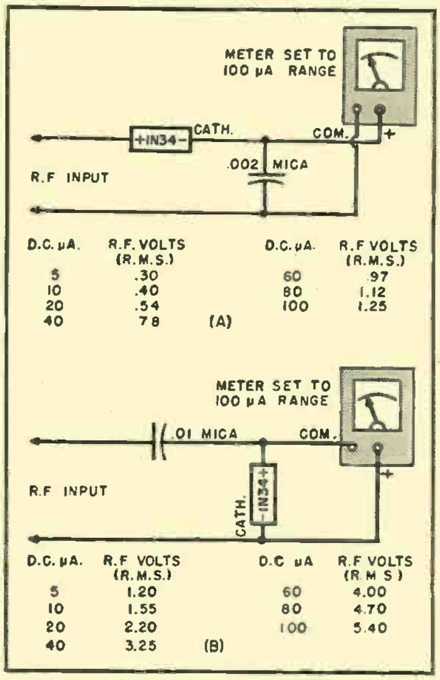

D.C. μA.	R.F. VOLTS (R.M.S.)	D.C. μA.	R.F VOLTS (R.M.S.)
5	.30	60	.97
10	.40	80	1.12
20	.54	100	1.25
40	.78		

(A)

D.C. μA.	R.F VOLTS (R.M.S.)	D.C μA	R.F VOLTS (R M S)
5	1.20	60	4.00
10	1.55	80	4.70
20	2.20	100	5.40
40	3.25		

(B)

Fig. 3. Radio frequency voltmeters. (A) A series-type unit, and (B) a shunt-type.

the values of applied voltage. Fig. 3 also shows sample calibration figures obtained for the series- and shunt-type r.f. voltmeter circuits using the 100 microampere d.c. range of the Model 260.

Galvanometer

A sensitive center-zero d.c. galvanometer is useful as a balance (null) indicator in a Wheatstone bridge, and as an indicator in the alignment of discriminator and ratio detector stages in FM and television receivers.

Fig. 4 shows how the multimeter may be converted easily into a zero-center galvanometer by means of an external battery and potentiometer. Either the 2½ or 10 volt d.c. scale, or the 100 d.c. microampere scale may be employed. To set the instrument initially, temporarily short-circuit the two input terminals, and adjust the potentiometer to bring the pointer exactly to the center of the meter scale used. The battery voltage should be 1½ volts when using the 2½ volt or 100 microampere d.c. scale, and should be 6 volts when using the 10 volt d.c. scale.

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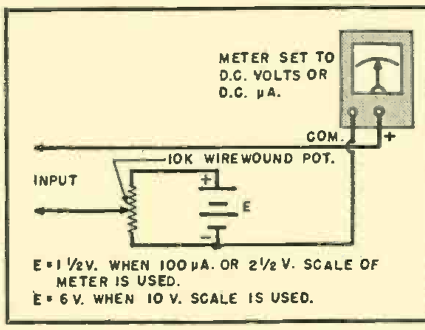
Fig. 4. Center-zero d.c. galvanometer.



Technical BOOKS

"FATHER OF RADIO" by Lee de Forest. Published by *Wilcox & Follett Co.*, Chicago. 490 pages. Price $5.00.

This is a rather nostalgic autobiography by the man whose life work helped to create the era of science which is synonymous with the Twentieth Century.

The scientific achievements of the "Father of Radio" are well-known to almost everybody connected with the radio industry but this book reveals many of the little-known sidelights and the "human interest" angles surrounding Dr. de Forest's monumental inventions. In this book he has revealed many heretofore unknown facets of his personality, details of his childhood, early education, and his courtship and marriage.

The full story of his inventions is a valuable contribution to the technical literature of the industry and the fact that all of this information has finally been captured between the covers of this book will be welcomed both by present and future historians of the radio art.

All of those interested in radio, television, the phonograph, radar, guided missiles, etc. (and that includes just about everybody) will find in this book the heartwarming story of a typical American boy from the Midwest who went forth to become one of the true geniuses of our era. Dr. de Forest deserves our gratitude for giving us this complete record of his important works.

* * *

"RADIO TUBE VADE-MECUM 1950" Published by *P. H. Brans, Ltd.*, Antwerp. Distributed in the U.S.A. by *Editors and Engineers Limited*, Santa Barbara, California. 508 pages. Price $3.00 and $3.20 (by mail). Eighth Edition.

This tube manual is so well known throughout the world that it hardly requires a review, however there are some new and particularly noteworthy additions to this edition which require comment.

Probably the greatest improvement is the consolidation of the material into a single volume. Thus, while the book is bulky it does possess the unquestionable advantage of having *all* of the data within a single set of covers.

The new edition includes data on the 7-grid tubes, the nonodes and phasitrons, planar-triodes, transducers, projection tubes, and accelerometers. A new section on crystal diodes and crystal triodes has been added in recognition of the increasingly important part these units are playing in electronics.

The entire manual has been revised and completed with information on new tubes from the entire world. Additional data on older types of tubes, which previously had been unavailable due to war conditions, has now been secured and is included in this tube manual.

As with previous editions the manual is published in English, Dutch, French, German, Danish, Swedish, Italian, Spanish, Portuguese, Russian, Finnish, Greek, Serb, Czech, Polish, Turkish, Arabic, and Japanese. Complete instructions on the use of the manual are given in all of the listed languages.

* * *

"TELEVISION SERVICING" by Walter H. Buchsbaum. Published by *Prentice-Hall, Inc.*, New York. 330 pages. Price $5.35.

This is a thoroughly practical handbook for the television technician. The author has provided a completely understandable explanation of how and why a TV receiver works (or fails to work) without resorting to the use of mathematical formulas and complicated diagrams.

The book is divided into three parts, the first dealing with the theory of TV receivers, the second with installation practices, and the third covering troubleshooting.

Regular readers of this magazine will find this book written in the same straightforward manner that characterizes the author's articles. For technicians who are a little weak in the higher mathematics end of television, this book will provide a special boon.

-30-

AFCA NEWS

ARMED FORCES COMMUNICATIONS ASSOCIATION

Augusta—Camp Gordon

Signal Corps officers recently attached to the Signal Corps Training Center at Camp Gordon were guests of the Augusta-Camp Gordon Chapter on September 27th. The meeting was held at the Chateau of the Augusta Arsenal and was presided over by Colonel Henry J. Hort, chapter president.

Mr. Marion Symms, one of Augusta's civic leaders, gave an interesting historical sketch of early Augusta and a brief account of the history of the Augusta Arsenal itself. Mr. Scott Nixon, an amateur photographer, showed some excellent colored movies of the many beautiful gardens in Augusta.

A Dutch lunch was served at the conclusion of the meeting, and the chapter members and their guests had an opportunity to become acquainted.

Baltimore

Baltimore decided to have its first fall meeting in the form of a social affair to enable members and chapter officers to become acquainted. The meeting took place on September 27th at the Park Plaza Hotel, Baltimore.

After dinner, Chapter President Wilbur Webb, Director of Engineering and Research, *Bendix Radio Division*, introduced the new officers and Colonel George Dixon, AFCA National Executive Secretary, who had come up from Washington for the meeting. Colonel Dixon discussed the general objectives of the association and emphasized the importance of fraternization during chapter meetings to develop closer friendships among AFCA members.

At the conclusion of the meeting, the movie "Air Siege" was shown to the group.

Boston

Capt. Charles Horne, former Deputy Chief of Communications, USN, and now Director of Federal Airways, CAA, delivered an excellent talk on "Aeronautical Communications, Present and Future" before a meeting of the Boston Chapter on September 20th at the Boston Naval Shipyard. At the conclusion of his talk, he conducted an interesting and instructive question and answer period.

A social hour and dinner preceded the meeting. Chapter President T. F. Halloran of the *General Communication Company* greeted the members and guests and stressed the chapter's current membership drive. Membership Chairman John B. Russell of the *S. H. Couch Co.* reported on the progress of the drive.

Arrangments for the evening's program were made by Raymond B. Meader of *New England Tel. & Tel. Co.*, who is chairman of the chapter's program committee.

This Association is a patriotic non-profit organization, with chapters in most of the larger cities, dedicated to developing and maintaining efficient personnel, commissioned, enlisted, civilian, for the supply (including design and development), installation, maintenance, and operation of communications and electronic equipment for Army, Navy, and Air Force and their supporting civilian activities. It publishes a magazine "SIGNALS" at its national headquarters in Washington. Every American interested in any way in communications is eligible and invited to join. Dues are $5.00 per year. Application should be submitted to the secretary at 1624 Eye St., N. W., Washington 6, D. C., who will furnish details upon request.

Chicago

The Chicago Chapter held its opening meeting of the 1950-51 schedule at the Edgewater Beach Hotel on the evening of September 27th. Some seventy members and guests attended a double-feature program at the Sheridan Room, after an informal dinner at which reports of past national conventions were given and suggestions made for the 1951 convention to be held in Chicago.

The program was opened with a talk on "Research Applications of Photography" by Perry M. Thomas, Director of Sales Training at the *Bell & Howell Company*. The talk was illustrated with a series of spectacular slides of stroboscopic flash photographs made in connection with several actual military and civil research projects, including the investigation of icing conditions on aircraft propellers and wings, helicopter flight, and the flight of German "Buzz Bombs."

The second feature of the program was a panel discussion of defense procurement procedures. Moderator of the discussion was Harry C. McCluskey, executive vice president of the *Kellogg Switchboard and Supply Company*. Guest participant was John E. Nylin of the Chicago Office, Signal Corps Procurement Agency. Chapter members participating were Raymond K. Fried, expert on the legal aspects of procurement, and Carrington Stone, experienced in industry-military relationships.

Mr. McCluskey had prepared a series

of questions designed to bring out both the basic facts of procurement planning and procedure, and to develop specific answers to current problems. The questions were directed in turn to the panel members, who answered them on the basis of individual knowledge, or placed the subject in discussion.

Several interesting points arose in the panel discussion, and questions were accepted from the floor. On the question as to what Signal Corps contracts were subject to renegotiation, Mr. Nylin replied that to his knowledge renegotiation can apply to any negotiated contract or subcontract of $1000 amount or over. On the question of supplier's rights for renegotiation, Mr. Fried stated that in a case within his knowledge a supplier had asked for renegotiation on the grounds that operations had been conducted at a loss, but that this was not sufficient grounds for renegotiation. Only recourse of a supplier for upward price revision is supplemental agreement, Fried said, based on changes in specifications or similar understanding.

On the question of government specifications, all members of the panel were in agreement that the phrase "or equal" has very little flexibility when used in connection with an item designed at a single source. The consensus was that to be able to bid on a proprietary item, it is virtually a necessity to have working drawings of the proprietary item together with drawings of your own equivalent, with the statement that the two are electrically and mechanically interchangeable. Naturally it is not customary to have available working drawings of a competitor's product, the panel pointed out, although some instances of supplier's drawings being available to government contractors for bid distribution have been known.

The meeting adjourned after questions from the floor had been answered.

New York

New York Chapter members turned out for a most interesting meeting on September 13th which featured Dr. J. O. Perrine, Asst. Vice President of the *American Telephone & Telegraph Co.*, and his demonstration-lecture on "Micro-Radio Waves in Civil and Military Communications." Dr. Perrine presented a similar lecture before AFCA's four Southern chapters last year.

Colonel George P. Dixon, AFCA National Executive Secretary, reported on some of the things that national headquarters are working on.

Chapter President Thompson H. Mitchell, *RCA Communications,* in calling the meeting to order introduced the following: Maj. Gen. H. C. Ingles, President of *RCA Communications* and former Chief Signal Officer of the Army; Brig. Gen. Carroll O. Bickelhaupt, Secretary and Vice President of the *AT&T Co.;* Rear-Admiral Ellery W. Stone, President of *All Amer-*

ican Cable & Radio Corp.; Robert A. Gantt, Vice-President of the *IT&T Corp.;* Vice Admiral W. S. Anderson, Vice-President, *International Automatic Electric Corp.;* Ralph S. Grist, Coordinator of Military Services, *Southern Bell Tel. & Tel. Co.,* and President of AFCA's Atlanta Chapter; Col. H. R. Yeager, Communications and Electronic Officer, Continental Air Command; Brig. Gen. A. W. Marriner, Aviation Technical Director, *IT&T Corp.*

Colonel Mitchell announced the appointment of Col. Allen E. Wharton of the *New Jersey Bell Telephone Co.,* Newark, N. J., as chairman of the New York Chapter's Civilian Defense Committee. This committee will assist and cooperate in all possible ways with the recently established state and city civil defense organizations for the New York metropolitan area.

Philadelphia

New officers were installed and committee chairmen appointed at the Philadelphia Chapter meeting on Oct. 3rd.

Retiring President W. W. Watts, Vice-President of *RCA Victor Div.,* and National AFCA Vice-President, installed the officers as follows: President—Harry A. Ehle, Vice-President and General Manager, *International Resistance Co.;* 1st Vice-President—L. J. Woods, Vice-President, *Philco Corp.;* 2nd Vice-President—R. E. Cramer, Jr., Vice-President, *Radio Condenser Co.;* Secretary—J. R. Curley, *RCA Victor Div.;* Treasurer—L. C. Coller, Signal Corps.

New committee chairmen are: Program—James McLean, *Philco Corp.,* and John Schimmel, Franklin Institute, as co-chairmen; Membership—Walter F. Denkhaus, *Bell Telephone Co.;* Publicity—Erwin May, *RCA;* Civilian Defense Coordinating Committee for Philadelphia—Admiral J. Bowling, *Philco Corp.;* Civilian Defense Committee for Camden—W. W. Watts.

Guest speakers for the evening were: Col. George Dixon, AFCA National Executive Secretary; Col. Wellington Dillinger, new commanding officer, Signal Corps Procurement Agency; and Col. Glenn S. Meader, new commanding officer, Signal Corps Stock Control Agency.

Colonel Dixon outlined plans for the association for the coming year and brought the chapter members up to date on all aspects of AFCA national activities.

An eye-witness account of conditions as they exist today in Germany was given by Colonel Meader who very recently returned to this country from an extended tour of duty in Heidelberg. He stated that it was his personal impression that resentment against occupying nations is gradually waning in the non-Russian sectors.

A probing analysis of the present attitude of the Japanese was presented by Colonel Dillinger, who noted that the retention of the Emperor was perhaps the shrewdest of all General MacArthur's farsighted decisions in handling postwar Japan.

Eighty members and guests attended

the meeting and the dinner which preceded it at the Officers' Club, Philadelphia Quartermaster Depot.

Pittsburgh

A tour of the *West Penn Power* plant in Springdale, Penna., marked the first fall meeting of the Pittsburgh Chapter on September 12th.

The plant is the second largest power producing plant of the *West Penn Power Company* which supplies power for the area surrounding Pittsburgh, Northern Pennsylvania, West Virginia, Ohio and Maryland. The tour was of special interest to the chapter members since the plant is a part of a network vital to the defense industry in the Pittsburgh area.

San Francisco

Colonel T. F. McCarthy, Director, Disaster Planning for the City of Berkeley, Calif., gave an interesting and instructive talk on "Municipal Disaster Planning" before a meeting of the San Francisco Chapter at the *Don Lee Studio* of Station KFRC on September 21st. In addition to the problems of disaster relief planning for Berkeley, he had a number of up-to-date comments on the material which had been recently distributed by the National Security Resources Board.

Colonel Lloyd C. Parsons, Signal Officer, Sixth Army, brought the chapter up-to-date on the local military situation and stated that the Signal Corps units sponsored in San Francisco by *RCA Communications, Graybar Electric Co.*, and the *Associated Telephone Co.* had all been called into active service. He also told of the changes in communications personnel recently made by the Navy in the San Francisco area.

Seattle

The Seattle Chapter has decided to forego its practice of holding bimonthly meetings and instead meet every month until the present national emergency is over. Representatives from the chapter attended a recent meeting of the local civil defense authorities, and reported on the ways the AFCA chapter could be of assistance in the civil defense planning.

At the chapter's September 20th meeting, Mr. J. Dingwall, assistant to the Mayor of Seattle, spoke on the non-technical part of the Seattle civil defense board which is headed by the Mayor and is composed of the directors of the following departments: public health, fire, police, engineering, utilities and welfare (performed by the Red Cross). Mr. Dingwall explained plans for handling an atomic bomb attack and pointed out that an underwater atomic bomb burst is more dangerous than an air burst. Other phases of the defense plan he described were the development of a recruiting program, housing facilities, screening stations, purchasing division, mutual assistance with neighboring cities, and radiological monitoring equipment.

—30—

Mac's Service Shop

(*Continued from page 46*)

scrawny TV signals that reach out here.

"Another more common example is the shifting of a radio's i.f. frequency a couple of kilocycles or so in order to move a bad heterodyne off a popular local station.

"But you have to be *sure* that you really are making an improvement. A horrible example of not doing so is the case of a technician I know who invariably places bypass condensers across the cathode resistors of sets that do not already have them. He figures this does good because it increases the volume, and he is of the opinion that the manufacturer was simply too cheap to include these condensers. Really, that is not always the case. Quite often these condensers have been deliberately omitted in order to introduce degenerative feedback and so produce better over-all frequency response. Using the condenser increases the volume all right, but it quite often impairs the tone."

"Any other cases where you suggest changes?"

"Well, sometimes you get one of these small radios that simply do not have enough sensitivity to pull in distant stations. After you have checked everything else, you will often find that moving the loop antenna away from the receiver a little way will increase the sensitivity tremendously. The reason is simple: in order to achieve 'smart compactness,' the manufacturer has jammed the loop coil right up against the metal chassis, with a resultant lowering of its '*Q*' and an increase in the distributed capacity. When cardboard or wooden spacers are used to move the loop away from the chassis an inch or so, the '*Q*' goes up, the receiver does a better job of separating stations, and distant stations can be received much more readily. On top of that, the receiver is usually better ventilated with the loop set back a short distance."

"Did you ever catch a manufacturer pulling an out-and-out boner?"

"You might call this one," Mac said as he picked up an a.c.-d.c. chassis. "See where this 110 volt bayonet base dial lamp is located? Notice that it is directly behind the speaker cone and only an inch and a half from that cone. Now listen."

He turned on the set, and Barney instantly detected an annoying scratching sound that seemed to play a sort of background accompaniment for the voice and music coming from the speaker.

"Get this," Mac said as he removed the pilot lamp. Instantly the noise stopped. In quick order Mac substituted a half-dozen other lamps from a new box, and every one was noisy. Then he removed the screw that held the lamp bracket in place and moved it to the rear of the chassis where it was shielded from the speaker cone by the back of the speaker. With the lamp in this location, none of the bulbs caused any noise.

"The manufacturer slipped up there," Mac said. "When these fragile filaments are pushed around by the speaker vibrations, they make noise; and the only way to get rid of it is to place the lamp in a position where it is not buffeted around by the sound waves."

"As I get it," Barney said slowly, "the point you are trying to make is that there are times when, as you put it, the lily really does need gilding; but before you pick up the paint brush, you want to be sure that a little wiping off with a damp rag will not do the trick."

"That's a horribly involved way of putting it," Mac said with a grin, "but that's the idea. If you will just keep in mind the revolting thought that the fellow who designed the set you are working on was probably *almost* as smart as you are, you will be a better technician for it." —30—

Engineering Integrated Communications System

(*Continued from page* 39)

the terminal station, complete with associated carrier equipment, has been designed to fit into a vehicle of the three-quarter-ton weapons carrier type.

Intermediate area radio relay equipment will be under procurement before the end of the fiscal year in the form of a system with adequate bandwidth for 12 voice channels or the equivalent in facsimile, data transmission, or teleprinter channels. The same 12-channel carrier terminals being developed for wire systems will be utilized. Primary employment is contemplated for main-line communications from Army to Corps, and from Corps to Division.

To meet rear area requirements, development has been pointed toward 48- to 96-channel relay systems with ultimate ranges up to 1500 miles. Due cognizance has been given to engineering features necessary to assure the capability of satisfactory transmission of television and wide-band facsimile. While the equipment has reached the engineering model stage and tests have been satisfactory, it will probably not be ready for production this year. To provide a usable system in a shorter time, a modified version utilizing time division multiplex to obtain 24 channels is being placed in production in the next few months. Primary use will be for communications from Theater to Army Group to Army, and for providing main line circuits within the communications zone.

Amplitude Modulated Radio

The addition of FM and radio relay principles to the military radio system has not by any means reduced the necessity for conventional AM systems in certain applications. It is obvious, for example, that FM with its short range in the frequencies used—

and radio relay systems with their dependence on relays for range—would be of little use to an airborne division landed 100 miles behind the enemy lines. Mobile communications over intermediate ranges also obviously point toward AM sets. Global networks covering distances up to 12,000 miles must, of necessity, continue to utilize frequencies suitable for long ranges and methods of modulation giving maximum frequency conservation.

The main development being pursued currently in the low power AM field is a 100-watt set for use by lower echelons within divisions and by airborne troops. Ruggedness, reliability, small size, and simplicity are the keynotes that have governed the development. Quantity production is expected to start within the near future.

In planning development to satisfy requirements for sets working over ranges calling for wattages from 500 to 50,000 the Signal Corps has proceeded on the "building block" principle utilizing the 500-watt transmitter as the basic component. Addition of a 5 kw. power amplifier provides a set suitable for military communications in the 1000- to 2000-mile range, while the addition of a 50 kw. amplifier and necessary auxiliary equipment leads to a high-powered system for use on a global basis. Provisions are made for teleprinter, facsimile, voice, and c.w. transmission. Accessory equipment is provided for single sideband adaptation. In addition, parallel development is proceeding on a simplified single sideband transmitter. Within a few months production on 500 and 5000-watt sets will be under way. Receivers for the above equipment will be taken from a general receiver family being developed to fit communications, intercept, and direction finder roles.

Integration

While the above equipments have been discussed as individual items, it must be emphasized that they are developed within the concept of an integrated system and that devices for radio-wire integration are either integral to the equipment or furnished as auxiliary items.

Wire Communications

Wire systems are still considered in general to be the backbone of most Army communications despite the improvements being made in the radio field. Consequently, postwar effort on development of wire equipment has paralleled the effort on radio systems and is producing comparable results as will be indicated.

Wire and Cable

One of the really significant advancements now paying off in Korea and elsewhere is the new Signal Corps field wire which has been developed to replace both the well-known W-110-B field wire and the W-130 type assault wire of the past war. No rubber is contained in the new wire and substantial [redacted]n made in other st[redacted]s. While W-110-B wire [redacted] around 140 pounds per mile, the new wire weighs only 48 and has an increased talking range, better abrasion and moisture resistance, and longer life. To facilitate wire laying, a new canvas wire dispenser has been perfected which allows high- or low-speed wire pay-out from the inside of the package without the use of reels or axles. Besides the obvious advantages, particularly to the forward area wire layers, a considerable saving in metal reels is realized. Also nearly developed is a lighter and tougher spiral four field cable for use with 4- and 12-channel carrier systems. The basic cable for both systems is identical physically and electrically, with loading for 4-channel operation being accomplished by insertion of a small weatherproof loading coil between cable connectors.

Switchboards

The system of switchboards contemplated for the integrated system provides capacities required from battalion to theater level and utilizes, when possible, the "building block" system. Just going into production is a 12-line monocord board of the magneto type weighing about 22 pounds versus the 72 pounds of its predecessor and utilizing retractable cords. Capable of stacking up to three units, this board will be suitable for use up to regimental level. Also soon to be available for use at regimental and divisional level is a 30-line magneto board of the more conventional type capable of 60- to 90-line expansion and using many of the basic components of the smaller board. For use where larger capacities are necessary, a common battery board, based on a 70-line position and capable of expansion up to 2000 lines, is being developed. For ease and speed of installation, this board is equipped with plug-in type cables for interconnection between positions, and between main frame and switchboard. As with all Army equipment, the ability to stand the bumps and adverse weather conditions inherent in military operations has been built into the equipment.

Teleprinters

The Signal Corps' main contribution to the teleprinter field is the development of a simplified page printer weighing only 45 pounds, usable at speeds from 60 to 100 words-per-minute, and designed specifically for ruggedness and dependability and ease of maintenance. Due primarily to its 225 pound weight, and multitudinous parts the teleprinter previously standard for the Army was not suitable for use in lower units, whereas the new unit with only one-fifth the weight and 300 fewer parts will allow teleprinter service to be employed down to the regimental level. A 17-pound tape printer now in development will further extend the use of this most desirable means of communications to battalion level. Recently completed voice frequency line units for use with these two equipments will allow the utilization of radio voice channels on tactical radios for teleprinter service. Of comparable importance, the voice frequency principle will make possible the use of teleprinters over local subscriber telephone circuits and through standard telephone switchboards.

Carrier Equipment

Commercial telephone and telegraph carrier equipment is designed for fixed station operations under controlled conditions where size, weight, and ruggedness are not determining factors. The Army requirements for carrier equipment include lightweight, small equipment built to take rough usage, and operate with little attention under adverse weather conditions and over communications lines subject to considerable electrical variations. To fill this need three carrier systems are currently under development, a 4-channel telephone carrier, a 12-channel telephone carrier, and a 48-channel system. A new 8-channel telegraph terminal can be used as needed in conjunction with any of the above terminals. The terminal equipment of each of the above systems will be used not only in the 4-, 12-, and 48-channel wire sets but also with the 4-, 12- and 48-channel radio relay equipment. Commercial standards for transmission levels and quality are being closely followed in development of such equipment so that long distance communications over the integrated communications network will approximate, insofar as practical, that found in American commercial systems.

Conclusion

Any brief article dealing primarily with the results of development in the communication field has the danger of leaving the reader with the impression that a completely short-range program is being pursued. Such is certainly not the case. The Signal Corps maintains at its own laboratories, and sponsors in the laboratories of universities and industry, a long-range program of research and development having as its objective the constant search for new basic knowledge, principles, techniques, and materials; and their application to the Integrated Communications System. By continuing a vigorous, long-range effort, the Signal Corps expects always to provide the best military communications in the world. —30—

International Short-Wave

(*Continued from page* 118)

tral P. O. Area, Tokyo, Japan; sent nice souvenir folder commemorating first Japanese broadcast of March 22, 1925. JKM2, 9.69, Tokyo, excellent 0130 in Japanese; announces "NHK." (Russell, Calif.)

Madagascar—Radio Tananarive currently is using French on 3.900, 6.172, and 9.515 weekdays 2230-0030, 0400-0600, 1000-1430, Saturdays at 2300-0245 (Sundays), 0350-0600, 0915-1430; news in French is at 2310 weekdays, 0000 weekdays, 0015 Sundays, 0400, 1100, and 1315. Programs in Malgache are broadcast on 7.375 and 9.693. (Copenhagen DX broadcast) Stark, Texas, hears 9.515 and 9.693 both opening 2230 with "La Marseillaise"; former takes French program, latter uses Malgache.

The 9.515 outlet is heard at 1200 in Israel. (Bluman)

Malta—FBS, Middle East, has dropped 4.965 and is now using 6.015 in parallel with 7.220 at 2300-0115 (has BBC news relay 0100); announces will reopen 0430 on 11.895, 7.220. (Pearce, England, Bellington, N. Y., others) Also noted on 6.015 afternoons around 1300-1400 and later; probably runs to 1600 or 1700. (Pearce, England)

Mozambique—Pearce, England, has heard Lourenco Marques on approximately 15.278 (believed CR7BG moved from 15.191) at 1425; signed off with "A Portuguesa" at 1459; all-Portuguese.

New Caledonia—Radio Noumea, FK8AA, 6.038, is heard daily 0200-0532; signs on and off with "La Marseillaise"; *no English noted as yet.* (Neeley, Calif.)

Norway—Radio Sweden reports a *new* schedule for *Radio Norway* in which "Norway This Week" (a 15-minute program in *English*) is now radiated Sundays 0700, 0900, 1500, 1900, 2100; four channels are used—one of which is *always* 15.170.

Pakistan—Radio Pakistan, measured 7.1402 (probably Dacca?), noted in oriental program 0630; at 0700 is parallel with measured 11.5782 and 11.845 with news. (Oskay, N. J.)

Paraguay—ZPA3, 11.85, Asuncion, noted with weak signal; at 1915 announced for ZPA, ZPA3, *"Radio Teleco";* followed with program of announcements in Spanish, then popular music; at 2100 had "Reporte Esso" (news in Spanish) and left air 2105. (Ferguson, N. C.)

Peru—OAX4Z, 5.895, Lima, heard to 2329 sign-off; slogan is *"Radio Nacional del Peru";* listed 14 kw. (Neeley, Calif.) QSL from this station lists schedule of 1900-2330; frequencies are OAX4A, 854 kc.; OAX4T, 9.562, 10 kw., inactive; OAX4Z, 5.895, 10 kw. QRA is Av. Petit Thouars, 447, Lima, Peru; transmitters are located at San Miquel; card was in *English;* asked for further reports. (Slutter, Pa.)

Philippines—Radio Australia reports that DZH8, Manila, Far Eastern Broadcasting Corporation, is *temporarily* using 15.300; noted from 0100 to closedown 1105; has program summary daily 0300. Heard by Balbi, Calif., at 0100 with news.

Manila, 6.17, has news 0745 daily. (Balbi, Calif.)

DZH4, 6.000, Manila, noted 0900 with request program; DZFM, 6.17, "The People's Station," heard 0915 with weather report, marine news, and report of how many cases of different diseases have broken out in various countries, badly squeezed by Saigon on 6.165 and BFEBS, Singapore, on 6.175; DZH2, 6.140, noted 0930 with popular music, fair signal, relays DYRC. (Neeley, Calif.)

Poland—A station heard widely in USA on 9.523 to closing 2030 is believed to be *Radio Warsaw.*

Noted in England on 9.523 with *English* 1215-1245 in parallel with 6.215; second broadcast 1300-1400 is on 6.215 only; announces as "The Peace Station." (Pearce)

Sao Tome—"Radio Clube de Sao Tome" sent this schedule—CR5SA, 11.785, 1 kw., inactive; CR5SB, 17.6775, 1 kw., 0700-0800 on Thursday and Sunday *only;* CR5SC, 4.8075, 1 kw., 1430-1600 *daily;* CR5ST, 9.615, 1 kw., inactive. (Mann, N. Y., via NNRC)

Southern Rhodesia—A further verification from Salisbury stated broadcasts on 4.880-4.890 were only test transmissions with power of 1 kw.; present frequencies are "local day-time" on 7.290, testing on 9.490; "local evenings" on 3.320, testing on 6.018 and 9.490. (Pearce, England)

Spain—Radio Nacional de Espana has been heard near 6.125 with recordings at 0805 and noted signing off 1100; frequent announcements; news in Spanish from 0825; believed to sign on 0700. (Pearce, England)

Switzerland—Via airmail comes this winter schedule from Berne—*To Europe*—Weekdays 0015-0140, Sundays 0055-0140, HER3, 6.165, and HER4, 9.535; Mon.-Fri., 0500-0830 and 1000-1700, Saturday 0500-1700, Sunday 0245-1700, HER3, 6.165, and HER4, 9.535. *To Africa*—Daily 0015-0140, Sunday 0055-0140, HER6, 15.305, 0500-0730, HER8, 21.520, and 1000-1700. HER6, 15.305. *To Australia, New Zealand, Far East*—Daily 0215-0445, HER5, 11.865, HER8, 21.520, and HER7, 17.784. *To Japan, South East Asia*—Daily 0745-0930, HER5, 11.865, HER7, 17.784, and HER6, 15.305. *To India and Pakistan*—Daily 0945-1130, HER7, 17.784, and HER5, 11.865. *To The Middle East*—Daily 1145-1330, HER7, 17.784, and HER5, 11.865. *To The United Kingdom and Ireland*—Daily 1345-1530, HEU3, 9.665, and HER5, 11.865. *To Spain and Portugal and to South America* (first broadcast)—Daily 1545-1715, HER5, 11.865, and HEU3, 9.665. *To North America* (first period)—Daily 1730-1815, HER5, 11.865, HER3, 6.165, and HER4, 9.535. *To South America* (second broadcast)—Daily 1830-2000, HER5, 11.865, HEI5, 11.715, and HEU3, 9.665. *To North America* (second period)—Daily 2030-2300, HER5, 11.865, HER3, 6.165, and HER4, 9.535. A free illustrated program schedule will be sent on request to Swiss Shortwave Service, Neuengasse 23, Berne, Switzerland.

Taiwan—BED7, measured 7.134.6, Taipeh, now has news 0630-0640; good signal in Eastern U. S. (Oskay, N. J.) Should be using 11.735 in parallel.

Tangier—Pan American Radio, 15.048, noted testing around 0700-0743. (Pearce, England)

Thailand—At the time this was compiled, HS8PD was using 6.240 again for the Overseas Service daily 0500-0630; news 0615. (Oskay, N. J.) Fair signal here in West Virginia but some CWQRM; should have news also 0515.

Trinidad—Despite overseas reports that VP4RD has moved to 9.640, at the time this was compiled it was on listed 9.625. Slutter, Pa., received schedule of 0600-2300 daily on 1295 kc. and 9.625; gave QRA as Broadcasting House, Port-of-Spain, Trinidad, B.W.I. Heard by Mulvey, Conn., on Sunday 1530 with "Bringing Christ to the Nations." I recently heard this one from 0500 although lists schedule as from 0600.

Turkey—By this time, *Radio Ankara* should be using TAP, 9.465, again for Mailbag Program on Sundays 1630-1700.

USSR—Radio Tashkent noted on 6.825 with news 1115-1130; stated has two daily broadcasts in *English*—0900 and 1115. (Pearce, England) Charkow has been heard at good strength at 1100 on 7.330. (Radio Sweden)

Venezuela—YVKR, 4.92, Caracas, heard at 2330 sign-off. (Russell, Calif.)

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Last Minute Tips

I have received word direct from Henry J. Nolan, S. J., of *Vatican Radio* that when the *new* high-powered transmitter is put into operation next year (1951), it will operate on medium-wave, long-wave, and short-wave. Apparently, this refers to the transmitter being presented by Dutch Catholics to His Holiness the Pope in commemoration of Holy Year.

Officials of *Radio Brazzaville,* French Equatorial Africa, recently announced —"We have no printed schedules available but hope soon to start a *monthly* magazine which will be sent to all who care to subscribe to this. It will consist of articles and photographs about this country and also about our station." Has a *new* verification card.

"Radio Watani el Kurds," the Kurdish National Radio, is now on 7.040 at 1030-1130; no location is given but local news items indicate may be Kermanshah, Iran. (Bluman, Israel, via Radio Sweden)

A flash from Hannaford, South Africa, indicates Lourenco Marques, Mozambique, has been heard testing "mornings" (presumably around 2300-0100 or later) in the 42-meter band, asking for reports.

Saigon has been reported testing around 0520-0559 on 9.495 (claims 9.524) and on that channel until 1630 (in latter period is parallel with approximately 17.722). (Radio Australia)

In a letter to Neeley, Calif., *Radio Malaya,* Singapore, stated that when new installations—now in progress—are completed, more transmitters, increased powers, and extended schedules will be effected. Present schedule was listed—*Red Network*—6.135 at 2330-0115 Indian program, 0115-0130 Chinese program; 4.780, 0430-0630 Indian program, 0630-0830 Malay program, and 0830-1030 Chinese program. *Blue Network*—7.250 at 2330-0030 Malay program, 0030-0130 *English,* 0430-0530 Chinese program, and 0530-1030 *English* program; on Saturdays has additional *English* programs at 0130-0425 and 0425-1100; on Sundays has additional *English* programs from (Saturday) 2030 to 2330 (Sunday), 0130-0425, and 0425-1100. Kuala Lumpur, 6.025, relays the Blue Network programs.

Latest schedule for the International Service of *Radio Canada* is—*European Service*—0915-1130, CKNC, CKCX; 1130-1345, CKNC, CKCS; 1345-1400, CKCS; 1400-1545, CKCS, CHOL; 1545-1600, CHOL; 1600-1830, CHOL, CKLO. *Australasian Service*—2250-2320, CKLX, CHOL, commentaries from the United Nations (except Sat., Sun.); 0340-0530, CHOL, CKLO, Sun. *only. Caribbean and Latin American Service*—1850-2045, CKRA, CKCX; 2045-2100, CKRA; 2100-2235, CKRA, CKLO; (*English* is 2100-2145). *Northwest Territories (Northern Messenger)*—Sunday *only* in *English* and French 2320-2400, CKLO, CKOB. Channels are CKNC, 17.82; CKCS, 15.32; CKCX, 15.19; CKLX, 15.09; CKRA, 11.76; CHOL, 11.72; CKLO, 9.63, and CKOB, 6.09.

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Press Time Flashes

At the time this was compiled, *Radio Ankara* had started experimental tests in *English* daily 1600-1645 (some days to 1700) over TAS, 7.285 (best), and TAP, 9.465; by this time may be using some other channel/s experimentally. Has news now 1445, and the Mailbag Program on Sunday and Talks on Turkey (also *English*) on Thursday are now over TAP, 9.465 (and whatever experimental channel/s currently used) at 1630-1700.

New schedules of *Radio New Zealand* are—Australian Service daily 1300-1545, ZL3, 11.78, 1600-0145, ZL10, 15.220, and 0200 to closedown, ZL3, 11.78; the Pacific Service is on ZL4, 15.28, at 1300 to closedown, which is 0500 Sun., 0530 Mon.-Fri., and 0630 Sat. (Cushen, N. Z., via Radio Australia)

At press time, *Radio Peking* was using 11.6853 in parallel with 15.054V mornings, news 0830 yet; the old 10.260 channel was being used irregularly for communications and at times for relaying broadcasts, and was also reported in Eastern USA opening 1800 (buried in CWORM by 1830), carrying regular "morning" broadcast in Chinese (*no English noted*).

By this time, *Radio Moscow* will have effected winter schedule to North America—daily 1820-2300 on 15.23, 11.88, 11.82, 9.67, 7.29, 7.24; it is believed the "morning" beam 0800-0830 will not be affected (is heard here in West Virginia best on 15.18).

Radio Australia is now using old VLC7, 11.81, to North America 0700-1115.

Hannaford, South Africa, flashes that Salisbury, Southern Rhodesia, is now operating Monday-Saturday 0400-0615, Sunday 0330-0615 on 7.280; 1100-1500 Mon.-Thur. and Sat., 1000-1500 Friday, 1300-1500 Sunday on 3.320, 6.018, 9.490.

CBNX, 5.970, St. John's, Newfoundland, 300 watts, is scheduled 0600-2230; CBNX on 3.480 and 9.470 is inactive. VONW, 3.490, 100 watts, Labrador, is heard Sundays irregularly. (Peddle, Newfoundland)

Serrano, Brazil, airmails me this data on Brazilian outlets—*Radio Inconfidencia* operates on 880 kc., m.w., PRI3, 22 kw., and on s.w. 5.995, PRK5, 5 kw., scheduled 0500-2200; reports may be sent in practically any language—including *English*—and all correct ones will be answered by QSL card (reverse shows partial view of Belo Horizonte) by surface mail; *IRC should be enclosed;* QRA is Radio Inconfidencia, Feira Permanente de Amostras, Belo Horizonte, Minas Gerais, Brazil. *Radio Record,* Sao Paulo, definitely has moved from 9.605 to 9.505. A *new* station heard on (announced) 9.37, poor level, closing 1200, is at Sao Paulo, operated by the Astronomical and Geophysical Institute of the University of Sao Paulo; has service similar to WWV. *Radio Nacional,* Rio de Janeiro, noted in dual on 9.72 and 6.147 lately.

DZB2, 3.320, logged 0530; is Far Eastern Broadcasting Co. (missionary station), Manila, Philippines; heard announcing DZB2, 3.320, DZH6, 6.03, and DZH8, 15.300, "The Call of the Orient." (Cushen, N. Z., via Radio Australia)

Don Trelford, Ontario, Canada, has just informed me that he has resigned as North American Representative of the *New Zealand Radio DX League,* and that all requests for *World Radio Calls* (price 35 cents—seven 5-cent stamps are acceptable) should be addressed to Lincoln A. Mayo, 783 Madison Ave., New York 21, New York.

CS2MA, 6.374, and CS2MF, 9.745, Lisbon, have extended "evening" beam to North America to 2100 (formerly signed off 2030). (Grove, Ill., others)

BED4, 15.235, Taipeh, Taiwan, is scheduled now 2300-0100; first hour in *English;* improved signal noted on West Coast. (Balbi, Calif.)

New is XEX, 11.900, "La Voz de Mexico," noted to after 1300, announcing "Servicio Internacional." (Stark, Texas, others)

Radio Tripolis, Greece, is operating on 7.010 at 0000-0200, 0500-0700, 1200-1400. (Radio Sweden)

Sofia, 7.671, Bulgaria, heard with news 1545 and 1645. (Cox, Dela.) Noted in Georgia signing on 2255 with strong signal but soon deteriorates. (Fargo)

Ponta Delgada, Azores, 11.090, is definitely now on winter schedule 1500-1600. (Bellington, N. Y.)

Warsaw, 9.525, Poland, seems to open 2000 and close 2030. (Stark, Texas)

EDV10, 7.170, Madrid, heard 1536, good signal for 1 kw.; EA8AB, Tenerife, Canary Islands, 7.514, noted 1548; CS9MA, 7.018, Ponta Delgada, Arozes, noted 1715 with music. (Cox, Dela.)

A *new* radio club is *World Radio Champion Society,* Box 19,033, Stockholm 19, Sweden; is arranging many special programs from foreign stations, of programs recorded in Sweden; first was aired by HCJB, "The Voice of the Andes," Quito, Ecuador. A DX-band contest is being sponsored by *"World Radio Handbook"* in conjunction with *International Short Wave League.* OTC, Belgian Congo, has been holding a similar contest on its own activities. These are all marks of increased interest in short-wave broadcasting and in international good fellowship.

English periods from Hilversum, Holland, are now (weekdays *only*) 0500-0555 to Australia, New Zealand, and Pacific Area on 21.48, 17.775, 15.22, and (for listeners in Europe) on 6.025; 1230-1325 to South Africa, Great Britain, Ireland, and Continental Europe on 11.73, 9.59, 6.025; 2100-2155 to United States and Canada on 11.73, 9.59; "Happy Station Programs," prepared and presented by Eddie Startz, are radiated Sundays 0930-1100 on 15.22, 6.025 to East, Far East, and Europe, 1600-1730 on 9.59 and 6.025 to South America, Africa, and Europe, and 2200-2330 on 11.73, 9.59 to North America; Tuesdays 0600-0730 on 21.48, 17.775, and 6.025 to the Pacific, Australia, New Zealand, and Europe; and Wednesdays 0930-1100 on 15.22 and 6.025 to East, Far East, and Europe, 1600-1730 on 9.59 to South America, Africa, and Europe, and 2200-2330 to North America on 9.59. (Hankins, Pa.)

SRI, Buenos Aires, became SIRA (the International Broadcasting Service of Argentina) on the Argentine Republic's "Loyalty Day". A *new* 100 kw. shortwave transmitter was inaugurated by the president of Argentina, Gen. Juan Peron and the First Lady of the Land, Senora Eva Peron, both of whom sent greetings of friendship and good-will to all the nations of the world. Concerts of native music, performed by Argentine composers rounded out the several-hour inaugural broadcast of SIRA. The new transmitter is using various frequencies, including (announced) 9.69 which is beamed to North America (in *English*) evenings around 2115-0100. I hope to have further details soon on the expansion of Argentina's International Service.

Acknowledgement

Thanks for the splendid cooperation! Reports are welcome from anyone, anywhere in the world—to 948 Stewartstown Road, Morgantown, West Virginia, USA. . . . . . . KRB.

Within the Industry

(*Continued from page 28*)

ELECTRIC PRODUCTS INC. . . . THE AUDIO-MASTER CO., manufacturers of transcription players, has moved to larger quarters at 341 Madison Avenue, New York 17, N. Y. . . . Application for a building permit for the construction of a new television plant in Raritan Township, New Jersey has been filed by **WESTINGHOUSE ELECTRIC CORPORATION** . . . The **GENERAL ELECTRIC COMPANY** has announced that it will reopen its Clyde, New York plant and transfer the production of germanium products now being made at the company's Thompson Road plant in Syracuse to the Clyde factory . . . **PYROFERRIC COMPANY** has acquired a manufacturing plant at 14 Bleeker Street, Mount Vernon, New York to supplement its present facilities for the production of iron cores . . . **CENTRAL TELEVISION SERVICE** of Chicago has opened a South side branch at 6901 South Anthony.

* * *

CHARLES M. ODORIZZI has been elected to the post of operating vice-president of the *RCA Victor Division* of *Radio Corporation of America.*

He has served as vice-president in charge of service for the division since July of 1949. In his new post he will continue as chairman of the board of the *RCA Service Company.*

Mr. Odorizzi joined the company in 1949 as administrative head of service activities for the *RCA Victor Division.* Most recently, he completed organization and establishment of a special Government Service Division to facilitate and expedite the handling of government requirements.

Before joining *RCA* he served as vice-president and general manager of the mail order division of *Montgomery Ward & Co.*

* * *

RADIO-TELEVISION MANUFACTURERS ASSN., through its president, Robert C. Sprague, has recently named a fifteen-man "Town Meetings" Committee which will function under the continued leadership of Harry A. Ehle, vice-president of *International Resistance Co.*

The RTMA committee is currently conducting "Town Meetings" for television dealers and technicians in television areas throughout the country. The programs are being financed on a voluntary basis by TV set manufacturers.

Serving on the newly-appointed committee are: Benjamin Abrams, *Emerson Radio & Phonograph Corp.;* A. T. Alexander, *Motorola Inc.;* A. A. Brandt, *General Electric Company;* H. C. Bonfig, *Zenith Radio Corp.;* Leonard F. Cramer, *Allen B. Du Mont Laboratories, Inc.;* J. B. Elliott, *RCA Victor Division;* G. M. Gardner, *Wells-Gardner & Co.;* H. L. Hoffman, *Hoffman Radio Corp.;* J. J. Kahn, *Standard Transformer Corp.;* Stanley H. Manson, *Stromberg-Carlson Co.;* Leslie F. Muter, *The Muter Co.;* Henry T. Paiste, *Philco Corporation;* A. D. Plamondon, Jr., *Indiana Steel Products Co.;* and Edward C. Tudor, *Industrial Development Engineering Associates, Inc.*

* * *

JOSEPH H. MOSS, JR. has been appointed to the newly-established post of manager of distribution for the receiver sales division of *Allen B. Du Mont Laboratories, Inc.*

Mr. Moss will handle the administration of the company's distributors throughout the country. He will be responsible for distributor follow-through on all sales and merchandising policies formulated at the firm's New Jersey headquarters. He will make his offices at the East Paterson, N. J. plant.

He has been a member of the *Du Mont* sales force since 1947 and was the company's first regional sales manager. He established the Central States Regional Sales office in Chicago and set up the company's present distribution pattern in the Middle West.

* * *

MICHAEL D. KELLY, formerly assistant television sales manager of *The Hallicrafters Company* has been named regional television sales manager for the central region with headquarters in Chicago . . . **EDWARD FISHBEIN** is the new head of the parts sales and service division of *Emerson Radio & Phonograph Corp.* . . . *Reeves Soundcraft* has appointed **ROBERT G. KILLGORE** to the post of manager of government operations for the company . . . **DR. P. N. HAMBLETON**, formerly of the *Philco* Tube Development Laboratory has been appointed electronics engineer in charge of the Electronic Laboratory at *Superior Tube Company*, Norristown, Pa. . . . **SAUL D. LEWIS** of *Air King Products Company, Inc.* has been promoted to the post of purchasing agent . . . **O. W. PIKE**, manager of engineering for the *General Electric* Tube Divisions in Schenectady, passed away recently in that city. He was associated with *G-E* for 30 years . . . The new director of advertising and sales promotion for *Packard-Bell Co.* is **GEORGE OLIVER** . . . **WALTER R. JONES**, associate professor of electrical engineering at Cornell University, has been retained as a member of the editorial staff of *Howard W. Sams & Co., Inc.* . . . **HARRY R. SMITH** has been named head of the television transmitter development department of *Standard Electronics Corporation* . . . **E. ARTHUR HUNGERFORD, JR.** has joined the sales staff of *General Precision Laboratory* . . . The *W. H. Brady Company* of Chippewa Falls, Wis. has named **WILLIAM E. SCHNEIDER** as merchandising manager of the firm . . . **M. W. CRADDICK** is the new sales manager for *Starrett Television Corp.* in the metropolitan New York and New Jersey areas . . . **ARTHUR H. TRACY** has been named credit manager of *Quam-Nichols Co.* . . . **L. R. WANNER** has been appointed plant manager in charge of plastics operations for the Parts Division of *Sylvania Electric Products Inc.* . . . **JOE H. MORIN** was recently named sales manager of the distributors' division of *Shure Brothers, Inc.* . . . **H. E. COLLIVER** is now serving as manager of the newly-established mideastern regional office of *National Electric Products Corp.* . . . **GERALD LIGHT** has been named manager of the government contracts division of *Emerson Radio & Phonograph Corp.* . . . The *Allen B. Du Mont Laboratories, Inc.* has named **ALBERT C. ALLEN** as assistant central states regional sales manager with headquarters in Chicago . . . **JOHN L. DOONER** has joined the *Brach Manufacturing Corporation* as an antenna research engineer . . . **LOUIS J. CHATTEN**, formerly vice-president of *North American Philips Co.*, has become associated with *Olympic Radio & Television, Inc.* as merchandising consultant and contact on electronics matters with federal procurement agencies . . . **REX L. MUNGER** has been named jobber sales manager of *Permoflux Corporation* of Chicago . . . **ARTHUR E. CHAMPAGNE** has been appointed to the post of New England district sales manager for the *National Company* of Malden and Melrose, Mass. . . . **E. W. MERRIAM**, manager of the *Teleset* service control department of the *Allen B. Du Mont Laboratories, Inc.* has been named chairman of the Radio-Television Manufacturers Association's service committee.

* * *

JEROME BERGER, formerly manager of the Devices Division of *The Brach Manufacturing Corporation*, has been named assistant sales manager for all of the company's TV and electrical products.

In his new post Mr. Berger will be responsible for specialized sales engineering programs for TV manufacturers and their distributors who incorporate the company's 2, 4, and 16 set TV "Mul-Tel System" in their TV set sales campaign, and for the sale of custom and brand products. He will also act as assistant to Ira Kamen, the company's new director of TV sales, in promoting TV products to the jobber market.

Mr. Berger has been with the company eleven years and has held various posts with the organization during that time.

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Strategic Air Communications
(*Continued from page* 65)

this is no enemy decoy message, it's the real thing. He acknowledges the message and switches the intercom to "call" to pass the message to the aircraft commander.

Thousands of miles away in the operations room of the Strategic Air Force commander the line on the map showing the progress of the bomber from base toward target is now dog-legged toward the secondary target assigned to this aircraft.

The worried Intelligence Officer wrinkles his forehead and mutters, "Well, he got it; there'd have been hell to pay if he hadn't."

Yes, there'd have been hell to pay if he hadn't. These bombers pack a punch—the Sunday punch. And command has to stretch all of the way—clear to the instant of bomb release. But the message has been put through. The airborne operator has functioned more reliably than any little black-box. He had transmitted to the pilot the change in order of the strategic air commander, communicated over the ground-air radio.

Liaison Set Development

After the close of World War II the U. S. Air Force began concentrating great effort toward providing aircrews with the improved radio communications equipments which were so sorely needed.

Queries were sent out to all operational agencies asking for comments on the weaknesses of existing equipments and a statement of desires in improving radio sets. The replies seemed at first to be demanding the impossible but careful evaluation disclosed many major deficiencies in the currently standard equipments.

Of all the radio communications equipments presented for scrutiny, the liaison set provoked the greatest comment—much of which may have been interpreted as a scathing denunciation. There seemed to be little about it that was right. Although it was a substantial advance over its predecessor, it was a far cry from what could be considered the ideal set.

A recap of the criticisms revealed that they all came to focus at one point: it was not possible to train radio operators to the required degree of proficiency in the limited time available between induction and assignment to a combat aircrew. In other words, aircraft manufacturers could produce radio operator positions in heavy aircraft faster than we could man them. It was difficult enough to teach operators the Morse Code, combined Communications Procedures, radio circuit discipline, and communications security, but when he was placed in front of his liaison radio equipment, the profusion of knobs and switches proved to be just so many statistical opportunities for error.

The radio operator had already been

relieved of as many of the knob settings as was possible. The maintenance crews had set up the preset frequencies in the storage mechanisms of the ten-channel transmitter, leaving him only the task of tuning the antenna circuits, a task that accounted for frequent communications failures. His receiver was a bandswitching, "coffee-grinder tuning" equipment containing sufficient permutations and combinations of operator-error to account for additional communications failures when the requisite skills were missing.

"Give us a set," pleaded the tactical operators, "where the operator turns it on, sets the exact frequency in a window, and starts beating the key, knowing that his transmitter and receiver frequency could be used for calibrating WWV." "Make the antenna tuning automatic," echoed others, "regardless of whether he's on the fixed-wire or trailing antenna." "Let him store up at least twenty frequencies so that he can QSY within a few seconds to another assigned channel." "Take all of the knobs away from him but a channel selector and a volume control." "Make it so simple that a pilot can operate it."

Five years have gone by since the new liaison set was visualized by the operational commands and several hundred man-years have been expended in developments and monitoring activities. The needs of the two services having major interest, the USAF and the USN, have been combined in Joint Military Characteristics and each service has engaged in separate developments—all with the aim of providing a single, jointly standard liaison radio equipment. The products of these separate developments are nearing the evaluation stage—both having demonstrated that the ideals expressed by the operational commands were attainable. True, there were compromises. Neither of the developments could meet the desired weights or QSY times—and the cost of attaining some of the ideals has caused some last-minute soul-searching on the part of the operational commands.

The sets are not simple. As a criterion, let's consider the number of tubes as an index of complexity. The present USAF standard liaison radio set, AN/ARC-8, contains 23 vacuum tubes. The several developments currently assessable contain 54, 86, and 137 vacuum tubes respectively. Just how much of the automatic operation should be accepted, and how much could be given back to the intelligence of the radio operator with a net saving in circuit complexity?

Representatives of the major USAF commands were invited to observe the detailed functioning of the 137-tube development and the questions were propounded. "Here is the set you've dreamed about" they were told, "you've seen it perform in accordance with your desire of five years ago. We can save a lot of tubes and complex circuits here and there by giving some of the tasks back to the radio operator. Just which of the automatic functions do you feel that you can dispense with?"

Generals turned to confer with their specialists. Radio operators looked at each other quizzically. Engineers looked expectantly for a sign of weakness—for some indication that the operational personnel were appalled with the complexity of frequency synthesizers, were suspicious of mechanical brains, or were skeptical that the set could function under service conditions. A hand went up tentatively.

"I don't think the channel-storage function is absolutely necessary," one general observed. "As a matter of fact, I like the idea of the radio operator being 'frequency-conscious' rather than 'channel-number-conscious.'"

"We like the channel-storage feature," said a representative of another command, "most of our frequencies are firm assignments and they can all be set in."

When the comments from the USAF representation were analyzed, it became clear that no one was willing to forego any of the automatic features, that the suggestions and comments were for additional features and advances. They would like to have a flexible liaison radio set that would answer any of the requirements of the major operational commands without interfering with the ideal of interchangeability of major components. Even when the engineers made little pleas for the relaxation of certain demands, they were received coldly. The concept of a fully automatic liaison radio sat rather well with the operators in spite of the increased dependence upon tubes and integrity of circuit components.

As an innovation in the unveiling of a new development, the maintenance activities were given an opportunity to assess the impact of such a complex device upon the various echelons from the squadrons to the major repair depots. The representatives of Training Command came to the alert. Just how could a man—an ordinary man—be trained to find the source of a malfunction in such a complicated mechanism within his own lifetime?

"Maintenance of this equipment," began the speaker, "is divided up into three echelons—the organizational, the field, and the depot." As the narrative of maintenance actions unfolded, the Training Command representatives relaxed in their chairs. What had appeared as an insurmountable difficulty now was as simple as A, B, C—the equipment was designed so that it would practically maintain itself—at least, it is possible for a uniformed lad to take a simple test set and be guided unerringly to a faulty section of the transceiver. Employing a number of "go—no go" tests, the organizational mechanic would isolate a faulty removable section and replace it on the spot, placing the set back in service within the hour. The faulty chassis would be sent to the field repair shops where additional test equipment would single out the faulty sub-assembly, allowing the return of a serviceable section back to the organizational supply shelves within the day. In neither case was it necessary to heat up a soldering iron. The sub-assemblies are divided up into two categories: those capable of economical repair and those to be thrown away. The former are returned to the rear areas for depot repair. It seems at first glance that the maintenance activities have simply unloaded their problem onto the already sagging shoulders of the supply organization, however, upon arrival at a realistic level of supplies to be maintained at each echelon, the problem of "not-in-stock" disruption of maintenance operations appears surmountable.

Now that an acceptable piece of hardware appears to be within the capabilities of industry, the whole problem of liaison radio communications is in need of review. The existing developments have produced an equipment that has relieved the radio operator of certain skills that are purely apart from his basic skill of transmitting and receiving intelligence with the dots and dashes of the Morse Code. The time available for his training in these respects is still too short to provide the required degree of proficiency. In the last war, the greatest fault was poor radio discipline—radio operators were under such compulsion to get their own messages through that they transmitted out of turn and caused interference to other aircraft or ground stations by persistent calling. Code speeds were those of the slowest operator—too slow, in fact, to permit clearing the transmissions of several aircraft within a short space of time. An attempt was made to relieve congestion by permitting only the lead aircraft of a formation to transmit operational messages, screening the organizations for the most accomplished operators and assigning them to lead crews. This, of course, caused a deterioration of interest on the part of the remaining operators and they found themselves so far down in proficiency when an emergency did arise that they were unable to place the radio equipment on the air and establish communication with navigation or rescue agencies.

The success experienced in attaining our aspirations in radio transmitting and receiving equipment led us also to believe that the problems of the radio operator could be solved by employing some "visual message presentation system" for transmission and reception of the intelligence contained in a purely operational message. Numerous systems were reviewed against the stated objective of a three to six thousand mile transmission path and each was found to be considerably less than automatic. Considered were standard teletype, facsimile, telautograph, lighted "marble-board" panels, and specialized printing systems. There was one insuperable difficulty. In spite of CRPL assistance in determining optimum working frequencies, there remained propagation phenomena such as selective fading and multi-path reception, as well as a hopelessly congested high frequency spectrum. Who was to "clear" the channels needed for printing systems that can't tolerate radio interference? Who was to predict in advance of a flight the channels that could be presumed to be free of interference at various geographical points far removed from monitoring stations? When would the optimum frequencies be so cluttered with multi-path reception that teletype or facsimile would be out of the question. It seems hopeless to design a machine with the intelligence of a trained c.w. operator—a machine that can selectively "listen" to a desired signal to the exclusion of all others present and put down on paper the desired intelligence and none other.

The experience of our point-to-point communications activities was consulted for a solution. It was found that in spite of a constant transmission path, use of optimum frequencies, erection of large directive antenna arrays, employment of high power, and operation by personnel of skill and experience, there was a constant level of unpredictable and unscheduled circuit outage. Take away from the fixed communications station its constant path, its optimum frequency, its efficient antenna system, its high power, and experienced maintenance attendants and you have the equivalent of an airborne communications terminal. It can be seen that the probabilities of an aircraft, say, at three thousand miles from its ground station, making an initial unscheduled contact employing radioteletype or facsimile is remote indeed. Consequently, for the time being until a suitable system comes along, we are still considering c.w. as the primary emission from the liaison radio equipment. Secondarily, for certain specialized applications, it appears that teletype and facsimile show promise, however, for ranges up to six thousand miles, nothing is in sight that can compete with manual radiotelegraphy that is adaptable to the airborne radio installation.

As a result of this conclusion, attention was redirected toward the development liaison radio set with the aim of tightening up the c.w. features and reviewing its capabilities for this method of communication. The transmitter was found to be at the highest state of development as a radiotelegraph set, having the capabilities of a secondary frequency standard in accuracy and stability. With the aid of automatic antenna tuning systems, it could deliver the maximum amount of available power to the antenna, whether fixed wire, wing-cap, or trailing wire. The emission was pure c.w. with no spurious components or frequency modulation. A study of the receiver showed room for improvement. In the initial form it was—in accordance with the military characteristics—a simple, straightforward receiver (embodying refinements, of course) using the usual beat-frequency oscillator "C.W.-Tone" control. The frequency accuracy was the same as the transmitter (being slaved to the same synthesizer) but the normal passband placed a lot of emphasis upon the skill of the radio operator in reading his desired signal through interference. It appeared that some improvement could be made in the rejection of unwanted signals by inserting the narrowest possible passband in the receiver output, permitting the radio operator to slice away on interfering signal even though it was only 500 cycles removed from the desired signal. The "C.W.-Tone" control then became the "Fine-Tune" control, allowing the radio operator some latitude in netting with stations that haven't the frequency accuracy or stability of the liaison set. Fortunately, the "C.W.-Slot" idea of adjacent channel rejectivity was attained without adding a single extra control, thus staying within the basic philosophy of a minimum of knobs and switches.

Considering the liaison set for c.w. communications, certain features begin to take on importance—features that are available for the first time in military communications history. The first, that of frequency stability and accuracy, permits an altogether new concept in netting a number of scattered airborne communications terminals with a group of ground stations on the same frequency. In the first place, there is no possibility of off-frequency operation—a contingency that has plagued us from the beginning—and a listening station employing a receiver of the same accuracy and stability as the airborne liaison set can receive transmissions from any number of aircraft without necessity of making readjustments in tuning to accommodate variations in frequency from one aircraft to another. All aircraft on a given frequency will practically "zero-beat" with one another. This will require radio discipline of a higher order than ever achieved previously since the ground operator will no longer be able to separate two interfering signals by taking advantage of slight frequency inaccuracies between two aircraft calling at the same time. The signals will be inseparable and both will be unreadable. On the credit side of the ledger is the fact that no longer can there be a missed contact caused by an airborne liaison set being off-frequency just enough to fall outside of the passband of the monitoring station receiver. He will be heard in exactly the same tuning position as all previous aircraft on the same channel. As a corollary, of course, ground station receiving equipment must have tuning accuracy and stability adequate to long channel guards on a given frequency without drift or inaccurate setting. Since the airborne liaison radio receiver will have a "broad" position for monitoring and a "fine tune" range of about plus or minus three kilocycles for any given channel setting, netability with existing ground transmitting equipment is assured even when using the narrow "C.W.-Slot."

There will be no further necessity for long call-ups or tuning transmissions with this degree of frequency accuracy nor any necessity of making constant fine adjustments because of receiver oscillator drift. The radio operator will be freed of any adjustments to transmitter or receiver other than selecting a frequency, putting the desired signal in the "slot," and adjusting the volume to a comfortable level. It is altogether conceivable that he will never see any part of the transceiver or antenna—all of his operations being conducted from a control box no larger than a folded pocket-handkerchief.

Until the sets are out of development it is not possible to reveal more of the details, but the feeling is shared in all quarters that the substantial advances in liaison set communications have been attained at a respectable cost and will soon be released to the field.

We used to say that "communications is a function of command." Now we may well say: "Communications *is* command."

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RADIO & TELEVISION NEWS

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INDUSTRY

MILITARY

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TEST EQUIPMENT

—30—

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SNIPERSCOPE & Snooperscopes wanted. Any type, any condition. Needed immediately. Box 495, % Radio & Television News, 185 N. Wabash Ave., Chicago 1, Ill.

WANTED: APR-4 receiver and tuning units. State condition and price. W2DB, 274 Boulevard, Scarsdale, N. Y.

AN/APR-4, other "APR-" Receivers; "ARC-," "TS-," "IE-" Equipment; R-89/ARN-5, ARR-5, ARR-7, ART-13, Ferris, Boonton, G-R Test Equipment, etc. Describe, price in first letter. Littell, Farhills, Box 26, Dayton 9, Ohio.

WANTED, BC-312, BC-342 and BC-348 Receivers. Good used or new surplus. SCR-284 complete, original packing. Advise, stating price, condition, any modification made. G. & M. Equipment Co., Inc., 7315 Varna Ave., No. Hollywood, Calif.

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G. E. CARNEY, Business Manager.

Sworn to and subscribed before me this 27th day of September, 1950.

[SEAL] Bernice Batkin Fusch, Notary Public.
(My commission expires November 4, 1953.)

INDEX OF Advertisers

DEC. 1950

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

TV Antenna Survey

(Continued from page 34)

gain. Both antennas are characterized by high gain and narrow bandwidth. The bandwidth is so narrow that it is just sufficient to cover a single channel in some cases. Because of the sharp radiation pattern, installation is quite critical but a gain of 9 db. can be obtained in the proper direction for any channel in the TV band.

(B) Square Corner Reflector. Another type of high gain antenna is the square corner reflector which acts as a mirror to the signal energy, catching the signal and reflecting it back to the dipole. This antenna is available for high frequency stations only and is cut for a particular frequency. (A low frequency reflector would be prohibitively large.)

This antenna has a gain of approximately 9 db. and a beamwidth of only 25 degrees (sharper than a yagi of equal complexity) and a front-to-back ratio of 20 db.

Conclusion

The author has tried to cover the important features of many of the popular antennas on the market today. The important characteristics of these antennas are summarized in Table 2. Grateful acknowledgement for data supplied is made to the following manufacturers: *Technical Appliance Corp., Ward Products Corp., American Phenolic Corp., Telrex, Shore Engineering, Dielectric Products Co., and Channel Chief Co.* —30—

FIBER FUSE PULLER

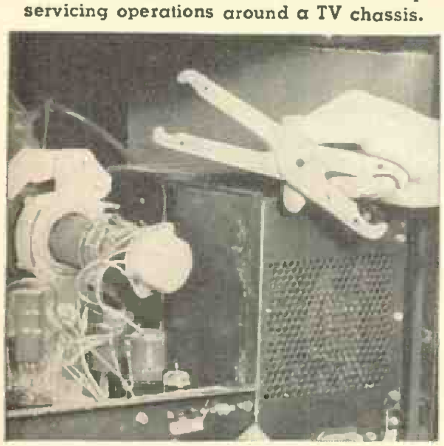
By H. LEEPER

A handy tool for television servicing can be adapted from an ordinary fiber fuse puller.

This versatile, seven-inch unit can be used as a tool for removing small tubes and performing other operations around a television chassis.

Because the tool is made of fiber, it is light in weight and is less likely to damage the picture tube should it be dropped or accidentally brought in contact with the cathode-ray tube. —30—

A fiber fuse puller can be used for many servicing operations around a TV chassis.



"TAB" YEAR-END SALE!

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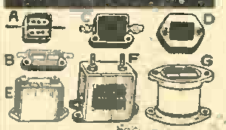

Brand NEW Made to Rigid Gov't Specs.

Fig. A. Postage & ½ Postage (*Silver Mica)

Mfd	Each	Mfd	Each
.000015*	$0.14	.0011*	$0.24
.00002	.07	.0012*	.19
.000022	.07	.002	.12
.000024*	.14	.00224*	.23
.000025*	.14	.0025	.12
.00004	.07	.003	.14
.00005*	.14	.003/1KV	.25
.000082	.07	.0033*	.29
.0001	.07	.004	.18
.0001*	.14	.004*	.36
.0003	.07	.005	.19
.001*	.14	.008	.19
.0011	.07	.01	.23

Fig. B. .001 mf, 8c; .006 mf, 19c; .01 mf ... .29c

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd	Each	Mfd	Each
600 WV		600 WV	
.0001	$0.24	.02	$0.65
.001	.35	.03	.98
.002	.37	1200 WV	
.003	.41	.002	$0.55
.004	.43	.004	.57
.005	.45	.005	.59
.006	.49	.01	.65
.008	.53	2500 WV	
.01	.55	.00047	$0.49

Fig. D. Screw Term & Mtg

Mfd	Each	Mfd	Each
600 WV		1200 WV	
.0001	$0.24	.01	$0.65
.00055	.31	.013	.75
.00085	.35	.03	1.59
.0012	.37	.033	1.98
.003	.41	2500 WV	
.005	.45	.0004	$0.49
.015	.59	.00082	.55
.02	.65	.002	.89
.03	.98	.0022	.89
.033	1.09	.0035	.98
.039	1.69	.0036	.98
.04	1.75	.0043	1.09
.05	1.98	.005	1.19
1200 WV		.006	1.29
.001	$0.51	.01	1.59
.002	.55	.015	1.79
.0051	.59	3000 WV	
.0068	.63	.005	$1.39

Fig. E. Upright Xmtg Micas

Mfd	Each	Mfd	Each
250 VDC		3000 VDC	
.05	$0.39	.005	$1.35
.2	.59	.008	1.49
1500 VDC		3500 VDC	
.04	$0.75	.000033	$0.65
.05	.90	5000 VDC	
2000 VDC		.000051	$0.75
.003	$0.90	.000082	1.35
.005	.98	.0001	1.49
.006	1.05	.00015	1.89
.01	1.19	.00018	1.98
.015	1.39	.0002	2.09
.02	1.69	.0003	2.29
.03	1.98	.00043	2.35
2500 VDC		.0006	2.98
.0025	$0.90	.001	3.29
.006	1.35	.005	3.69
3000 VDC		.01	3.98
.00005	$0.65	6000 VDC	
.0001	.90	.0006	$3.49
.0003	.95	.001	3.69
.0007	.98	.002	3.98
.0055	1.19		

Fig. F. Heavy Duty, Upright, Bklte Csd

Mfd	KV	Each	Mfd	KV	Each
.006	5	$2.49	.0003	8	$3.49
.01	5	9.95	.0025	8	4.75
.003	6	4.75			

Fig. G. HIGH CURRENT MICAS

MFD.	KV	AMPS.	MC	EACH
.04	1	25	1	$ 6.98
.09	1.5	40	1	11.95
.02	3	22	1	12.98
.02	3	60	1	23.50
.0006	5	7	1	4.98
.005	5	20	3	6.49
.01	5	20	1	6.98
.0001	6	3	3	3.98
.00015	6	4	3	4.29
.0002	6	5	3	4.49
.00025	6	6	3	4.69
.0004	6	6	3	4.98
.0006	6	8	3	5.49
.00075	6	8.5	3	5.69
.003	8	20	3	7.29
.0001	10	6	3	4.98
.00035	10	8	3	5.29
.0004	10	8.5	3	5.69
.005	10	30	1	21.95
.0015	10	14.5	3	7.49
.02	10	60	1	29.95
.00005	20	4.5	3	4.98
.00009	20	6	3	5.69
.0002	20	8	3	6.49
.000375	20	12	3	8.49
.0004	20	12	3	8.98
.003	20	24	3	29.95
.006	20	35	1	34.95
.0015	25	22	3	31.50
.0005	25	13	3	27.50

25000 VDC CNDSR, .012 MFD C-D Type BT14, 15" long. NEW ... $4.98

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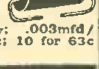

.1mfd/150wv; .05mfd/400wv; .003mfd/600wv. Each ... 7c; 10 for 63c

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1 mfd.	29c	.5 mfd.	35c
2 mfd.	39c	2x.25 mfd.	29c
4 mfd.	67c	3x.05 mfd.	25c
6 mfd.	89c	3x.22 mfd.	29c
8 mfd.	99c	1000 WVDC	
2x.1 mfd.	29c	.1 mfd.	45c
3x.1 mfd.	36c	.25 mfd.	63c

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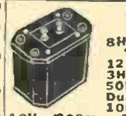

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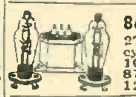

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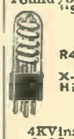

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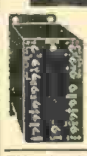

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3EP1	2.45	5LP1	11.89
3FP7	1.60	5MP1	4.75
3GP1	4.89	5NP1	3.98
3HP7	2.85	7BP7	4.65
3HP14	14.98	7CP1	12.95
3JP1	15.00	9LP7	10.98
4AP10	4.39	12DP7	12.45
5AP1	3.59	12GP7	12.70
5BP1	2.25	905	2.45
5BP4	4.50	910/3AP1	4.63

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OC3/VR105	1.03	6AB4*	2.00	6SD7GT	1.29	12BE6*	1.80	45S/VT52	.22
OD3/VR150	.85	6AB5/6N5	1.33	6SF5	.93	12BF6*	.85	45Z5	.90
OY4	2.53	6AB7/1853	1.42	6SF7	.98	12BH7*	2.40	46	.99
OZ4	.86	6AC5GT	1.29	6SG7*	2.00	12C8	1.39	47	.89
1A3	1.10	6AC7*	2.90	6SH7GT*	2.00	12F5	.90	49	.89
1A6	1.78	6AD5	1.19	6SJ7*	1.65	12H6*	1.80	50	1.35
1B3/8016	2.65	6AD7	1.60	6SK7GT*	1.80	12J5GT*	.75	50A5	1.35
1B4P	.98	6AF5G	.89	6SL7GT*	1.25	12J7GT	1.00	50B5*	1.80
1B5/25S	.98	6AF6G	1.33	6SN7GT*	2.20	12K7GT	.98	50C5	1.03
1C6	.89	6AG5*	2.65	6SQ7GT*	1.50	12K8	1.07	50C6*	1.49
1C7G	.98	6AG7*	2.88	6SR7*	1.80	12L8GT	1.59	50L6GT*	1.65
1D5GP	.98	6AH6*	3.90	6SS7	.90	12Q7GT	.90	50X6	1.10
1D8GT	.98	6AJ5	1.45	6ST7	1.33	12S8GT	.98	50Y6GT	.90
1E5GP	.98	6AK5*	3.90	6SU7GTY	3.37	12SA7GT*	1.05	50Y7GT	.99
1F4	.79	6AK6*	2.40	6SV7	1.45	12SC7	1.10	53	1.33
1F5G	.98	6AL5*	2.00	6SZ7	1.05	12SF5GT	.79	56	.85
1G5G	.98	6AL7GT*	2.65	6T7G	1.24	12SF7GT	.79	57	.89
1H4G	.98	6AN5*	6.00	6T8*	2.90	12SG7	.89	58	.89
1H5G	.87	6AQ5*	2.00	6U4GT*	1.25	12SH7	1.10	59	1.78
1J6G	.98	6AQ6	.89	6U5/6G5*	1.05	12SJ7GT	.89	70L7GT	1.95
1L4	.98	6AQ7GT	1.23	6U6GT*	1.05	12SK7*	1.80	71	1.00
1LA4	1.33	6AR5*	1.65	6U7G	.90	12SL7GT	1.07	72	.95
1LA6	1.33	6AR6	1.98	6V6GT*	2.00	12SN7GT*	2.20	73	1.67
1LB4	1.33	6AS5*	2.00	6V7G	1.18	12SQ7GT*	1.50	75	.83
1LC5	1.33	6AS6	1.89	6W4GT*	1.80	12SR7	.98	76	.83
1LC6	1.33	6AS7G*	6.75	6W7G	1.33	12X3	.90	77	.83
1LD5	.98	6AT6*	1.50	6X4*	1.50	12Z3	.98	78	.83
1LE3	1.33	6AU5GT*	2.65	6X5GT*	1.50	14A4	1.29	79	.89
1LG5	1.41	6AU6*	2.00	6Y5	1.85	14A7/12B7	1.08	80	1.19
1LH4	1.33	6AV5GT*	2.65	6Y6G*	1.25	14AF7/XXD	1.18	81	1.95
1LN5	.98	6AV6*	1.50	6Z5/12Z5	1.18	14B6	1.08	82	1.29
1N5GT	.98	6AW6*	2.65	6Z7G	.98	14B8	1.10	83	1.29
1P5GT	.98	6AX5GT*	1.35	6ZY5G	.98	14C5	1.29	83V	1.39
1Q5GT	.98	6B4G	1.54	7A4/XXL	.98	14C7	1.20	84/6Z4	.95
1R4/1294	.98	6B5	1.54	7A5*	1.10	14E6	1.10	85	1.10
1R5	1.00	6B6G	.98	7A6*	.90	14E7	1.33	89	.79
1S4	1.20	6B7	1.39	7A7*	1.62	14F7	1.10	VR92	.25
1S5	.95	6B8G	1.39	7A8	.90	14F8*	1.33	117L7*	1.95
1T4	1.05	6BA4	1.08	7AD7*	2.39	14H7*	1.20	117N7GT	1.95
1T5GT	1.33	6BA6*	1.80	7AF7*	.95	14J7	1.33	117P7GT	1.95
1U4/5910	.98	6BA7*	1.20	7AG7*	1.15	14N7	1.33	117Z3	.79
1U5	.95	6BC5*	2.00	7AH7*	1.16	14Q7	1.10	117Z4GT	1.45
1V	.98	6BD6*	2.00	7B4*	1.80	14R7	1.29	117Z6GT	1.20
1V2	.70	6BE6*	1.80	7B5*	1.80	14S7	1.33	117Z7GT	1.49
1X2*	2.65	6BF6*	1.49	7B6*	1.80	14W7	1.33	211/VT4C	.45
1Z2*	3.98	6BG6G*	2.25	7B7	.90	14X7	1.33	WE215A	.15
2A3	1.29	6BH6*	2.00	7B8	.90	14Y4	1.20	316A	.69
2A4G	1.20	6BJ6*	2.00	7C4/1203A	.89	19	.69	601B	.19
2A5	.89	6BQ6GT	3.20	7C5*	.89	19BG6G*	6.00	HY615	.18
2A6	.89	6C4	1.67	7C6*	1.62	19J6*	3.20	801A	.29
2A7	.89	6C5GT	.83	7C7	.95	19T8*	2.90	807	2.39
2B4	2.98	6C7	1.26	7E5/1201	1.25	20	1.17	829	6.48
2B7	.98	6C8G	.98	7E6	1.10	22	.99	832	7.98
2C26	.25	6CB6*	2.00	7E7	1.60	25A6	1.20	843	.39
2C34/RK34	.30	6CD6G*	6.00	7F7*	1.05	25AC5GT	1.95	864	.29
2D21	1.15	6D6	.89	7F8*	2.65	25BQ6GT*	3.20	866A	1.10
2E5	1.16	6D8	.98	7G7/1232	1.33	25C6	1.18	866Jr	1.15
2V3G	1.29	6E5	1.10	7H7*	2.00	25L6GT	.87	872A	1.29
2X2	.49	6F5	.83	7J7	1.33	25W4GT*	2.00	874	.35
3A4	.69	6F6GT*	.85	7K7	1.33	25Y5	1.45	954	.25
3A5	1.25	6F7	1.39	7L7	1.33	25Z5	.87	955	.49
3A8GT	1.90	6F8G*	1.49	7N7*	2.65	25Z6GT	1.50	956	.39
3B4	2.69	6G6G	.98	7Q7*	.95	26	.70	957	.39
3B5	.98	6H6*	.85	7R7*	1.16	27	.75	958	.39
3B7/1291	.69	6J4*	6.98	7S7	1.33	28D7	1.39	991	.25
3C6/XXB	1.60	6J5GT*	1.50	7T7	1.03	30*	.89	1613/6F6X	1.06
3D6/1299	.69	6J6*	2.90	7V7	1.33	31	.59	1616	.75
3E29	12.85	6J7*	1.80	7W7*	2.65	32	.59	1619	.29
3LF4	1.33	6K5GT	1.16	7X7/XXFM	1.33	32L7GT	1.09	1625	.49
3Q4	.98	6K6GT*	1.65	7Y4*	.90	33	.69	1626	.49
3Q5GT	1.15	6K7	.75	7Z4*	.95	34	.69	1629	.39
3S4	.99	6K8	1.07	10Y	.29	35/51	1.00	1632	.77
3V4	.99	6L5G	.98	12A6*	.98	35A5	.95	1633	.75
5R4GY	1.50	6L6G*	1.98	12A7	1.49	35B5*	2.00	1634	.77
5T4*	1.72	6L7	.98	12A8GT	1.00	35C5*	2.00	2050	1.80
5U4G*	1.65	6N4	2.39	12AH7GT	1.33	35L6GT*	1.65	2051	.89
5V4G*	2.40	6N6G	1.95	12AL5*	2.00	35W4*	1.25	9001	.98
5W4	.83	6N7GT	1.26	12AT6*	1.50	35Z3	.90	9002	.98
5X4G	.90	6P5GT*	1.26	12AT7*	2.90	35Z4GT	.75	9003	.98
5Y3GT*	1.25	6Q7	.89	12AU6*	2.00	35Z5GT*	1.50	9004	.79
5Y4G	.75	6R7	.98	12AU7*	2.40	REL36/6J4	.50	9006	.27
5Z3	.98	6R8	1.39	12AV6*	1.50	36	.69	Tubes Gtd Exc.	
5Z4	1.18	6S4*	1.80	12AV7*	3.20	37	.69	Open Fil & Break-	
6A3	1.39	6S7	1.29	12AW6*	2.65	38	.69	age. Shipped	
6A4	1.60	6S8GT*	2.65	12AX7*	2.40	39/44	.69	R'Exp Only.	

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