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PF Reporter, Nov., 1960, page 65 . . .
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Electronics World, Jan., 1961, page 103 . . .
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ORegon 9-7200

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ADVANCES IN MEDICAL ELECTRONICS
Here are some of the unusual ways in which electronics is being teamed with medicine in order to give us a better understanding of life processes.

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This method has advantages of lower cost, reduced power requirements, and freedom from room acoustics problems. A complete directory of available headphones with prices and specifications is included.

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Circuits and techniques for holding and transferring binary information and for performing basic mathematical operations.

INDUSTRIAL X-RAY APPARATUS
Many tests on materials can be made in no other way or no better way than by radiographic examination. The variety of methods and equipment are covered, along with details on how such equipment works.

IMPEDANCE MATCHING IN P.A. SYSTEMS
The concluding article in this series covers the constant-voltage method of matching—simple arithmetic is all that is needed to do the job.

STANDING-WAVE INDICATOR FOR CB TESTING
Design of a compact antenna-matching bridge for most efficient power transfer. The circuit requires a minimum number of parts.

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In order to insure top performance from a tape recorder the oscillator circuit must operate at peak efficiency. Here is how to check and adjust it.

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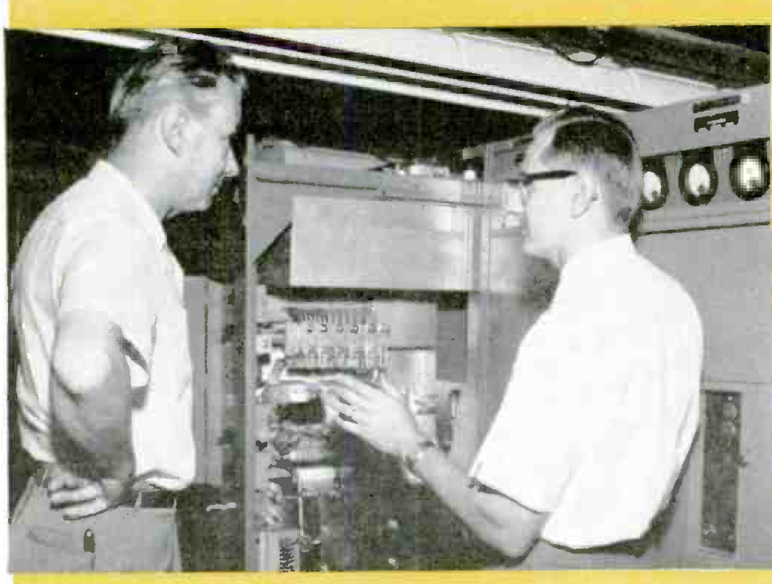

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. . . for the Record

By **W. A. STOCKLIN**
Editor

THE ELECTRONICS "TECHNICIAN"

An important fact—one that many of our present readers are not fully aware of—is that this publication has directed its efforts to the electronics technician ever since its founding in 1919. Over the years the industry has, of course, changed and so have the qualifications of the technician. Back in 1919, the electronics industry was confined to amateur radio activities.

From that point we moved rapidly through the hobby stage, to AM radio, FM radio, and television. Directly after World War II, the largest group of electronics technicians was working in servicing consumer products. To this day, this facet of the industry involves an impressive number of technicians and will continue to be an important segment of our readership.

Within the past few years the industry has shown signs of change and, in essence, has grown up. All of this can be attributed to military, government, missile, and industrial activities. This, for the most part, is history. Looking ahead, we foresee another stage. It is the period of "automation" when equipment controlled by "electronic brains" will perform many functions which are today handled manually. The technician will not be replaced but will, in fact, gain in stature. Technicians will be needed to operate and maintain this equipment and, in many cases, will serve as supporting personnel for original design engineers.

We know the industry, but who can actually define today's "technician"? Within the past year or two, dozens of surveys, statistical compilations, and various studies have been made of this group. Some of the reports have thrown a little light on the problem but, in essence, most of the material obtained has been so broad in nature that very little of it can be applied directly to the electronics industry.

We do know that there are about 125,000 full- and part-time servicemen maintaining consumer products and that there are approximately 100,000-125,000 electronics engineers and scientists. There are, in all, about 400,000 to 500,000 electronics technicians, not including military personnel. This is an impressive figure, and yet we know that there are not enough technicians.

Part of the responsibility of any publication is to eliminate confusion within the industry it serves. With this thought in mind, we propose to define and subdivide "technicians" as follows:

1. "Design Technician"—the man who works with the engineering department developing new designs and building prototypes.

2. "Service Technician"—the man who services or maintains electronic equipment in both the consumer and industrial areas.

3. "Operation Technician"—as the name implies, the man who operates electronic equipment.

In all cases, we would automatically eliminate any individual who lacks a basic, fundamental knowledge of electronic theory. A "technician" should have at least two years of technical training beyond high-school level, or have the equivalent amount of technical experience, and should be capable of reading circuit diagrams. This eliminates, for the most part, draftsmen, equipment operators who only know which buttons to push, and line testers who perform the same function day in and day out. There are, of course, cases where the job requires actual knowledge of electronic theory. Such men could then be granted the title of "technician" in recognition of their higher status.

We have used the word "technician" throughout this editorial, well aware of the fact that this term is frowned upon in some quarters. We agree that this word may not have as much prestige as it should have because of careless misapplication—but what other title more clearly identifies the technically trained professional we have been discussing?

We do know that with a number of companies "technician" is a clearly defined job category involving certain specific qualifications. In other companies the titles "Associate Engineer," "Assistant Engineer," and "Lab Assistant" are bestowed freely—adding to the general confusion. Obviously, being human, we all enjoy an impressive job title. However, we don't feel that it is fair to infringe on an engineering title without the degree and experience to back it up. In some instances an impressive title without the prestige and prerogatives is a disadvantage since it may involve a straight salary and deprive the technician of overtime pay.

We have given considerable thought to the task of coining a new title to replace the word "technician," but with little success.

Our goal, of course, is to eliminate confusion and increase the prestige of the technicians in our industry. Unlike Shakespeare who asked "What's in a name?" . . . we want the word "technician" to be specific and meaningful. As mentioned before, the points we have covered here are suggestions on our part. Needless to say, we will welcome your ideas—pro or con—on this important subject. ▲

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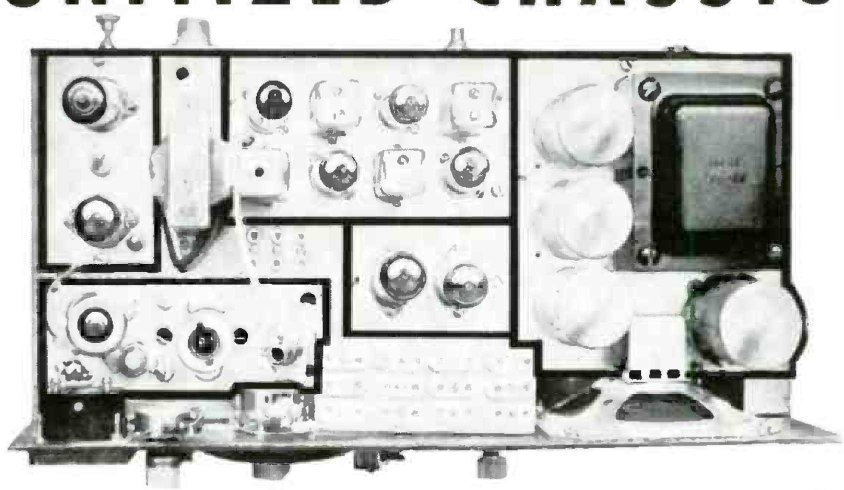

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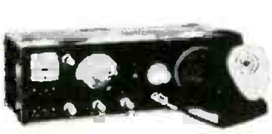

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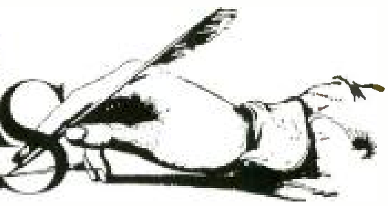

FROM OUR READERS

"DYNATUNER" LAB REPORT

To the Editors:

We would like to clarify a point or two in your excellent report on the "Dynatuner" in the September ELECTRONICS WORLD.

The circuit referred to as "a wide-band balanced ratio detector" is actually a wide-band *discriminator* design, although it bears superficial resemblance to a ratio detector. There is no electrolytic capacitor across the output (a characteristic of the ratio detector) although the balanced bridge discriminator does invert the diodes. There is no change of output level with signal strength, which is true of the ratio detector. In fact, the "volume sensitivity" of the "Dynatuner" is infinite.

We were quite surprised at the drift figure obtained in your measurements, as it is outside our acceptable tolerances, and may be the result of a defective component which slipped by. While this amount of drift may not be noticeable to the user, it is still more than the design intends.

ROBERT H. TUCKER
Dynaco, Inc.
Philadelphia, Penna.

We are glad to set the record straight concerning the detector circuit used in the tuner.—Editors.

* * *

FREE ESTIMATES

To the Editors:

First, let me congratulate you on the fine coverage you have given recently to the sticky problem of "free estimates." As a former TV technician and independent businessman I understand only too well the unrewarding and often costly policy of giving the customer something for nothing. Our free economy cannot operate successfully with such a policy; and no segment of that economy can long defy the simple logic of getting paid for services rendered.

Mr. Frye's approach to the problem is forthright and honest. But it can't succeed. "Free Estimates," as a slogan, has been too long identified with all types of repair services to be successfully bucked by the independent TV shop operator. Charging for estimates will not make the cash register tinkle a happy tune; instead, it will tend to make that cash box into a repository for lead nickels and tin quarters.

On the other hand, Mr. Marsh's solution is fine, as far as it goes. The trouble here is that it doesn't go far enough! The real solution is simple. Quote the customer a real healthy figure based on your past encounters with the equipment in question, and on the readily observable symptoms. When the job is completed give him a square count in figuring up the bill. In most instances that bill will be anywhere from 30 to 50 per-cent lower than the estimate. This kind of treatment cannot help but put grins on the faces of your customers, and enlist their active participation in advertising your integrity.

H. M. LAYDEN
Bronx, New York

Two different ways of handling "free estimates" were covered in a recent "Mac's Service Shop" by John Frye, and in the article "Practical Repair Estimates" by Allan Marsh, both in our May issue. The above comments on free estimates together with Reader Layden's solution to the problem are quite interesting. However, he may simply have proved once more that there is no "real" solution. What happens to the customer who is driven away by a boosted estimate into the arms of a competitor who has given a deliberate under-estimate?

The customer may be quite unhappy when he gets a bigger bill than he expected, but the service technician will have lost the job.—Editors.

* * *

IMPROVING THE WILLIAMSON AMPLIFIER

To the Editors:

Talbot M. Wright's "Improving the Williamson Amplifier" in your June issue is an interesting and informative article. However, Mr. Wright isn't discussing what he says he is.

Mr. Wright apparently holds the opinion that virtually any amplifier employing feedback from the output transformer secondary to the input tube cathode is a "Williamson." But *the* Williamson amplifier, as designed by D. T. N. Williamson, differs significantly from the hybrid of Mr. Wright's article.

Much of Mr. Wright's discussion, for example, concerns the "capacitor bypassing the cathode resistor of the output stage," although there is no such component in the true Williamson. In fact, Williamson deliberately avoided the use of a bypass capacitor here. As he states in one of his *Wireless World* articles, the "common unbypassed cathode bias resistor . . . assists in preserving the balance of the stage under dynamic conditions." And he adds that such a capacitor, if used, would introduce still another source of phase shift and possible instability, a matter Williamson took great care to avoid.

Another author, Robert M. Mitchell, in discussing "The Effect of the Cathode Capacitor on Push-Pull Output Stages" (*Audio*, November, 1955), found this capacitor served no useful purpose with class A outputs, but "in the case of a class AB amplifier, the bypass capacitor

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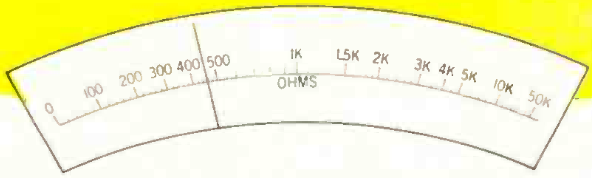

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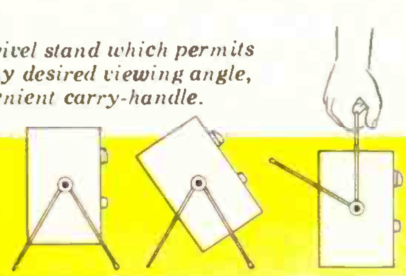

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is absolutely necessary if the amplifier is to perform within the modern limits of high fidelity performance." This statement leads to another criticism of Mr. Wright, who notes that "any 'Ultra-Linear'-type Williamson . . . will display a drop in "B+" during extremely loud passages." But *the* Williamson uses triodes, not Ultra-Linear tetrodes, and in view of statements published in *Wireless World,* Williamson does not favor the Ultra-Linear connection. The damping factor of *the* Williamson, for example, is 30, a factor any "redesigner" would be hard put to approach with Ultra-Linear circuitry. Further, the output stage of *the* Williamson operates in class A, not class AB. In fact, Williamson pointed out some of the problems inherent in class-AB stages in his original (1947) article.

All in all, Mr. Wright seems to be discussing various revamped versions of Williamson's original circuit, rather than that circuit itself. In justice to Williamson and his renowned amplifier, might I ask whether Mr. Wright is also of the opinion that all that glitters is gold?

RICHARD A. FLANAGAN
New York, New York

Strictly speaking, Reader Flanagan is correct. A better though longer title for the article might have been, "Improving the Ultra-Linear-Type Version of an Amplifier that was Based on the Original Williamson Design." The article's first sentence does tie down a little more closely than does the title just what circuit is being discussed.—Editors.

* * *

BC-221 TUBE REPLACEMENT

To the Editors:

I question the statement made in the article "Using the BC-221 To Check CB Frequency" (May issue) on replacing the 6SJ7 tubes with *RCA* Special Red ones. The audio output tube would present no problem, but the v.f.o. tube I think would be quite another thing. It would seem to me that the difference in tube interelectrode capacity would throw your dial calibration off with the book.

Having to replace this tube due to burn-out has worried me ever since I got the 221 and is one reason why I have not left my unit on all the time.

PAUL S. ANDREWS
Rotterdam, New York

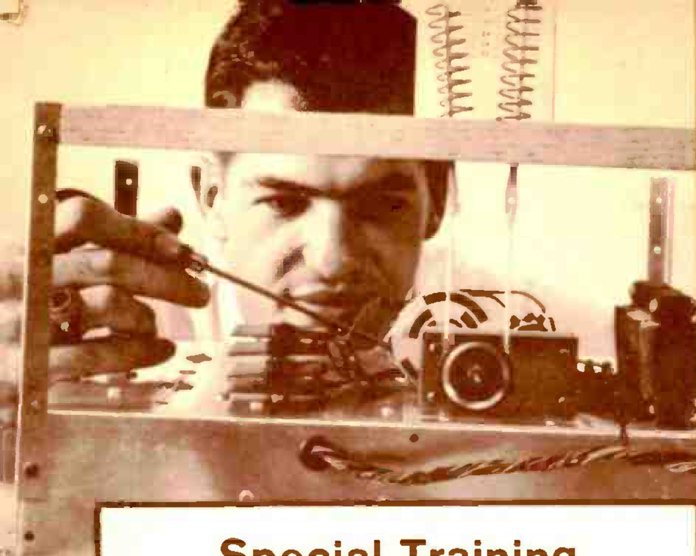
Here are Author Conhaim's interesting comments on this question.—Editors.

* * *

Dear Mr. Andrews:

I can understand your concern about replacing the 6SJ7 tube in the BC-221 with the *RCA* Special Red 5693. However, in actual practice, I found no difference in the operation of the BC-221. In checking the *RCA* Tube Handbook, you will find that there is only a very slight difference in the interelectrode capacitances of these two tubes. The input capacitance for the 5693 is listed as 4.8 $\mu\mu$f. minimum to 5.8 $\mu\mu$f. maximum, while the 6SJ7 input capacitance

(*Continued on page 16*)



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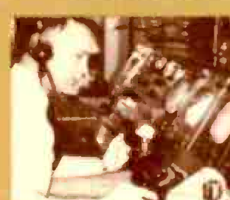

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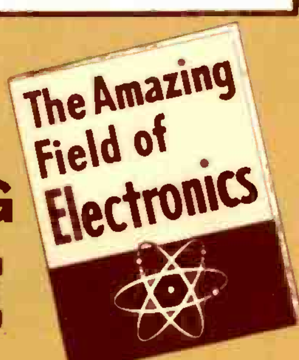

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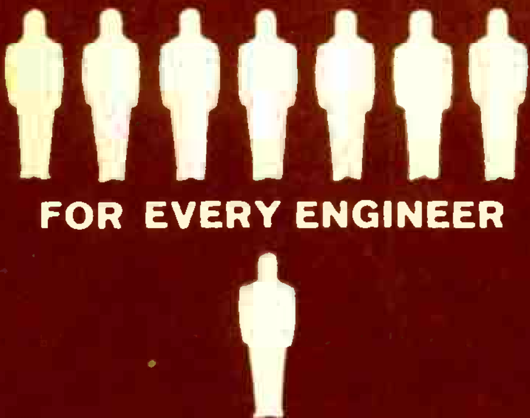

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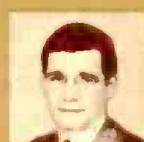
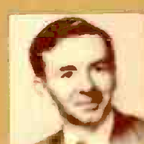
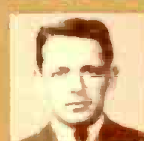


"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., Cayuga, N. Y., says of his position with The G. E. Advanced Electronic Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."



BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."



"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."

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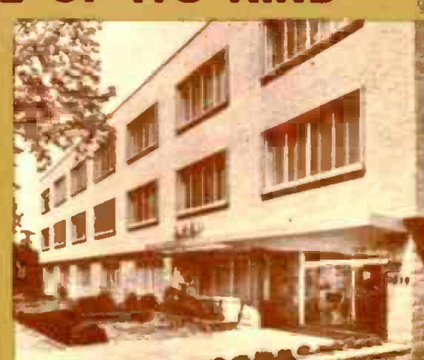

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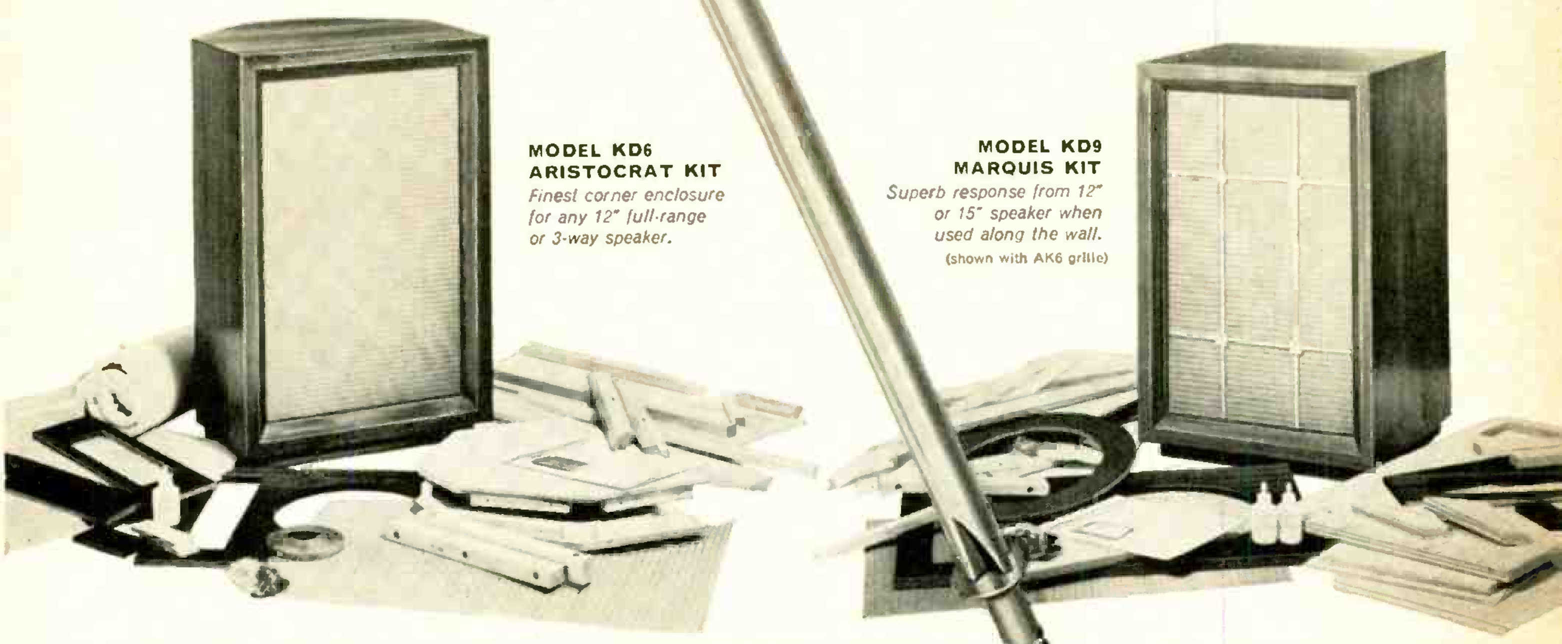

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ELECTRO-VOICE, INC., *Consumer Products Division, Buchanan, Michigan* is listed as nominally 6 $\mu\mu$f. Output capacitance for the 5693 is given as 5.6 $\mu\mu$f. minimum to 6.8 $\mu\mu$f. maximum and the 6SJ7 is listed as nominally 7 $\mu\mu$f. As you can appreciate, there will be some variation from tube to tube in the 6SJ7, although the variability is not shown in the tube handbook. According to the BC-221 tech manual, tubes can be replaced without need for recalibration, so that the variation in the interelectrode capacitances apparently will not affect operation. In practice, I found this to be so.

Incidentally, the tube used in the v.f.o. is normally a 6SJ7Y, the "Y" indicating a special low-loss base. This tube is still being manufactured by *RCA*. Our local *RCA* distributor ordered 6 of these tubes for me and had no difficulty getting them.

Concerning your remarks about leaving the BC-221 turned on at all times, we feel, as do many tube engineers, that tubes last longer under such conditions than under on-off usage. Apparently, many on-off cycles are harder on the heaters of tubes than leaving them on at all times. My BC-221 has been operating more than a year, left on at all times. So far, I have replaced only a 5Y3 in the power supply because of a badly cracked base.

R. L. CONHAIM
Dayton, Ohio

* * *

SPEAKER CONE TREATMENT

To the Editors:

Here's another suggestion about treating the edge of speaker cones to make them more compliant. Try some castor oil that has been thinned with acetone. This combination applied to the cone edge will work just as well as glycerine and is less hygroscopic.

CHARLES F. WEHER
University of Notre Dame
Notre Dame, Indiana

Still another suggestion that we have received recently came from a manufacturer of self-lubricating contact cleaners. This manufacturer claimed that if his slightly oily product were sprayed on the edge of the speaker cone, it would soften it up and lower its resonant frequency somewhat. We would not want to try any of these treatments on high-quality speakers, however, since it may do more harm than good.—Editors.

* * *

COMPACT HI-FI AMPLIFIER

To the Editors:

In the circuit diagram of the 6-watt amplifier ("Compact Hi-Fi Power Amplifier") in your June issue, you show the cathode connections for the 6BQ5's as pins 1 and 3. In tubes made by some manufacturers, pin 1 is an internal connection that is tied to the control grid (pin 2), therefore only pin 3 should be used for the cathode. Incidentally, I have built two of these units and am very pleased with their performance.

JOHN ROGERS
Harrison, N. J.

Reader Rogers is quite right. Those planning to build the amplifier please take notice.—Editors. ▲

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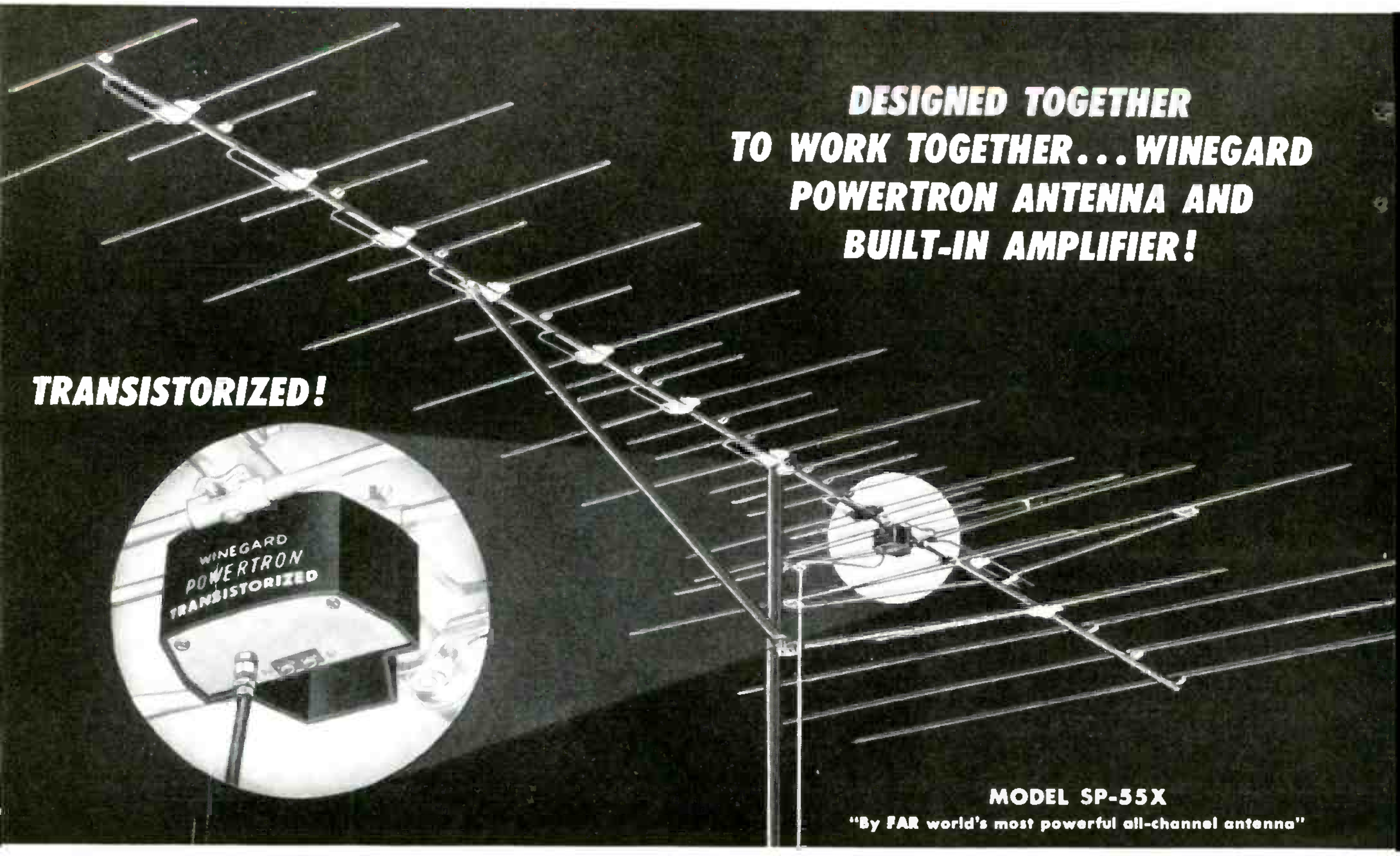

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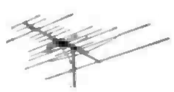
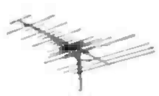


MODEL P-55
Powertron — transistorized, 14 elements.



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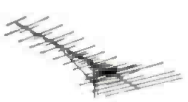

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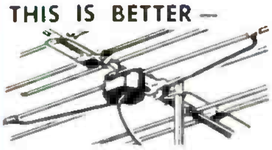

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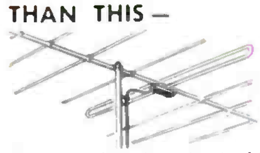
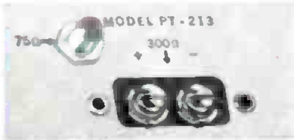


Not an after-thought "add on" signal booster hung on an ordinary antenna — not an old fashioned mast mounted booster.



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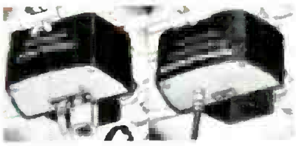

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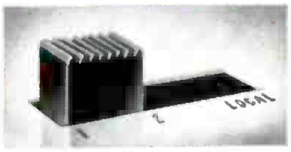
Transistorized Model has rectifier and filter in power supply — not in amplifier, where servicing is difficult. No batteries. Costs 27¢ to operate for full year. Battery types require $5 to $9 in batteries a year to operate continuously at maximum efficiency.



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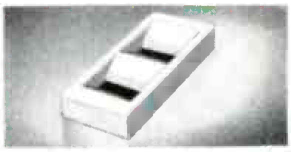

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Product Test Report

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DuKane Model DuK-30 Speaker System
Stereosonics Model PH-1 Phase Coordinator
Hartley "Holton" Speaker System
Columbian Hydrosonics "Aqua-Probe" Depth Finder
Eico Model 1064 Low-Voltage Power Supply

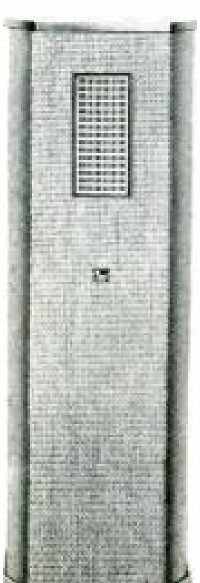
DuKane Model DuK-30 Speaker System

For copy of manufacturer's brochure, circle No. 56 on coupon (page 130).

SEVERAL years ago a French physicist announced the development of a revolutionary type of loudspeaker which had no moving parts. A cloud of ionized air particles, whose intensity was modulated by the program material, generated sound directly—eliminating voice coils, cones, and other vital portions of conventional loudspeakers. In its original form, the ionized air loudspeaker was a laboratory curiosity. Now, thanks to extensive development and refinement of manufacturing processes, it is available commercially. The U.S. manufacturing and distributing rights to the "Ionovac," as it is called, are held by *DuKane Corp.*, St. Charles, Ill.

Practical considerations limit the "Ionovac" to the role of a tweeter, operating at frequencies above 3500 cps. The heart of the speaker is a tiny quartz cell, about the size of a pencil eraser. The inside of this cell is ground out in the shape of a tiny exponential horn. A metal electrode extends from the rear of the cell into the horn mount. In operation, the cell is fitted into a metal sleeve which, together with the inner electrode, form the plates of a capacitor.

This capacitor forms part of the tank circuit of a power oscillator, operating at a nominal frequency of 27 mc. It is in a series-resonant circuit, which causes a very high r.f. voltage to be developed across the capacitor. This voltage ionizes the air in the cell, forming a violet glowing cloud. The audio program modulates the screen grid of the 6DQ6 oscillator tube, thereby varying the intensity of the ionized cloud. The expansions and contractions of the cloud form sound waves directly in the air. The quartz cell is coupled to a diffraction horn, which efficiently transfers the sound to the external surroundings.



Obviously, this unique speaker can have no problems with the mass of moving cones or diaphragms and should be capable of virtually perfect transient response. Of course, the ultimate performance of the system is dependent on the linearity and frequency response characteristics of the coupling transformer and the entire screen modulation process.

No matter how good a tweeter may be (and this one is available by itself to add to existing systems), it must be used with good lower frequency speakers if satisfactory results are to be obtained. *DuKane* has produced a rather unusual speaker system, the DuK-30, in which the "Ionovac" tweeter is combined with a 12" high-compliance woofer and a pair of small (4") midrange speakers to form a smooth, well-balanced system.

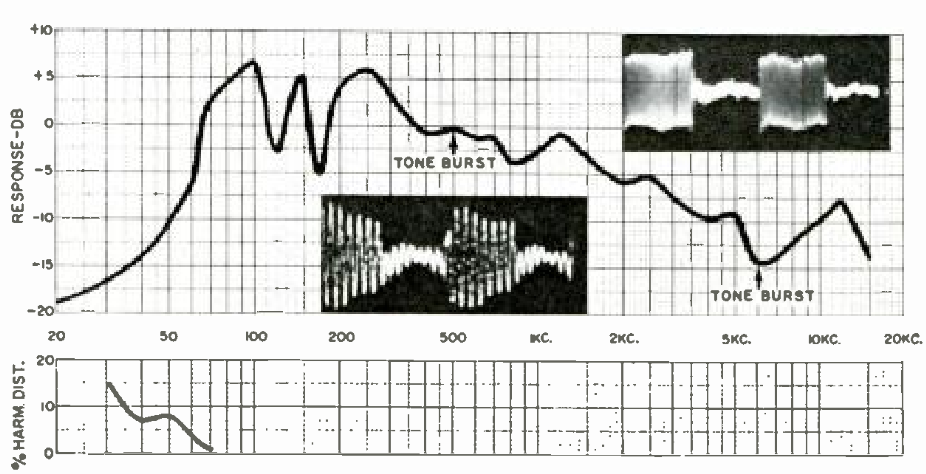
The DuK-30 is shaped like a tall upright column, measuring 48" high but only 15¾" wide and 11" deep. At the bottom is the woofer and its port, while the midrange units are about half way up the column. At the top is the "Ionovac" tweeter with its oscillator and power supply. A built-in crossover network (3500 cps) and tweeter level control complete the system.

We measured the response of the system in a room approximately 12 feet by 30 feet, with the speaker installed along one of the long walls and along one of the short walls. In each speaker position complete frequency response runs were made with four different microphone positions. The average of all eight readings was plotted *versus* frequency. Although the effects of room resonances cannot be completely eliminated from this type of measurement, it represents the actual frequency response of the speaker system in a normally reverberant room, rather than the unrealistic anechoic chamber response sometimes used.

The response curve shows an unusually smooth over-all frequency response, free from holes or peaks throughout most of the audio range. The irregularities between 100 and 200 cps are probably the result of room resonances, although they cannot be identified accurately. The tweeter level control was at approximately mid-position, and a considerable elevation of the region above 3500 cps was possible. However, the system sounded best with the level set at the point used in the tests. The low-frequency response is quite good down to about 60 cps, with relatively clean output down to 40 cps at reduced levels. We measured harmonic distortion of the acoustic output of the speaker at low frequencies, with 1-watt drive, and this data, when plotted, gives a good picture of the ultimate bass performance of the speaker.

Transient response, tested with tone bursts, confirmed the good impression we obtained from the response measurements. At 6 kc., in the operating region of the tweeter, the tone burst picture is nearly perfect. The ripples on the pattern are the result of hum in our equipment, not any deficiency in the speaker. At 500 cps, the woofer transient response is moderately good, although not exceptional.

Actually, all these measurements merely served to confirm our listening impressions. A very short period of listening to the DuK-30 makes it plain that this is a very clean, sweet-sounding speaker. The highs are unsurpassed, with a silky character rarely encountered except in some of the better electrostatic speakers. The polar dispersion of the tweeter virtually eliminates beaming effects. The lows are smooth, free from boxiness or boominess, and sound as though they go lower than they



really do. The extreme low end of the DuK-30 is not as good as a number of popular speaker systems but is nevertheless very satisfactory. The middles are so subtle that one is not aware that a separate pair of speakers is handling them. The blending is perfect.

The DuK-30 (actually the "Ionovac" tweeter itself) does have two weaknesses, one minor and the other possibly more serious. It consumes some 55 watts and the quartz cell has a limited life (guaranteed for 1200 hours). Therefore, its power must be switched off when it is not used, unlike electrostatic speakers which may be left running indefinitely. This can cause problems in some installations, especially where a pair of these speakers are used for stereo. The cell, by the way, is easily replaced by the user at a nominal cost.

The most serious objection (in our view) is the harmonic radiation from the oscillator. A strong signal at about 103 mc. obliterates any FM station on or near that frequency and some television interference on the lower channels has been observed. These effects are not likely to extend beyond the user's home, but can be troublesome anywhere in the vicinity of the speaker.

The price of the DuK-30 is $199.50.

(Editor's Note: According to the manufacturer, all systems made after June 1, 1961, have a circuit change to reduce radiation by a factor of 20 times. Also, the fundamental frequency has been moved so that harmonics no longer fall in the FM band.) ▲

Stereosonics Model PH-1 Phase Coordinator

For copy of manufacturer's brochure, circle No. 57 on coupon (page 130).

THE problem of maintaining correct phase relationships in stereo recording and playback has plagued professional recording engineers, to say nothing of amateurs. Of course, most home stereo amplifiers are so designed that the two channels are in-phase if the proper output connections are made, but in commercial equipment, which may have low-impedance lines connecting preamplifiers with recording amplifiers, there is always a possibility of accidental phase reversal.

It is known that some stereo records and tapes have been issued with one channel incorrectly phased. There are no standards on the phasing of AM/FM stereo broadcasts, and no doubt there will be some confusion when FM multiplex stereocasts become popular. Some stereo control amplifiers are equipped with phase-reversing switches to cope with such situations. Even with this facility, it is not always easy to tell by listening whether the phasing is correct.

The *Stereosonics* Model PH-1 Phase Coordinator is a simple, inexpensive means of comparing the phase of any two signals in the audio range. It indicates on a meter whether the signals are essentially in-phase or out-of-phase. Signals whose phase relationship is random, or at least not predominantly in-

or out-of-phase, do not deflect the meter from its normal center position.

The meter may also be used as a balance indicator, moving to left or right of center in accordance with the levels in the left and right channels. In a balanced condition, the pointer remains in the center of the scale.

Each input channel of the Phase Coordinator has a pair of terminals identified by "+" and "−" markings. These may be connected to an amplifier's speaker output terminals or across a studio line system of from 4- to 600-ohms impedance. The Phase Coodinator may also be connected across the output of a preamplifier or tuner, but it is recommended that it be turned off with the front-panel switch provided for that purpose except when taking a reading. The impedance of the unit is low enough to adversely affect the frequency response and distortion of many preamplifiers. In the "Off" position of the switch the loading effect of the Phase Coordinator is entirely removed.

Each channel has a level control, located on the rear of the unit. This may be used to set the sensitivity of the meter for on-scale readings when a normal operating level is established in the rest of the system.

The manufacturer's specifications rate the frequency response of the Phase Coordinator as 60 to 14,000 cps with music, sine waves, or pulse waveforms. We made a check on this, observing the signal level needed to produce full-scale meter deflection at different frequencies. The response at 60 and 14,000 cps is down less than 2 db from the 1000-cps response and only slightly less at 20 and 20,000 cps. At maximum sensitivity, about .06 volt deflects the meter to its limits in the "Balance" mode of operation and less than .4 volt of in-phase or out-of-phase signal is needed for full indication in the "Phase" mode. Unfortunately, the level adjustments have a rather limited range and, at their minimum settings, a signal of 1.2 to 1.4 volts will drive the meter to full scale. We would like to see a greater range of level control, particularly when the Phase Coordinator is used on speaker outputs which may reach several volts. *(Editor's Note: If the deflection is excessive, the manufacturer suggests that the meter be connected across a lower impedance output tap.)*

The impedance of the unit, at maximum sensitivity, varies from about 1000 ohms at 20 cps to over 20,000 ohms at 20,000 cps. It is 25,000 ohms higher when the level controls are turned down. Although this will not load line and speaker circuits significantly, it certainly is advisable, as the manufacturer suggests, to switch the unit off when it is driven from a typical preamp output.

In use tests, the PH-1 worked to perfection. Monophonic programs deflect the meter upward if they are in-phase or downward if they are out-of-phase. In monitoring a stereo program, an upward swing can be interpreted as in-phase (or sum) information, corresponding to sound originating between the speakers. The meter will normally fluctuate only slightly about the center position if there is considerable directionality. Consistent upward readings show that there is blending of the two channels. This is easily verified when using an amplifier having a blend control.

Apart from the obvious use in determining whether one's stereo records or broadcasts are phased correctly, it seems to us as though the Phase Coordinator should be most useful to the recording engineer in setting up his microphones, since it will quickly show up the sort of accidental phase reversal which can happen so easily if dissimilar microphones are used or if they have been wired incorrectly.

Other applications will no doubt suggest themselves. In playing various stereo discs, we were struck by the wide variations in directionality which the meter indicated. It seemed to be much more sensitive than the ear to the general separation of the two channels.

The price of the unit is $29.50. ▲

Hartley "Holton" Speaker System

For copy of manufacturer's brochure, circle No. 58 on coupon (page 130).

THERE seems to be a trend away from bookshelf-sized speaker systems and the *Hartley* "Holton" system typifies the trend. It is a handsome, floor-type enclosure measuring 30" x 24" x 13". In the unit we tested was the new *Hartley-Luth* 220 MS "magnetic suspension" driver. Few details were available to us on the workings of this system, except that it apparently uses the field of the speaker magnet to help restore the voice coil to its neutral position after an excursion. We will not

(Continued on page 84)

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See our other advertisement on page 111

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NEW BATTERIES

PROGRESS OR CONFUSION?

Description, characteristics, and applications of the new alkaline-manganese and sealed nickel-cadmium types.

By D. B. CAMERON

Manager, Sales Engineering, Union Carbide Consumer Products Co.

SELECTING a battery for a radio or instrument is not merely a dollar-and-cents decision. Proper choice from the many types now available can have a marked effect on the operation of the device and on the user's satisfaction and convenience. Every battery type and electrochemical system offers certain advantages and limitations. A general understanding of battery characteristics can eliminate confusion and permit a wise selection.

Prior to World War II, practically all primary batteries were the LeClanché or carbon-zinc type. Both flat and cylindrical cells were available, but choice of a battery for a particular use presented few problems. Wartime military requirements stimulated fantastic advances in electronics and created a need for specialized battery-power sources. Battery research and development efforts mushroomed. Efficient miniature carbon-zinc batteries became practical, and new electrochemical systems were evaluated. The mercury battery system was one result of this research.

In the years since the war, these efforts have continued. The mercury battery system and miniature carbon-zinc batteries were perfected, the transistor was developed, and battery-operated devices, from toys to radios, gained wide consumer acceptance. The need for compact, efficient, economical batteries has now brought two additional electrochemical systems into use: high-energy alkaline-manganese batteries and sealed nickel-cadmium rechargeable batteries.

The owner of a pocket radio powered by penlite cells has a problem. Shall he use standard flashlight cells, radio-type carbon-zinc cells, mercury batteries, alkaline-manganese energizers, or nickel-cadmium batteries? For example, there are eight different "Eveready" brand penlite cells, each designed for a particular use. The multiplicity of battery types has caused confusion. Has there also been progress?

Almost everyone, even a child, recognizes a battery and considers it a very simple device. Appearances can be deceptive. A battery is actually a small electrochemical plant. It must do nothing until power is needed and yet must start operating instantly when an electrical connection is made. It must operate in any position and withstand rough handling. A modern battery must be compact, efficient, foolproof, attractive, and economical; and it must operate under all sorts of adverse conditions. Consider the characteristics that would be desirable in an ideal battery: long shelf life, high energy, good light-drain performance, efficiency on heavy-drain use, reliable intermittent operation, good continuous service, high amperage, low impedance, high-temperature stability, low-temperature capabilities, constant voltage, rechargeability, small size, freedom from leakage, attractive appearance, and last but not least, it must be inexpensive.

Unfortunately, it is not yet possible to maximize all of these characteristics in a single battery. In order to supply each type of user with the best possible battery for his particular application, a battery manufacturer must produce a number of different batteries of the same size and shape, each tailored to maximize the most essential characteristics for a specific end use. To obtain the best battery value and satisfaction, the consumer or the professional who advises and supplies him, should understand at least the basic characteristics of the new batteries now available.

Carbon-zinc and mercury batteries have been in use long enough for most interested technical people to have a general appreciation of their characteristics. The carbon-zinc system is the workhorse of the industry. These batteries have the widest availability, a broad range of desirable characteristics, and the lowest initial cost. Mercury batteries provide longer life, a more constant voltage, and lower impedance—but at a higher price. What do the alkaline-manganese and nickel-cadmium batteries offer?

Alkaline-manganese batteries have a total energy almost equal to mercury batteries and they are capable of delivering their rated capacity even on heavy continuous drains where both the carbon-zinc and mercury systems become inefficient. Furthermore, this newest electrochemical system provides high amperage, low impedance, outstanding temperature characteristics, and good shelf life at a price between carbon-zinc and mercury battery cost.

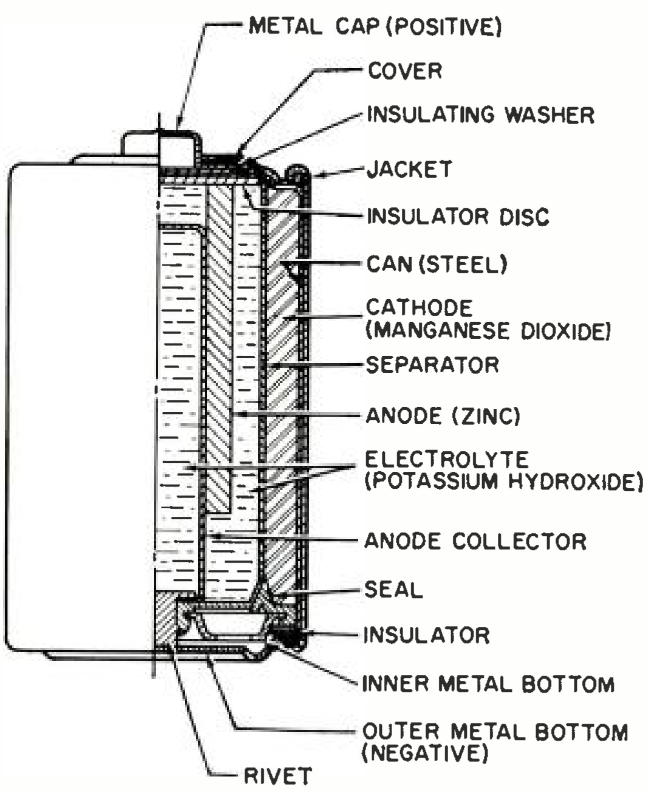
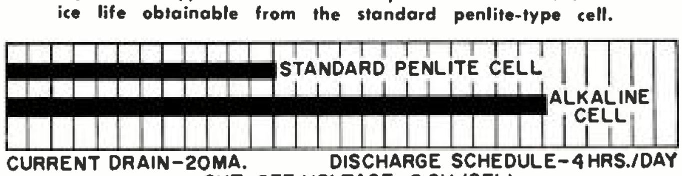


Fig. 1. Cut-away illustration of an alkaline-manganese cell.

Fig. 2. The type E91 alkaline cell provides twice the service life obtainable from the standard penlite-type cell.



The sealed nickel-cadmium system permits a maintenance-free battery that can be recharged hundreds of times and can be left discharged without damage. Unfortunately, practical areas of use are limited by high initial cost and by the fact that energy-per-charge is often much less than a primary battery can supply.

A discussion of battery performance and applications will help clarify the relative merits of the alkaline-manganese and nickel-cadmium battery systems.

Alkaline Primary Batteries

This cell differs from the conventional LeClanché cell primarily in the highly alkaline electrolyte used. The cell is a high-rate source of electrical energy. Its outstanding advantages are derived from the unique assembly of components and construction methods. See Fig. 1.

Two principal features are a manganese dioxide cathode of high density in conjunction with a steel can which serves as a cathode-current collector and a zinc anode of extra high surface area in contact with the electrolyte. These features, coupled with the use of a potassium hydroxide electrolyte of high conductivity, give these cells their very low internal resistance and impedance and high service capacity.

The cells are hermetically sealed and encased in steel, providing virtually a leakproof package. Each cell is a nominal 1.5 volts. The ampere-hour capacity is relatively constant over a range of current drains and a range of discharge schedules.

The primary advantage of the new system lies in its ability to work with a high degree of efficiency under continuous or heavy-duty, high-drain conditions where the standard round cell is unsatisfactory. Under certain conditions the new alkaline cells will provide more than ten times the service of standard round cells. Heavy current drains and continuous or heavy-duty usage impair the efficiency of the conventional carbon-zinc cell to the extent that only a small fraction of the built-in energy may be removed.

On light drains, such as portable radio or instrument use, alkaline-manganese cells often supply more than twice the service life (Fig. 2) of carbon-zinc batteries and very nearly equal mercury battery life. The low impedance of alkaline cells can improve radio performance by minimizing distortion and their low temperature characteristics result in good service life even under outdoor winter conditions.

The good low-temperature performance of alkaline-manganese batteries completely overcomes the temperature limitation of mercury batteries and far surpasses standard carbon-zinc cells. At light to intermediate drains, reasonable service can be obtained at −40 degrees F and below. This characteristic is particularly valuable in devices which may be stored or operated outdoors or in automobiles in winter.

The heavy-drain, high-amperage performance of alkaline-manganese batteries makes them particularly useful in toys and for photographic and hobby use. These cells will make practical completely new types of battery-operated equipment.

The E94 alkaline energizer is a new cell size. The diameter is the same as a "D" cell but it is only one-half the height. Two E94 cells will fit in a holder designed for a single "D" cell. Where it is desirable, and the device will stand the higher voltage, it is now possible to double the voltage in existing "D"-cell-powered units. The smaller alkaline cell has a service capacity equal to a standard "D" cell on heavy continuous drains. For example, four "½D" cells can be placed in a standard 2-cell flashlight. If the usual PR-2 lamp is replaced by a PR-13 lamp, designed for the higher voltage, the light output will be doubled. The brilliance will approach that of a 5-cell spotlight.

The E93 "C" size alkaline energizer, like the other alkaline-manganese cells, on heavy continuous drains will supply up to ten times the life of a comparable carbon-zinc flashlight cell.

Its first use was in the "Futuramic II" electronic flash unit manufactured by the *Heiland Division* of *Minneapolis-Honeywell Regulator Company*. The high energy and high amperage of the alkaline energizers made them ideal for this application.

Electrically powered toys are very hard on batteries because drains are heavy and the smallest possible cells are usually used. The majority of toys use "AA" or "C" size cells. The heavy drain capabilities of alkaline-manganese cells make them ideal for this use. They not only last several times as long as flashlight batteries, but they often improve toy performance as well.

When currents of one ampere or more are required for periods of several hours, larger alkaline-manganese cells must be used. Both "D" and "G" size cells are available, the latter both as a unit cell and series-connected to form the 6-volt No. 520 battery. Although the "G" size cell with insulated terminals ("Eveready" No. E97S) is about one-sixth the size and one-quarter the weight of the No. 6 cell used in the hobby field, it gives over 70 per-cent of the service of the No. 6 cell in glo-plug ignition operation for the engines of model airplanes.

In addition to electronic, toy, hobby, and other heavy-duty uses, the E95 "D" cell and the 6-volt battery (No. 520) are particularly adapted for emergency lighting use. Emergency flashlights or lanterns must be capable of supplying a bright light (high-drain bulb), they must be capable of continuous operation for the duration of the emergency (possibly many hours), and they must operate under adverse temperature conditions. Furthermore, the batteries must have a good shelf life so they will be capable of operation when an emergency occurs. These requirements spell out the important characteristics of alkaline-manganese cells. The flashlight in an automobile is an emergency light—and in winter it must be capable of operating when cold!

Battery Economics

The initial cost of alkaline-manganese batteries falls between that of carbon-zinc and mercury batteries. On all tests they deliver more service than carbon-zinc batteries and on heavy-drains or in low-temperature uses, service of alkaline-manganese batteries will exceed mercury batteries. Unless a flat discharge curve is essential, the cost-per-hour operation of alkaline-manganese cells is lower than for mercury batteries. It is also lower than carbon-zinc batteries in heavy continuous use, but may be somewhat higher in light intermittent uses. In some cases, superior electrical device performance, resulting from the better shelf life and lower impedance of alkaline-manganese batteries, may offset any increased operating cost.

Rechargeable Batteries

At first glance a rechargeable power source appears to offer the convenience of primary battery operation without the expense of replacement batteries. In some circumstances, this could be true and a rechargeable battery the only economical portable power source. In other applications a casual appraisal may be completely misleading. A primary battery may be less expensive for both the short and long term as well as being more convenient.

Consider the hypothetical case of two men who buy identical portable radios, operated by four penlite cells. Mr. A is a machinist working in a noisy shop. He operates his radio ten hours a day at high volume (45 ma. battery drain) so it can be heard above the ambient noise. Mr. B uses his radio an hour a day at low volume (15 ma. battery drain) in a quiet home. The radios can operate on any of the several types of primary batteries (assume No. 1015 radio grade carbon-zinc cells @ $1.00 per set of four) or nickel-cadmium cells can be used (No. N46 @ $11.00 per set of four plus approximately $7.00 for a charger).

Mr. A can buy nickel-cadmium cells and a charger, recharge them every night and recover his investment (compared to primary battery operation) in from 2½ to 3 months. A good investment. On the same basis Mr. B would have to remember to charge his batteries once a month and would require six years to recover his investment—and by that time he might well need new nickel-cadmium batteries because they do not last forever. Obviously a poor investment. Sealed nickel-cadmium batteries are a fine product but they should be used only where primary batteries are uneconomical or impractical.

For use in electronic equipment, any rechargeable battery should be hermetically sealed so that it is not necessary to add water and so that gassing on overcharge cannot carry corrosive vapor into the instrument. Also, the battery should be undamaged by long periods of storage, charged or discharged, and should have a low self-discharge rate. Sealed nickel-cadmium batteries meet these requirements best.

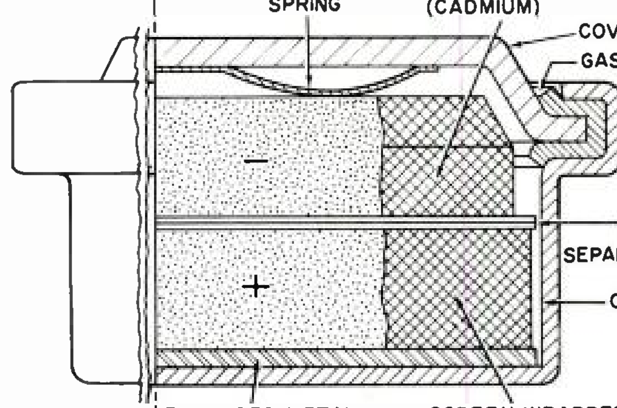


Fig. 3. Illustration above shows a cut-away view of a typical sealed nickel-cadmium button cell that is described in the text.

Sealed Nickel-Cadmium Batteries

The nickel-cadmium battery is a remarkable device and more than fifty years of successful use have proved this point. Nickel-cadmium batteries may be recharged many times, have a relatively constant potential during discharge, and have excellent charge-retention properties. They will stand more abuse than any other cell, have good low-temperature performance characteristics, and are competitive with other systems in terms of cost-per-hour use. They are true storage batteries using one of the very best electrochemical systems.

The nickel-cadmium cell has been used in Europe for many years in its orginal form as an unsealed cell, for automobile and truck starting and for fixed installations. Recent technological advances have made possible the extension of the nickel-cadmium system to small, hermetically sealed batteries—rechargeable batteries that are free from the usual routine maintenance, such as the addition of water. These developments have brought the economic advantages of rechargeability to small batteries.

A conventional vented-type nickel-cadmium battery will liberate oxygen and hydrogen plus entrapped electrolyte (potassium hydroxide) fumes through a valve. In order to hermetically seal a nickel-cadmium cell, it is necessary to develop means of using up this gas inside the cell. This is accomplished as follows:

1. The battery is constructed with excess ampere-hour capacity in the cadmium electrode.

2. Starting with both electrodes in the fully discharged state, charging the battery causes the positive (nickel) elec-

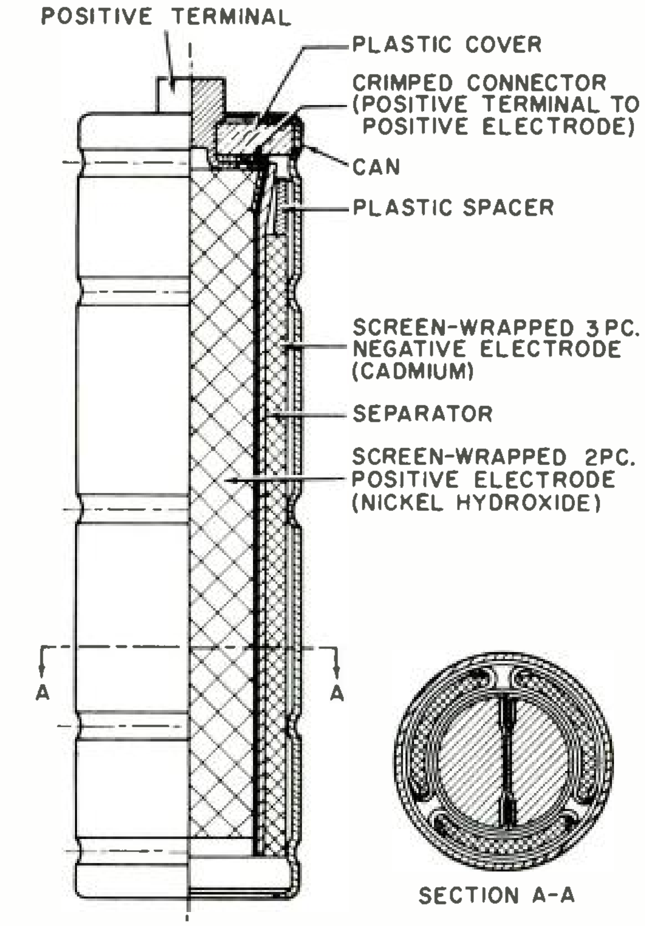


Fig. 4. Cut-away view of a cylindrical nickel-cadmium cell.

trode to reach full charge first and it starts oxygen generation. Since the negative (cadmium) electrode has not yet reached full charge it cannot cause hydrogen to be generated.

3. The cell is designed so that the oxygen formed can reach the surface of the metallic cadmium electrode where it reacts, forming electrochemical equivalents of cadmium oxide.

4. Thus, in overcharge, the cadmium electrode is oxidized at a rate just sufficient to offset input energy, keeping the cell in equilibrium at full charge.

This process can continue for long periods. The level of oxygen pressure thus established in the cell is determined by the charge rate used.

Sealed nickel-cadmium cells are available in a variety of sizes and capacities. See Figs. 3 and 4. These include: button cells (50-500 ma.-hour capacity), cylindrical cells (450-2000 ma.-hour capacity), and rectangular cells (2-23 ampere-hour capacity).

The capacity of most nickel-cadmium cells is specified at the 10-hour rate (current drain required to discharge the cell in 10 hours). When they are used at higher discharge rates, the capacity is reduced.

Nickel-cadmium cells have the desirable flat discharge (constant-voltage) characteristic. As shown in Fig. 5, note that the average voltage is about 1.2 volts per cell. The initial voltage shown on the curves is designated as the voltage under load after 10 per-cent of the ampere-hour capacity has been removed from a fully charged cell.

Any rechargeable battery will lose charge when stored. Nickel-cadmium batteries have a lower self-discharge rate than any other present secondary battery system. More important, the batteries are not harmed even if not used for long periods of time.

Sealed nickel-cadmium cells experience a relatively small loss of capacity at operating temperatures, ranging from −20 to +45 degrees C. Within this range, stable discharge voltage is maintained.

With most nickel-cadmium cells, the 10-hour rate should not be exceeded in constant-current charging. Fourteen hours charging at this rate will fully charge the cell. Constant-voltage charging, which is also acceptable, results in a higher initial charging rate. At the start of charge the current may greatly exceed the 10-hour rate, but the charging circuit must be designed so that 10-hour current (or less) flows toward the end of charge.

The battery can be trickle-charged or floated. For maximum performance in situations of continuous overcharge, with occasional interruptions, the current should not exceed the 30-hour rate.

These cells will also stand extended overcharge at rates considerably higher than those recommended for floating. Although charging at the maximum rate (10 hours) is normally expected to be completed in 14 hours, cells will not be damaged by occasional charging at this rate even for several weeks. Continuous overcharging at higher-than-necessary rates accelerates general degradation of the cell but complete or sudden destruction will not result unless the 10-hour rate is exceeded.

A typical, yet simple, charging circuit is shown in Fig. 6. Values of charging current for button and cylindrical cells range from 5 to 150 ma., depending on cell size, for a 14-hour charge.

When used in an appropriate application where true advantage can be taken of their simplicity and rechargeability, sealed nickel-cadmium batteries can make possible new battery-operated devices which would otherwise be completely uneconomical.

Conclusion

Is the present multiplicity of batteries worthwhile? Has there been any real progress? The answer is an unqualified "yes." New battery systems supplement existing batteries. They improve the operation of many present devices, make possible new uses, and offer the consumer new choices so that he can obtain the best battery buy for his particular device and operating requirements.

Battery and portable-power research and development continue unabated. Future years will bring still better primary and rechargeable batteries and probably fuel cells and thermoelectric generators as well. Thus more new devices will be able to operate electrically without being tied to a power line. ▲

Fig. 5. Typical discharge voltages at various drains for sealed nickel-cadmium cells.

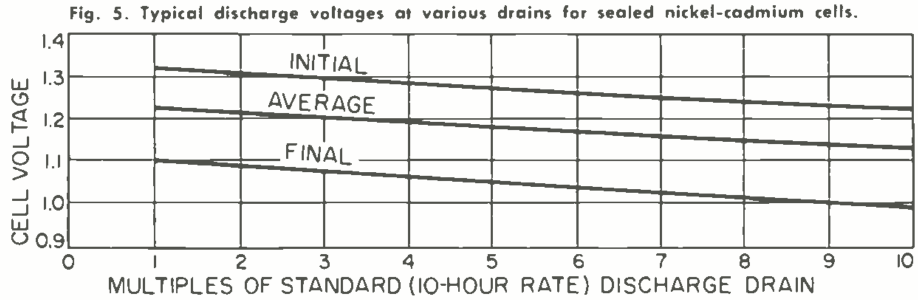
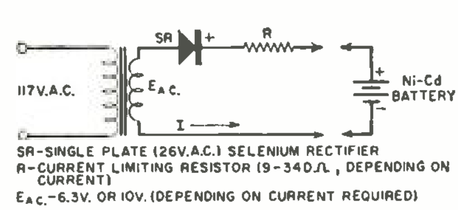


Fig. 6. Charging circuit for small sealed nickel-cadmium batteries.



COVER STORY

THE TERM "super-power" applied to a new family of grid-controlled amplifier tubes, developed to meet increasing demands for higher u.h.f. power output, is not a misnomer. These tubes, which are capable of producing megawatts of pulse power output and hundreds of kilowatts of average power output, are particularly well suited to applications such as long- and short-pulse long-range search radars and missile-tracking radars, particle-accelerator power sources, broadband radars, space-probe and satellite radars, satellite communications, and r.f. power sources for special-process and heating applications.

This new family of tubes includes the commercial types *RCA*-7835 (shown on this month's cover being inserted into an external resonant cavity), and *RCA*-2054, as well as several modified developmental versions used in government-procured or sponsored equipment. These tubes are the result of an integrated program designed to produce the world's most powerful u.h.f. power-output device in a single envelope. For example, the 7835 can produce 5-million watts of pulse power at 250 mc. (See Table 1)

Design Philosophy

Fundamentally, the new family of super-power tubes combines a number of triode units in parallel in a common ceramic-metal, water-cooled envelope. This is done to provide maximum emission-current capability without exceeding a practical electrical length for u.h.f. operation. A total of 96 triode units provide the total electron current required. The

MAXIMUM RATINGS*

Peak Positive-Pulse Plate Voltage	65,000 volts max.
Peak Negative Grid Voltage	500 volts max.
Peak Plate Current	325 amps max.
D.C. Plate Current	3.25 amps max.
Plate Input (average)	212,000 watts max.
Plate Dissipation (average)	150,000 watts max.

*For frequencies up to 300 mc. and for a maximum "on" time of 25 microseconds in any 2500-microsecond interval.

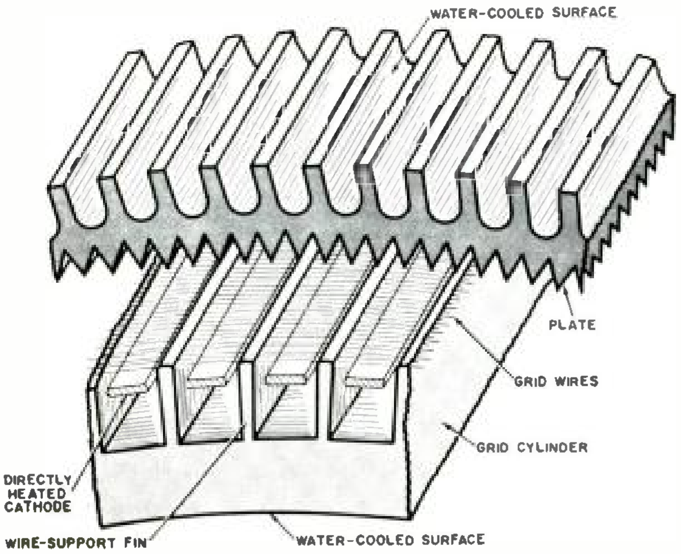
TYPICAL OPERATION**

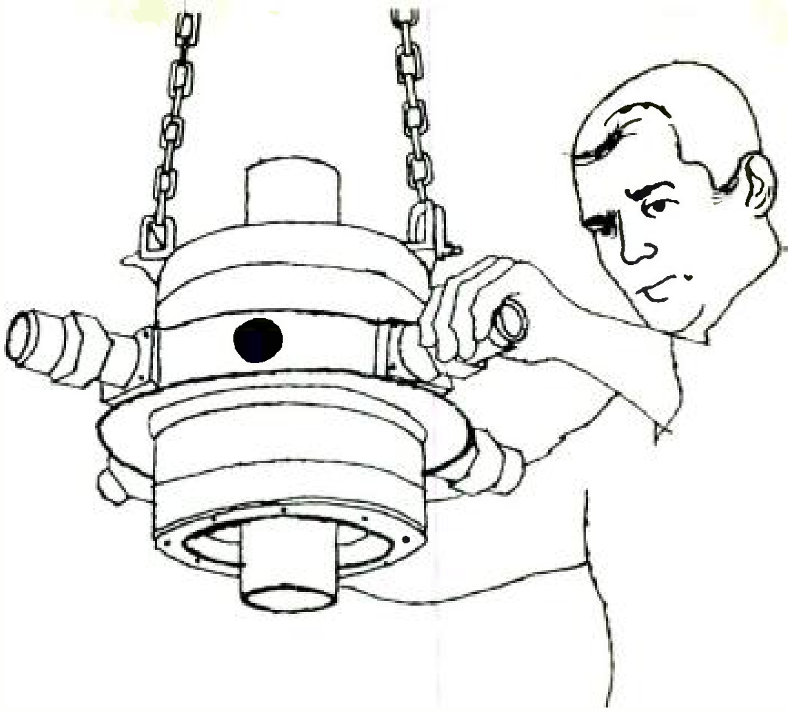
Peak Positive-Pulse Plate-to-Grid Voltage	34,000	60,000 v.
Peak Cathode-to-Grid Voltage	100	300 v.
Peak Plate Current	260	280 a.
D.C. Plate Current	2.6	2.8 a.
Peak Driver Power Output	150,000	200,000 w.
Useful Power Output at Peak of Pulse (approximate)	5,000,000	10,000,000 w.

**In a cathode-drive circuit, with rectangular-waveshape pulses, at 250 mc., with a duty factor of .006, and a pulse duration of 25 microseconds.

Table 1. Operating characteristics of type 7835 super-power triode (shown on cover) as plate-pulsed class B power amplifier.

Fig. 1. Cross-section of a portion of the active region of the tube showing the relative positions of plate, grid, and cathode.





SUPER-POWER U.H.F. TUBES

By R. E. REED & A. C. TUNIS
Electron Tube Div., Radio Corp. of America

Capable of producing millions of watts of pulse power, these tubes are designed for the maximum amount of u.h.f. power output from a single-envelope device.

cross-section of the active region in Fig. 1 shows the relative positions of the elements in each unit triode and the relation of each unit to adjacent units.

The plate, which is centered about the electronically active region of the tube on insulating low-loss ceramic bushings, forms the outer conductor of a portion of a coaxial output circuit located within the tube. The plate face is made of oxygen-free high-conductivity copper which provides the high thermal conductivity necessary to conduct the heat dissipated on the plate face by impinging electrons to the cooling water on the reverse side.

The grid consists of .003-inch-diameter pure tungsten wire wound around the circumference of the grid cylinder. Each grid wire is located in tiny slots across the radial fins that extend outward from the grid block between the cathode, as shown in Fig. 1. A rolling operation firmly fastens the grid wires in position and molds the edges of the fins around the wires to provide the necessary electrical and thermal contacts. The fins are an integral part of the water-cooled grid cylinder.

The thoriated-tungsten filamentary cathode strands have rectangular cross-sections with appropriate reduction in area at either end to compensate for thermal conduction to the supporting structures. Approximately 70 amperes of filament current is required to heat each strand to the normal operating temperature. The total filament power required for long-pulse and c.w. service is 6800 amps at 3.5 volts. For short-pulse service, 1800 amps at 1.3 volts is used.

Mode of Operation

These super-power u.h.f. amplifier tubes are designed for use with external coaxial-cavity resonator circuits, as

(*Continued on page 70*)

Infrared Binoculars

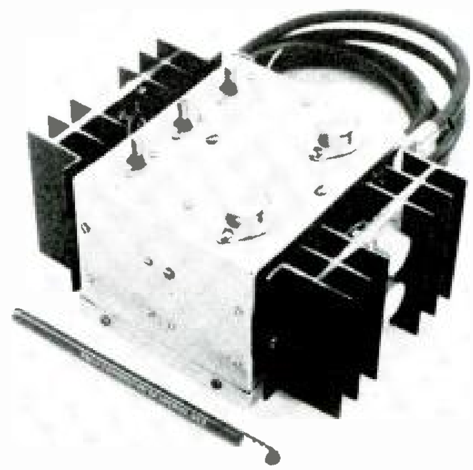
◀ *One of the items under development by the U.S. Army Engineering Research & Development Labs. Fort Belvoir, Va. is an infrared binocular which will enable military personnel to see in the dark. The binoculars, made by American Optical Co., require an operating voltage of 12 kv. for the built-in infrared-converter tubes.*

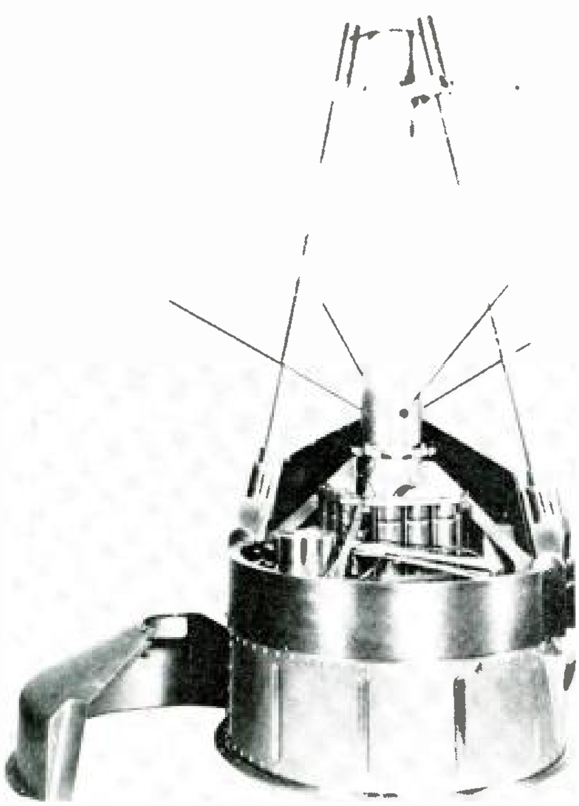
50-Watt Transistorized Hi-Fi Amplifier

This all-transistorized, 50-watt monophonic amplifier, using a new type of transistor for hi-fi sound systems, was exhibited by RCA recently. The key transistors are two new drift-field power types designated TA2017 and TA2048. In pilot production for the past several months, they are available in commercial quantities for a variety of consumer products.

▼

RECENT DEVELOPMENTS IN ELECTRONICS





Ionosphere-Density Probe

◀ *A sounding rocket launched from Wallops Island, Virginia, successfully made the first test of some equipment that will be used in the nation's "Topside Sounder" satellite. The satellite, scheduled for launch in late 1962, will determine the electron density of the ionosphere by sending radio signals downward into the ionosphere from above. The rocket, together with a payload of electronic equipment encased in its nose cone, was programmed to reach an altitude of about 700 miles and radio back to a ground station the measurements of the density of electrified particles as a function of altitude. The technique used for sounding involved the measurement of the time delay between pulsed r.f. transmissions from the payload and received echo signals reflected back from the ionosphere. Pulsed transmissions were made alternately and repetitively at about 4 and 6 mc.*

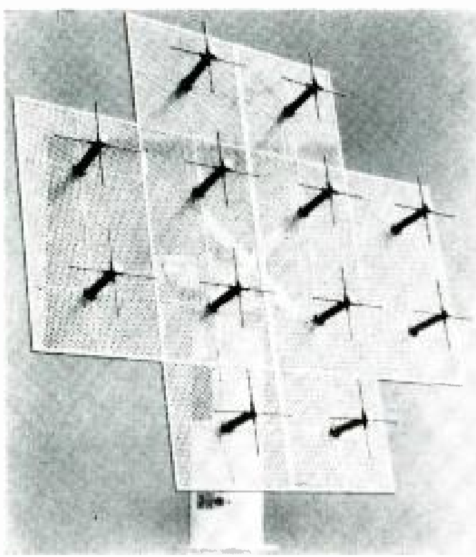
The "Topside Sounder" satellite payload equipment (shown at left) is 15 inches in diameter, and contains storage batteries, a single transmitter-receiver and telemetry link. The central column supports a spring used to jettison the rocket nose cone. After the cone was dropped, the telescoped antenna poles clamped to the central column were brought into sounding position at right angles to the payload body. The four small projecting wires are telemetry antennas. The entire program is the work of Airborne Instruments Laboratory and the Central Radio Propagation Laboratory, both under contract with NASA.

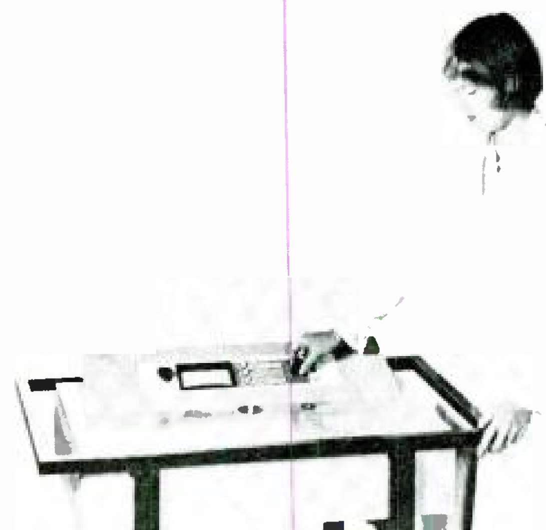
775-kv. Line Tested by Tape

A record-breaking electrical power line, built by American Electric Power Service Corp. *and* Westinghouse, *was energized recently at Apple Grove, W.Va., for a 5-year test program. Tests on the new line are completely instrumented, using magnetic-tape data logging equipment which records 50 test items every 20 minutes. Lineman on ladder in photo is working on one of the r.f. decoupling filters installed in the system to permit separate radio-influence measurements on the 3 main line sections.* ▶

Two-Dimensional Dipole Array

A two-dimensional array of crossed dipoles used as a telemetering, receiving, and tracking antenna is shown. The 237-mc. antenna can operate with vertical, horizontal, or circularly polarized signals. Designed by Rantec Corp., *the array is said to have slightly more gain and lower side-lobes than a four-helix antenna.* ▼





▲

Transistorized Computer Measures Blood Volume

A new automatic instrument that determines the amount of blood in a person's circulation rapidly, repeatedly, and with great precision was demonstrated recently by Atomium Corp. *The instrument operates by taking radioactivity measurements on a small blood sample from a person who has previously been given an injection of a known and harmless amount of radioactive iodine. Computer circuits in the instrument calculate the exact blood volume from the amount of dilution of the radioactive material. Total volume is read out on a directly calibrated meter. The instrument, called a "Volemetron," has been used in open-heart surgery, where it has shown precisely the amount of blood that must be transfused into a patient at the end of the operation.*

Digital Transmission Equipment

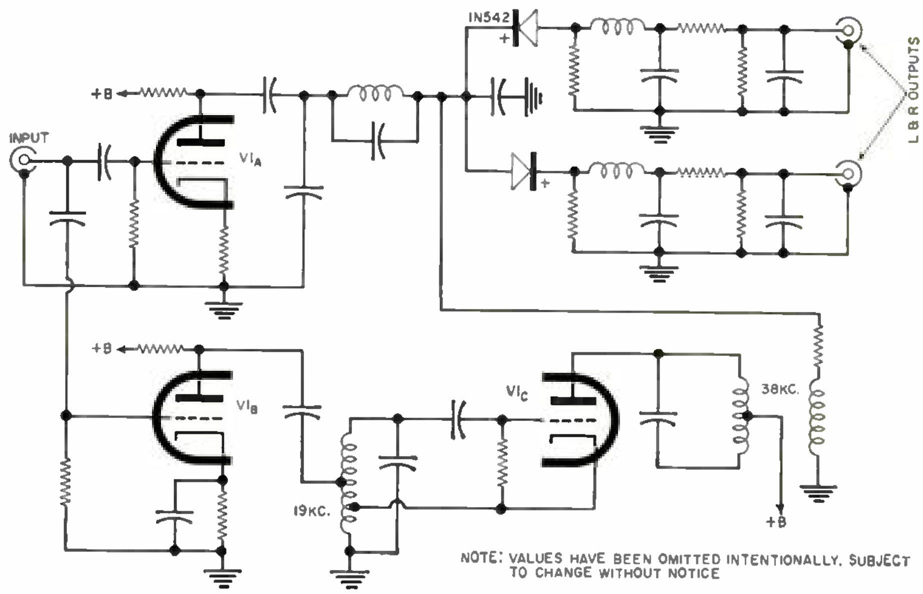
◀ *A "house of cards" could describe* ACF Electronics' *new building-block communications equipment that adapts digital data machines, such as teletypewriters (foreground) and computers for simultaneous high-speed, long-range transmission. The equipment makes extensive use of a large number of plug-in printed-circuit cards for the various circuits.*

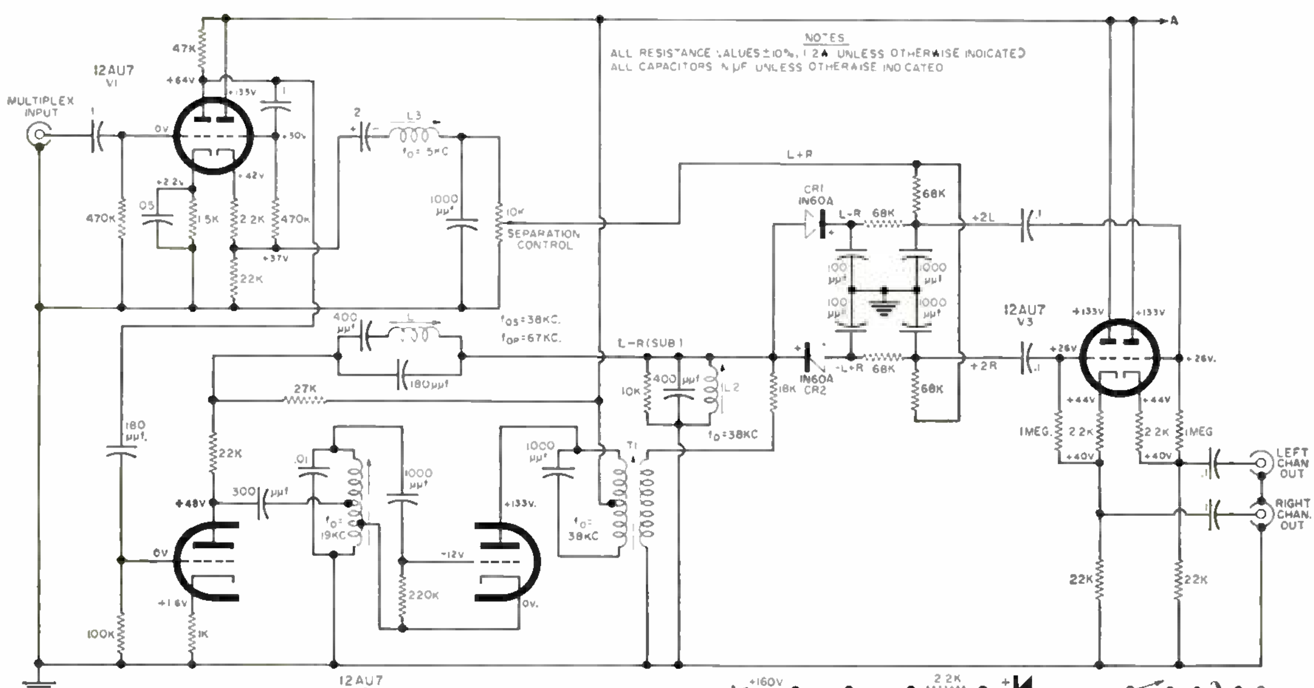
STEREO FM MULTIPLEX ADAPTER CIRCUITS

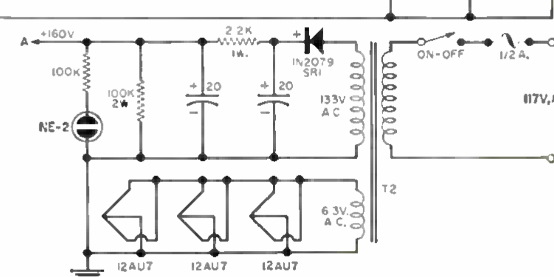
Schematic diagrams and circuit descriptions of four new commercially available FM multiplex adapters.

By **MILTON S. SNITZER**
Technical Editor, ELECTRONICS WORLD

BELL SOUND *Model MXA-1 adapter (right) consists of a triple-triode "Compactron" tube and a pair of crystal diodes. Power for the unit is obtained from the FM tuner with which the adapter is used. Signals from the tuner are applied to triode sections V_{1A} and V_{1B}. V_{1A} is a wide-band amplifier for the composite stereo signal, consisting of information on both the main channel and the subcarrier channel. A trap in the output circuit of this section removes any SCA (background music) signals. V_{1B} amplifies the 19-kc. pilot subcarrier and applies it to V_{1C}, operating as a locked oscillator whose output circuit is tuned to 38 kc. This 38-kc. signal is applied via the transformer directly to the crystal diodes along with the composite stereo signal. Because of the way that the crystals are connected, first one and then the other is switched on by the 38-kc. signal. This switching technique permits one crystal to sample the left channel and the other crystal to sample the right channel, without using any matrixing circuits, bandpass or phase-delay filters. Low-pass filters in the output of each crystal remove high-frequency signals that might interfere with tape-recorder circuits.*

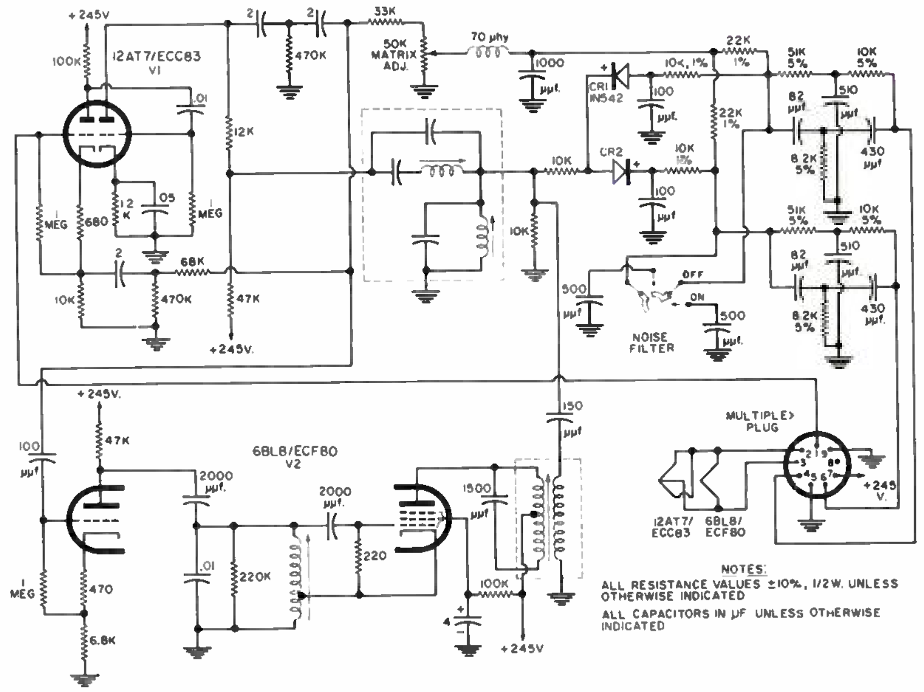




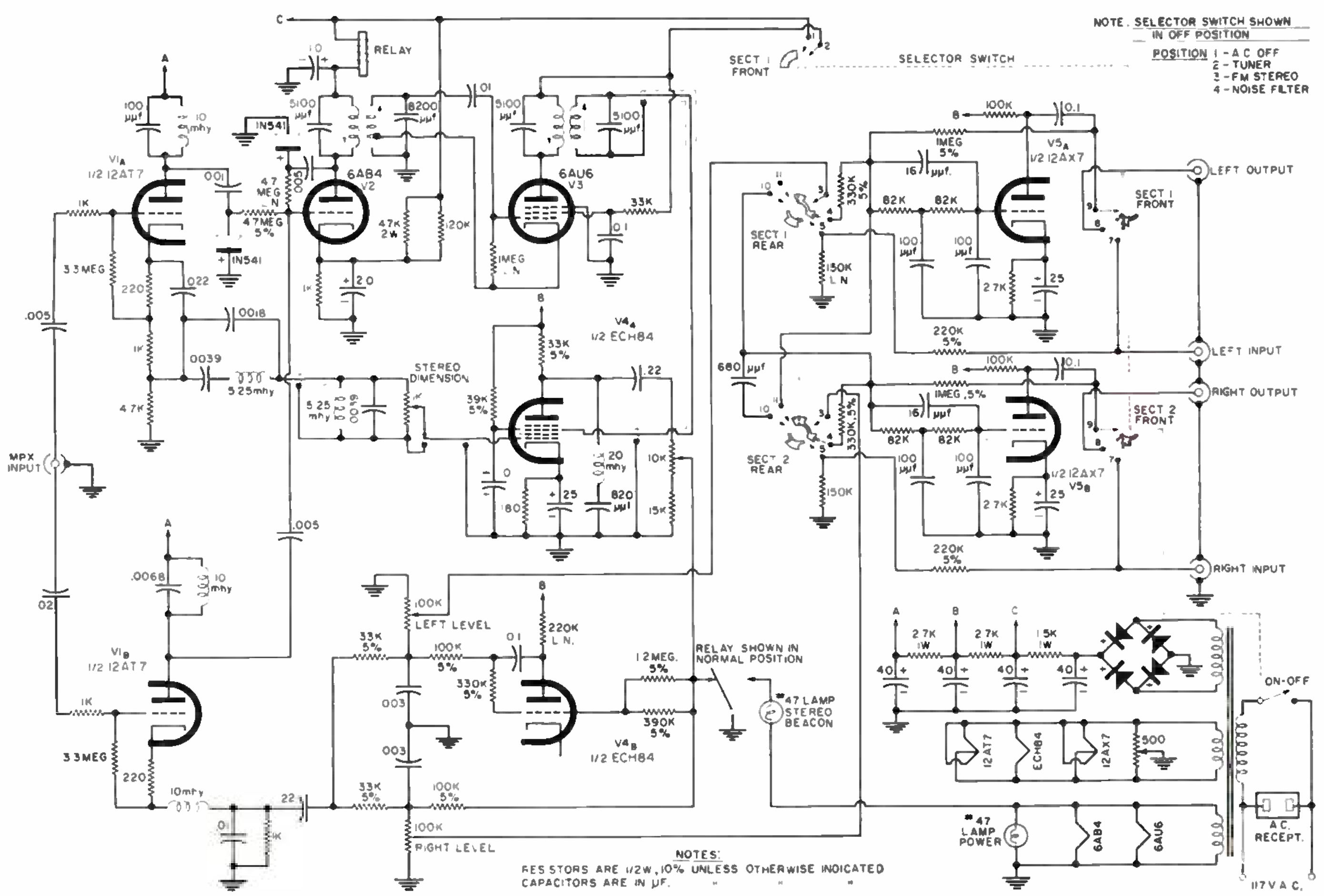


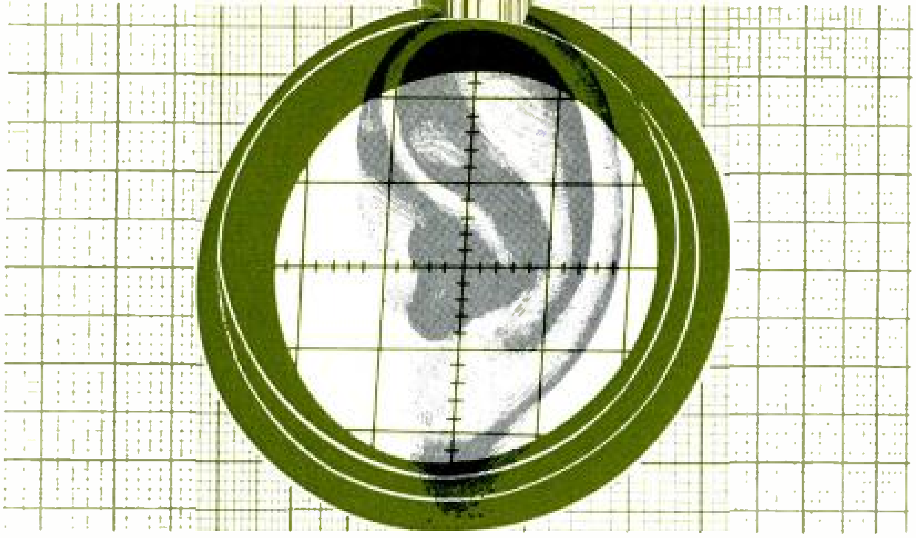
HEATH *Model AC-11 self-powered adapter (above) uses three twin triodes, two crystal detectors, and a silicon-diode rectifier. Signals from the FM tuner are applied to isolating amplifier V_1 whose output section is a cathode-follower. A low-pass filter (L_3 and associated capacitors) permits only the sum (L + R) signal to be applied through a matrix network to the crystal diodes. Output from the first section of V_1 is also applied to the first section of V_2, a bandpass amplifier whose tuned circuits accept only the pilot subcarrier and the difference (L — R) signal. SCA signals are rejected here as well. The 19-kc. pilot subcarrier keys an oscillator (second section of V_2) whose output is tuned to 38 kc. This signal is then applied to the balanced crystal detector through T_1. The detected difference signal from the crystals is mixed with the sum signal (through the 68,000-ohm resistors) to produce the original left and right signals. These are then applied to a pair of cathode-followers (V_3) from which the two outputs are obtained. A conventional half-wave rectifier with R-C filtering supplies the "B+" voltage required for the circuit.*

HARMAN-KARDON *Model MX-500 (right) employs two tubes and a pair of crystal diodes in this multiplex adapter. Power for the unit is obtained from the associated FM tuner through the power plug shown. Detected signal from the tuner is applied from pin 1 of the plug to a broadband isolation amplifier V_1. Filter circuits at the output of V_1 separate the sum-signal channel (including the 19-kc. pilot subcarrier) from the difference-signal channel. The filters also reject SCA signals. The sum signal is applied through a resistive matrixing network to the output of the crystal detectors. Output from V_1 is also applied to the triode section of V_2, where the 19-kc. pilot subcarrier is amplified. The pilot subcarrier synchronizes an oscillator (the pentode section of V_2), whose output circuit is tuned to twice the input frequency—38 kc. This 38-kc. signal is then transformer-coupled to the balanced crystal detectors. These produce a difference signal along with an inverted difference signal which are then combined with the sum signal in the matrix network. The resultant outputs from the crystals, which are the original left and right signals, are then applied to pins 4 and 6 of the multiplex plug. From this point the signals are applied to the stereo amplifier in the conventional manner.*



FISHER RADIO *Model MPX-100 self-powered multiplex adapter (below) employs five tubes, two crystal rectifiers, and a crystal bridge power rectifier. Signals from the tuner are applied to V_1, from which both cathode and plate outputs are taken. The cathode circuit of V_{1A} contains a bandpass filter for the difference-frequency signal, which is then passed on to V_{4A}, a product detector. The plate output of V_{1A} contains wide-band noise which is applied to V_2, a relay amplifier, through a crystal-rectifier circuit. Also applied here is a 19-kc. signal from the plate of V_{1B}. When tuned to a station transmitting stereo, the relay is energized, a "stereo beacon" lamp is on, and the adapter functions normally. When tuned to a mono station, the relay is de-energized and the subcarrier signal path is grounded. The noise input mentioned above prevents interstation noise from operating the "beacon." Cathode output of V_{1B} delivers the sum signal to the matrix. V_3 is an oscillator, synced by the 19-kc. signal from V_2, whose 38-kc. output is applied to the product detector. V_{4B} serves as phase inverter for the detected difference signal as required by the matrix. Twin-triode V_5 is a pair of low-impedance anode-followers which deliver left and right signals to the stereo amplifier.* ▲





LOUDSPEAKER TESTING AND MEASUREMENT

By EDGAR VILLCHUR
President, Acoustic Research, Inc.

While listening tests are important, a speaker's performance can be predicted from properly made and interpreted test measurements, even before it is hooked up to a hi-fi system.

THERE is a widely accepted myth in the high-fidelity field that loudspeakers (unlike amplifiers, tuners, or pickups) cannot be tested objectively. It is frequently said that a listening test is the only way to check speakers.

Objective Testing

The objective testing of loudspeakers is more difficult and more complicated than the testing of other components and some writers have been led to the conclusion that such testing is not meaningful. However, the fact that meaningful speaker information is more difficult to come by, or that misleading information is easy to come by, does not invalidate objective investigations. As a matter of fact, the experienced person who can interpret properly made measurements can predict accurately what a speaker will sound like before it is even connected to the hi-fi amplifier.

A measured 1% distortion in an amplifier has the hi-fi enthusiast up in arms and writing indignant letters to the manufacturer. A measured 30% distortion in a loudspeaker, at the same frequency and signal level, is passed off as meaningless. It is how the loudspeaker sounds to *you* that counts, one is told, and never mind the distortion curve. One listens to music, not to curves.

It takes only a little bit of reflection to realize that such an argument can be used, with equal force, to disparage all electronic or acoustical measurements. One doesn't listen to tuner sensitivity figures, but to the clarity of reception; one doesn't listen to amplifier watts, but to the volume of sound, etc. The argument is just as faulty in each case.

Objective measurements can describe the accuracy of reproduction of any of the components in a high-fidelity system. If one is looking for a speaker sound which is dramatic and exciting in its own right (over and above the drama and excitement of the music), evaluation is a matter of taste and objective testing has no place. But if one sets out to evaluate the degree to which an amplifier or speaker reproduces accurately the musical signal fed to it, there are test procedures which tell the story.

Frequency Response

The most talked about measurement, and certainly one of the most important, is frequency response. The frequency response of a loudspeaker has the same significance as the frequency response of a cartridge or amplifier; a 10-db peak in the midrange or a sharp cut-off below 80 cycles, will produce the same aberrations of sound in any of these three components. Yet it is a fact that there often seems to be little correlation between the frequency response "curve" of a loudspeaker and the character of its sound.

This does not mean that speaker performance relies on some elusive quality not subject to scientific observation. It means that the particular curve does not actually represent the frequency response of the loudspeaker in question.

The output of an amplifier or of a cartridge appears as an electrical signal at definite terminals and the characteristics of these devices can be measured at these terminals. The output of a loudspeaker, however, consists of sound radiated into the room in many directions. The frequency response of the speaker may be completely different at different angles to its axis. If one were to listen to a loudspeaker in an anechoic chamber or out of doors, one would hear the quality represented by a frequency response curve recorded from a microphone placed at the particular listening position. This isn't true in a normally reverberant room. The listener hears a combination of direct and reflected sound and the major part of the sound is reflected back and forth between the room surfaces before it is heard.

Therefore the character of a loudspeaker in a room is for the most part dependent on the *total power* radiated at different frequencies, not on the particular "pressure" frequency response that exists in a direct line from the listener to the speaker. Even though one were sitting on-axis to a speaker, one would perceive all of its off-axis frequency response characteristics because they would be heard in the reflected sound. Two speakers with identical on-axis frequency response curves, but widely variant off-axis curves, may seem completely different in performance.

Off-Axis Performance

Frequency response curves which accurately represent the performance quality of a loudspeaker are not difficult to produce. It is necessary to measure a family of curves, both on and off the speaker axis. Experimental work may require that we take speaker frequency response curves for every 5 degrees between 0 and 90 degrees from the axis. Once it is established that there is a regular pattern to such a family, it is possible to represent the speaker's frequency response by a selected group of curves—for example, on-axis, 30 degrees off-axis, and 60 degrees off-axis.

Fig. 5 shows a midrange tweeter being clamped to a swivel board at one of *AR*'s anechoic chambers. Fig. 1 is a family of curves made by the *General Radio* automatic level recorder at the left in the photo. The *power frequency response* of this speaker is represented by all of the curves taken together. Although the on-axis curve by itself would seem to indicate response within ± 1½ db to about 15,000 cycles, the actual radiated power is considered as rolling off at about 7500 cycles. Hence this is the crossover frequency employed for a super-tweeter that is used with the midrange unit.

These considerations are most important for the treble range because it is here that the on-axis and off-axis characteristics of the speaker tend to be so different. There are also special problems with regard to representing the bass response of a loudspeaker.

Solid Angle

If a speaker were suspended by a rope in the center of the universe it would radiate bass sound in all directions and it would be said to "see" a solid angle of 360 degrees. Each time that this solid angle is reduced (by putting the speaker against a wall or at the junction of two surfaces) the cone is given a better bite of the air it engages and becomes more efficient in the bass range without the rest of the frequency response being affected. It is therefore not possible to place a speaker in an anechoic chamber—where it effectively radiates into 360 degrees—put a microphone in front of it, and procure a representative response curve of its bass range.[1] (See references.)

The author once received a letter from a puzzled music lover who had originally reacted to the musical sound of his

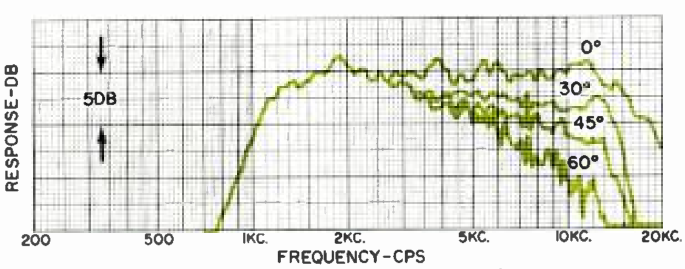


Fig. 1. Part of a family of curves for a midrange tweeter, recorded automatically by the equipment illustrated in Fig. 5.

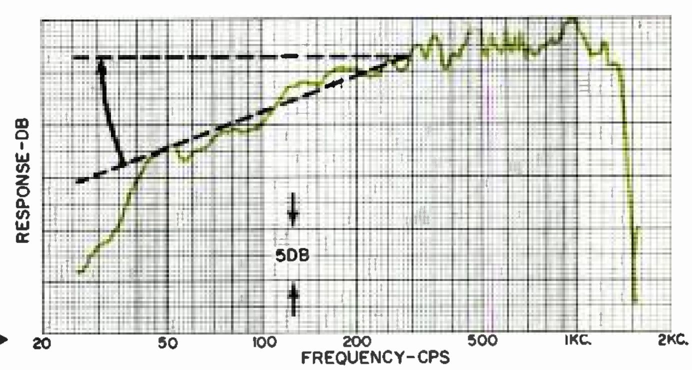


Fig. 2. Graph sent in by dismayed music lover. Response was measured in anechoic chamber. Dashed lines show bass correction.

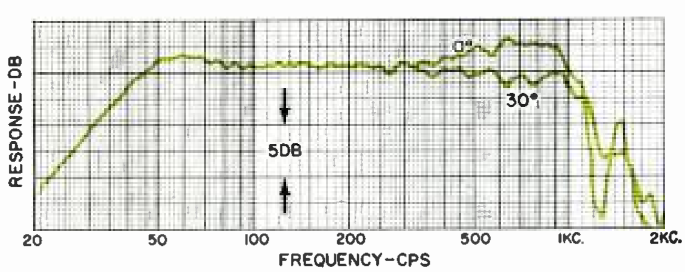


Fig. 3. Acoustic frequency-response curve of a woofer. This curve was recorded by the use of the outdoor testing setup that is illustrated in Fig. 6. Note that the diffraction dip that occurs at 1250 cps disappears when mike angle is changed.

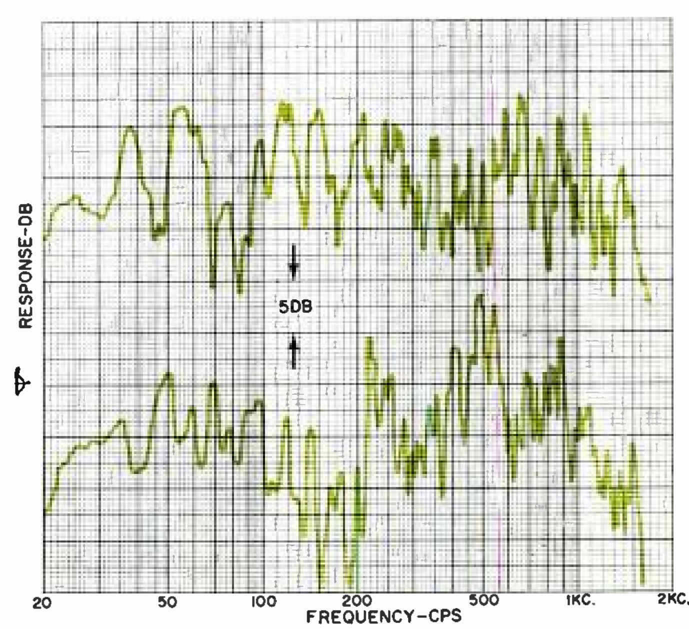


Fig. 4. Two frequency-response curves of the same woofer taken indoors, in an uncontrolled acoustical environment. The speaker was in a corner, about five feet off the floor; the two curves represent responses at two different microphone positions. Note the lack of similarity in over-all curve shape, and in location of the worst peaks and dips. These curves give more information about the listening room than they do about the loudspeaker.

Fig. 5. Midrange tweeter is being clamped to swivel board at an anechoic chamber, in preparation for frequency-response measurements to be taken at various angles.

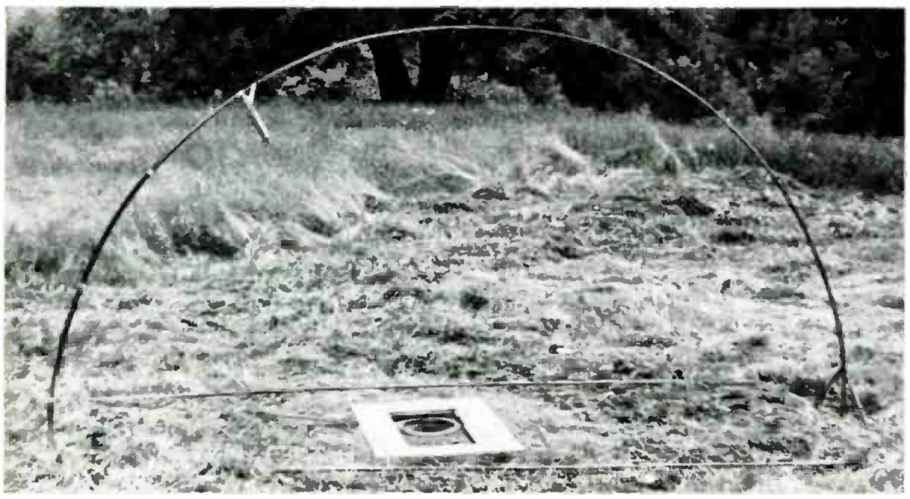


Fig. 6. Measuring frequency response of woofer at an outdoor test site with the speaker radiating into a controlled 180° solid angle. Mike is at 30° off-axis.

speakers with enthusiasm and delight. An engineer friend of his then got into the act and took the loudspeakers to be measured in an anechoic chamber. The friend, probably with an air of triumphant superiority, produced curves that he claimed made the speaker look very sick. The poor music lover was disturbed enough to send us the curves and this plaintive statement: "The enclosed curves seem to prove that my ears are wrong."

We were pleased to receive these curves because it is always good to have one's own measurement data confirmed by other sources and other test equipment. The bass curve which was interpreted as being so awful was, within very close tolerances for acoustic work, almost the same as our own anechoic chamber curves. If you take the curve shown in Fig. 2, representing radiation into a solid angle of 360 degrees, and convert it to represent normal room mounting (which usually involves something like a 90-degree solid angle), response in the bass range is increased; in the low bass the increase would be about 6 db. Applying further corrections for the chamber deficiencies in the very low range—including a chamber peak of 50 cycles—we have a woofer curve which is ± 2 db over its range.

A better way to test bass response in loudspeakers is to start out with a smaller solid angle and use an outdoor free field. Present speaker testing standards call for radiation into a solid angle of 180 degrees and this is often a very convenient method since the speaker can be buried in the ground[2] as shown in Fig. 6. Fig. 3 shows the curves produced by the test setup illustrated, using the same model speaker as employed in Fig. 2. This outdoor measurement is more accurate than an anechoic chamber measurement for the bass range because test chambers cease to be anechoic at very low frequencies, but the results are very close to the original curve of Fig. 2, if one knows how to interpret the latter. The particular speaker shown in the photograph was also measured in an anechoic chamber for other characteristics; the uncorrected chamber curve was very similar to that produced by the music lover's engineer friend.

Controlled Acoustical Environment

Sometimes attempts are made to get a rough indication of speaker frequency response by taking microphone measurements in an ordinary room. Such a method does not even give rough results because there will be far more variation caused by the room and by the particular positions of speaker and microphone than by the performance characteristics of the speaker itself. Fig. 4 shows two measurements of the frequency response of the same speaker in a live room, using different microphone positions. It will be noted that the peaks and dips in the two curves do not occur at the same places and it is these peaks and dips which, in a properly measured response curve, are the most significant elements that predict quality of performance.

One type of test that can be made without a rigorously controlled acoustical environment is the search for rattles, buzzes, "birdies," and other foreign noises which sometimes make their appearance at particular frequencies. The speaker is swept over the frequency spectrum by an audio oscillator, slowly, at a reasonable listening level. The tone should remain pure, without extraneous sounds and without the simultaneous production of tones different in frequency from the oscillator signal. It is important here to eliminate from consideration possible sympathetic vibrations of things in the room.

This is one kind of speaker deficiency which frequency response curves will probably not reveal, although tone-burst tests at the frequencies involved will display it clearly. The musical results are intermittent; blurring or a piercing shrillness is liable to occur only when the musical signal contains appreciable energy in the offending frequency region.

Interference

It is not possible, from the point of view of measurements, to treat a multi-speaker system as though it were a single unit. Interference patterns set up between different drivers, particularly in the crossover regions, produce a ragged curve which does not actually reflect performance. Merely moving the microphone position may convert a peak to a dip, or an elevated section to a depressed section. This interference effect, however, does not change the total power radiated by the system and therefore has little influence on the way the speaker actually sounds. If a multi-speaker system is to have its frequency response measured, one of three methods must be used—each driver must be measured separately, or the microphone must be placed at a great distance from the system to minimize path differences to the separate drivers, or the measurements must be taken in a reverberant rather than an anechoic chamber. The latter method produces a uniform sound field which relates to the total energy

(*Continued on page* 98)

TV MUSIC AND THE BROADCAST TECHNICIAN

By *WAYNE BRANDT* / CBS Television, Hollywood

The job and equipment of the technician who tapes the background music for network television shows.

THERE are many interesting areas of activity for the technician in broadcasting. We are all somewhat familiar, through our daily association with television entertainment, with the work of cameramen and audio men. Besides these more obvious jobs, there are many more technicians engaged in the recording, distribution, and transmission of television programming.

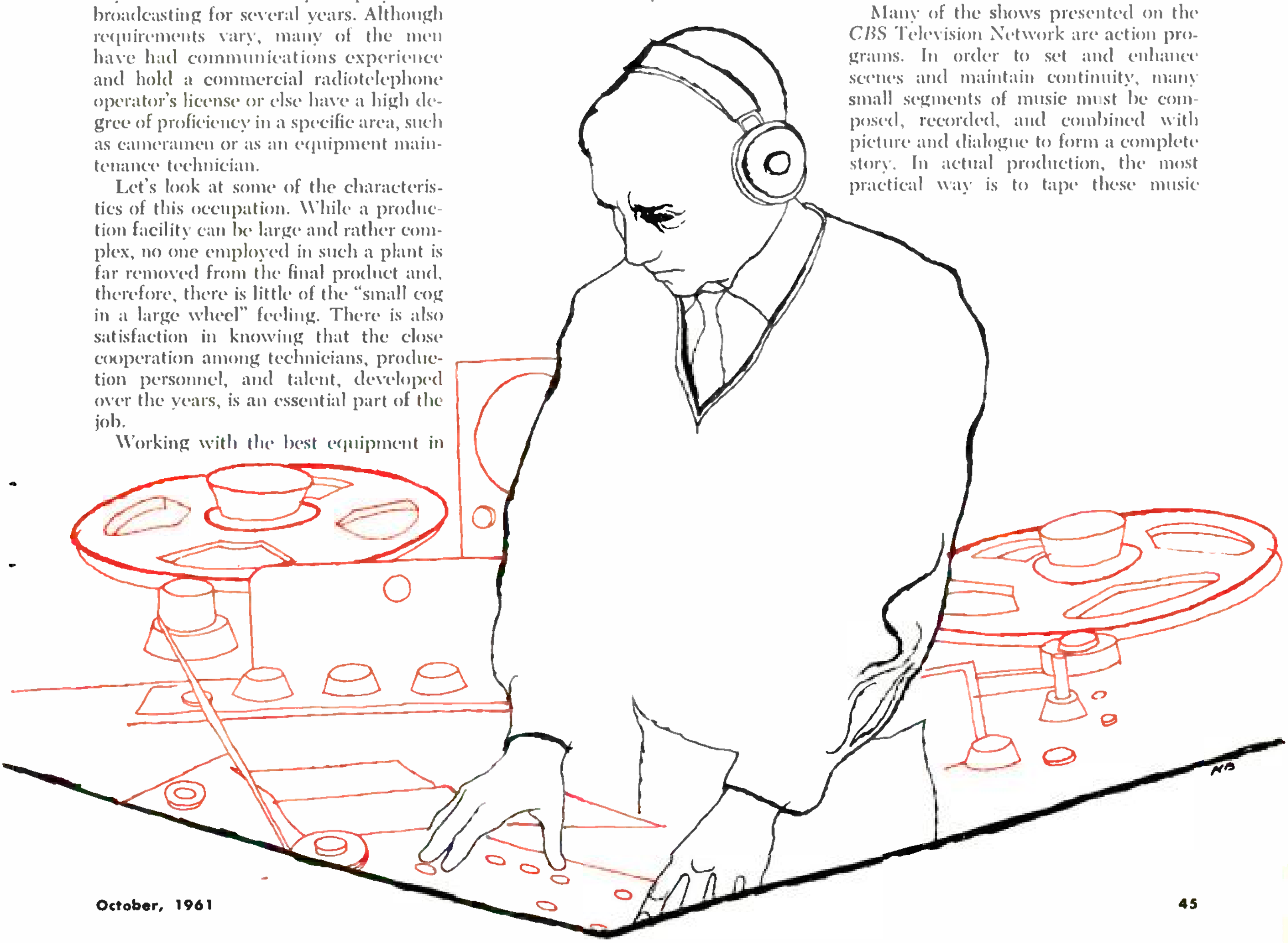
Most of the members of the technical operations staff at a television studio today have been actively employed in broadcasting for several years. Although requirements vary, many of the men have had communications experience and hold a commercial radiotelephone operator's license or else have a high degree of proficiency in a specific area, such as cameramen or as an equipment maintenance technician.

Let's look at some of the characteristics of this occupation. While a production facility can be large and rather complex, no one employed in such a plant is far removed from the final product and, therefore, there is little of the "small cog in a large wheel" feeling. There is also satisfaction in knowing that the close cooperation among technicians, production personnel, and talent, developed over the years, is an essential part of the job.

Working with the best equipment in the field is another rewarding aspect. The pay is satisfactory and, while the author hesitates to use the term "show business," there is a certain muted excitement in the realization that all of the equipment and ability is used to provide entertainment for millions of people. For the men so employed, all these things outweigh the few disadvantages which include a certain amount of unusual working hours and a varying level of employment.

While the industry as a whole has a certain fascination, individual areas, when carefully scrutinized, become even more interesting to the technically oriented individual. One such area is the Television Music Department. The men assigned to this department are drawn from the technical operations staff. In addition, it is desirable that they have an interest in and an ear for music since they must interpret, technically, the artistic desires of the musical supervisor assigned to each program. Let's see how this works.

Many of the shows presented on the *CBS* Television Network are action programs. In order to set and enhance scenes and maintain continuity, many small segments of music must be composed, recorded, and combined with picture and dialogue to form a complete story. In actual production, the most practical way is to tape these music



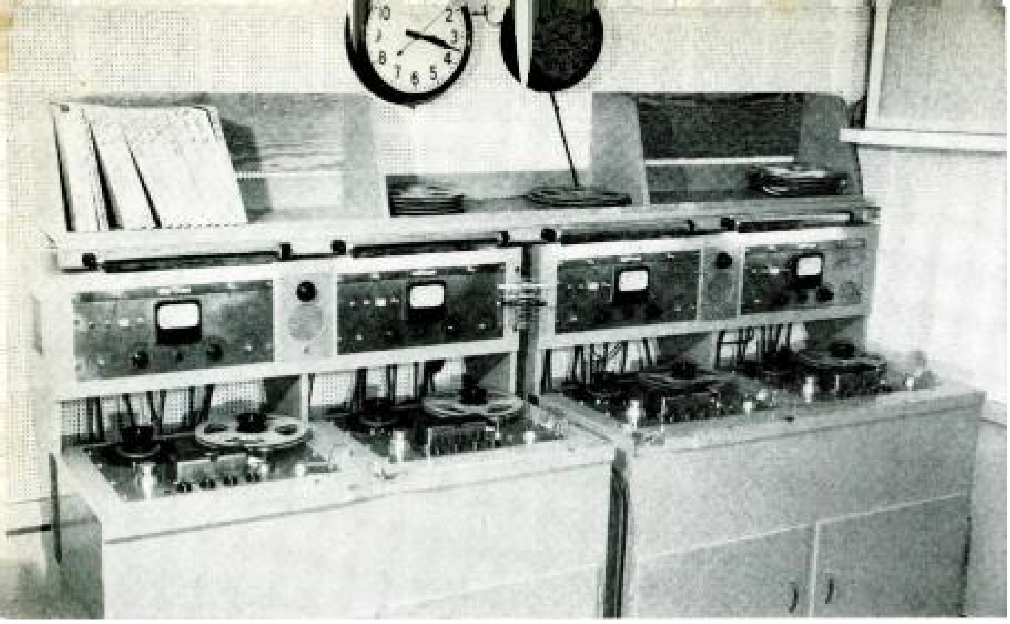


Fig. 1. The four Ampex recorders are mounted in two cabinets. These are on swivel casters and may be pulled away from the wall for access to the rear of the machines.

bridges or "cues" separately, at another time and place, and insert them later during the final dubbing or recording operation.

There is also a vast library of stock music inserts available for this purpose. These prerecorded bits and pieces must be timed and often edited to fit a smaller period of time or a portion of a "cue," perhaps just a few notes will be re-recorded and spliced into the original track to lengthen it and thus more nearly match the picture portion of the story.

It is sometimes necessary to make a composite track by mixing two or more cues and re-recording to obtain the desired effect. Also, blank leader stock must be spliced into the tape between each cue, to insure quick location during the final dubbing process.

Finally, all the cues for a single program are rewound onto one reel and delivered to the film duplicating plant or video recording studio. The Television Music Department is responsible for all of this and the editing and dubbing facilities are of interest to us here.

Equipment

At Television City in Hollywood, there are two dubbing rooms, identically equipped. Fig. 1 shows the four *Ampex* 350 tape recorders. Each pair of tape machines has a cueing speaker which can be switched to the output of either machine. A safety switch bypass has been added to enable the operator to spool waste tape off the machine into a convenient container, without the need for taping down or otherwise fastening the right-hand tension arm. The tape deck pivots upward for maintenance and the electronics chassis pulls out for access to the tubes and service adjustments.

The specially built mixing console and its associated pair of equipment racks, as seen in Fig. 3, are to the left of the tape recorders. The console has two output channels, each feeding a recording bus. Any combination of the four tape playback outputs, and up to four auxiliary signals, can be fed into either of the two channels. The control in the lower left of the photo is the "echo" or reverberation control. Its use will be described later.

The four controls in a group at the lower left are auxiliary input level controls. The first control is fed by a six-input push-button selector located in the upper left corner of the console. The corresponding inputs appear in the patch bay.

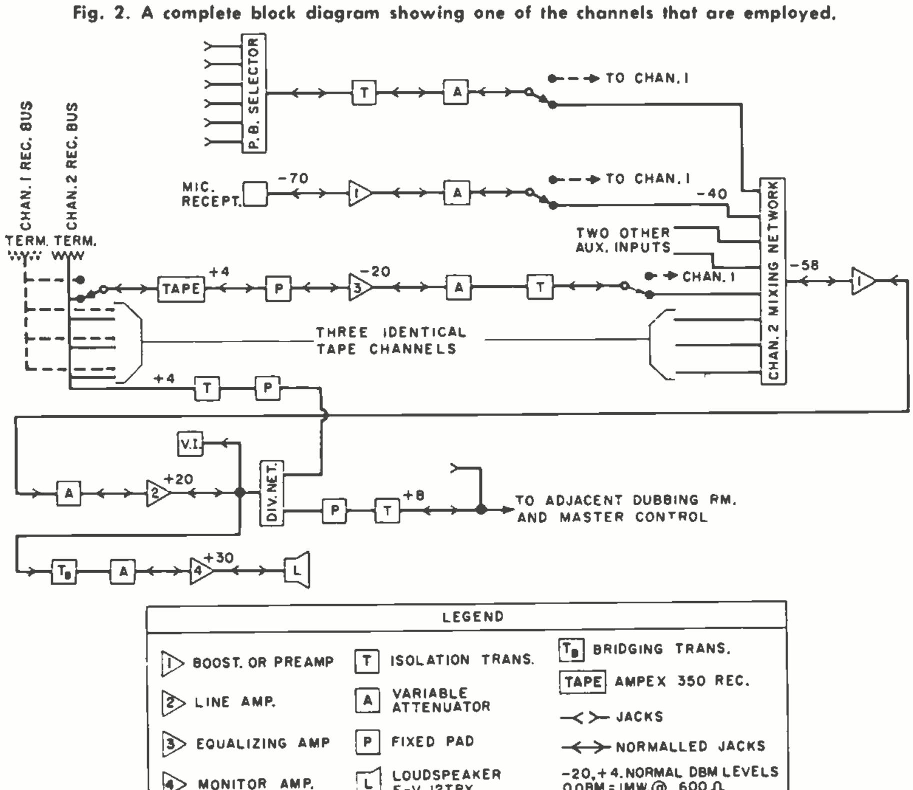
The remaining three auxiliary input controls have a microphone preamplifier preceding them, although this may be "patched out," that is, not used, if the auxiliary signal is of sufficient amplitude. The key switch directly above each control selects the channel to which its corresponding input is assigned. Each tape playback output goes to one of the vertical faders, located just to the right of the center of the panel.

The ease with which two or more signals can be simultaneously controlled with these straight-line potentiometers eliminates the need for a sub-mixing control. Above each vertical fader is the channel selector switch for the corresponding tape machine output. To the left of these keys are the keys which assign the tape machine record input to either recording bus of the console. To the right of these controls are the two master gain controls for the two output channels. The volume indicator for each channel is in the right-hand rack, directly above the console.

The far right end of the panel is occupied by the tape machine remote controls. These are included so an operator, when making multiple dubs, can start the recording machine, start one or more playback machines, and control levels with a minimum of leg work. In addition, a playback turntable is provided for disc-to-tape copying. Its output can be patched into one of the auxiliary inputs.

Directly above the console, in the left-hand rack, is the patch bay. Under usual conditions, a minimum of patching is required, since the circuits are "normalled" for routine requirements. However, almost every amplifier input and output, each tape recorder, and certain other cir-

Fig. 2. A complete block diagram showing one of the channels that are employed.



cuit points are available by patch cords to provide the needed flexibility.

Fig. 2 is the basic block diagram of one of the two channels of the system. Four basic amplifiers are used. The program or line amplifier provides sufficient power to distribute the signal of +8 dbm to the adjacent dubbing room or elsewhere in the plant. This amplifier must also feed the recording bus. A *Langevin* Type 117 is used here. This is a high-quality power amplifier of 50 decibels fixed gain and a maximum output of 8 watts. In this use, however, the normal output is about 1 watt. The booster amplifier raises the level out of the mixing network to that sufficient to drive the line amplifier. Since the input signal to the booster is quite low, on the order of −58 dbm, the booster must have a low inherent noise level. These conditions are similar to those for the microphone preamplifiers so the same amplifier, a *Langevin* Type 116B, is used here. This is a low-noise, two-stage amplifier of 40 decibels fixed gain, designed for low-level applications. The combined gain of 90 db for the line and booster amplifiers is necessary to make up the insertion loss of the mixing and output dividing networks and the variable attenuators and to insure adequate amount of reserve gain.

The specially built equalizing amplifiers are quite flexible, as Fig. 4 indicates. It is possible to boost or attenuate any three out of a possible 12 portions of the audio band, up to a maximum of 15 db correction. These amplifiers have a 6 db insertion loss when the controls are set for "flat" or unequalized response. Two 30-watt *McIntosh* amplifiers are employed for monitoring. These amplifiers have been adequately described in the past, so further description is unnecessary. Each monitor amplifier drives an *Electro-Voice* 12TRX monitor speaker, mounted in a bass-reflex cabinet. In tape editing, a speaker with good low-frequency response is quite helpful when locating the point at which a cut is to be made. These speakers are more than adequate.

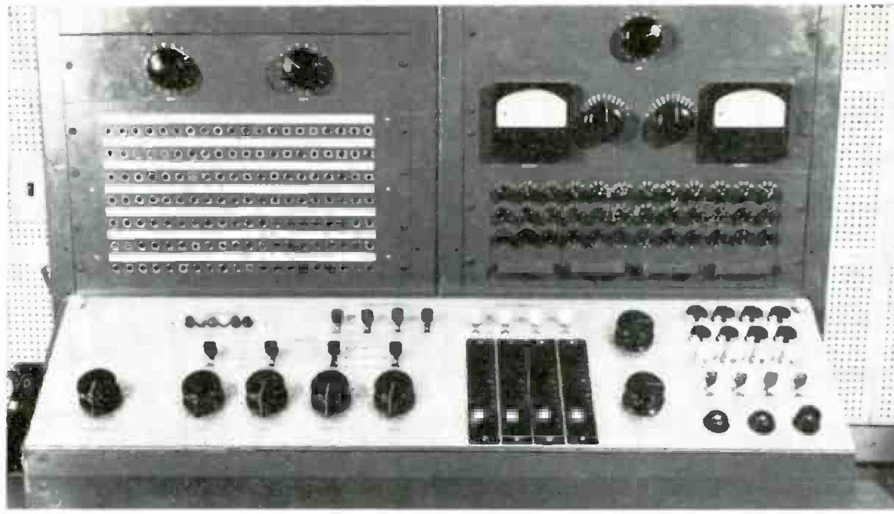


Fig. 3. The mixing console, with patch bay at left and equalizing amplifiers at right.

Reverb & Speed Regulation

Certain other circuit elements call for more complete explanation. The one-knob reverberation control is a time-saving feature. Each of the remotely located echo chambers has its associated amplifiers adjusted so that there is unity gain between the jacks labeled "reverberation in" and "reverberation return." A multiple of the original signal is patched to the "reverberation in" jack. Then the "reverberation return" signal is fed to one input of a cross-fading potentiometer and the normal signal, *i.e.*, without echo, is fed into the second input.

The cross-fade control consists of two ganged, linear-taper controls, whose outputs are combined and connected so that, in the counterclockwise position, the output from the control is original signal only and in the clockwise position, reverberation only. By rotating this con-

(*Continued on page* 66)

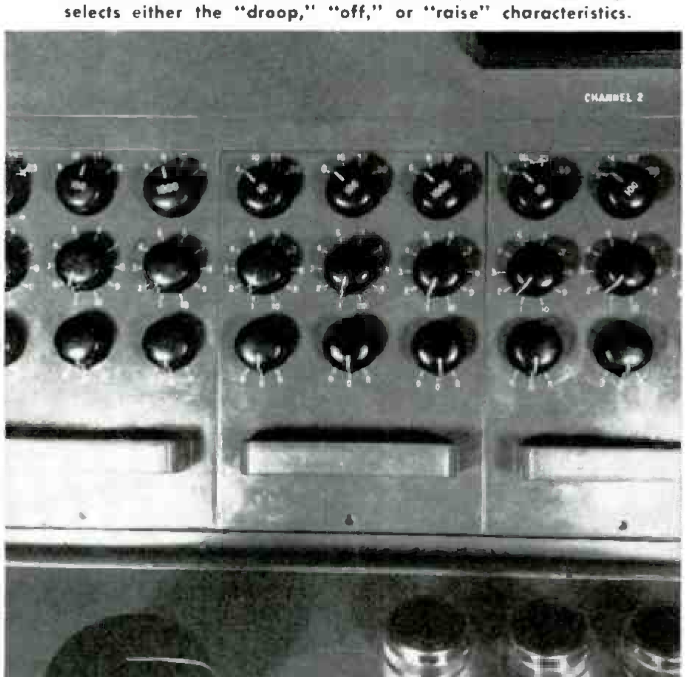
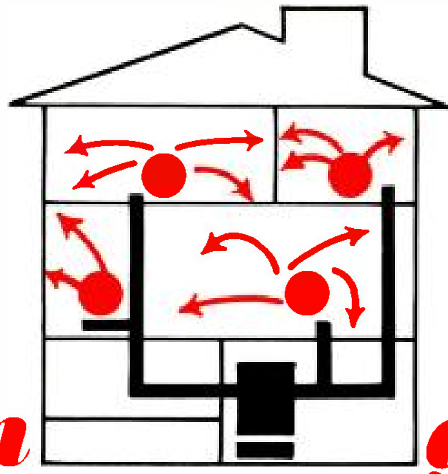


Fig. 4. The controls of the equalizing amplifier. The three knobs at the top, labeled "10," "100," and "1000," select the frequency that the operator wishes to equalize. The knob immediately below each frequency-selecting knob determines the amount of correction; the knob below that, labeled "D-O-R," selects either the "droop," "off," or "raise" characteristics.

Fig. 5. The tempo regulator in use with one of the regular tape machines. The revolving head drum is the part that looks like a small pulley in a cup, in the center of the panel. The large control at the left is the speed control, and the lever knob at the right of the panel engages the capstan idler, thereby setting the tape into motion through the machine.



ion generator & electrostatic air filter for the home

By **R. E. PATRIE** / Technical Staff, Philco TechRep Div.

Design and construction of precipitation filter-ionizer for installation in warm-air furnace. Unit cleans air and generates ions that may give feeling of well-being.

EDITOR'S NOTE: *Some investigators have found that concentrations of air ions, either negatively or positively charged, have little or no effect on general well-being or on respiratory ailments. There needs to be much more controlled data collected in order to substantiate some of the positive benefits claimed for negative ions, as outlined in this article. On the other hand, the air-cleaning ability of electrostatically charged surfaces has been definitely proven. The many commercial installations of equipment using this principle attest to this fact. For those of our readers who want to experiment with a means of generating negative ions along with electrostatic air cleaning, we offer the following article. Readers are also directed to the article "Electronic Air Purifiers" appearing in the July 1961 issue of this publication. WARNING: The voltages involved in this construction are extremely high and the precautions noted in the text must be taken to avoid serious shock.*

WHAT PROMISES to be a far-reaching "modern miracle" of electricity is now unfolding as a result of a better understanding of electrically charged air ions and how they affect us through the air we breathe. These small particles, only a few molecules in size, are either positively or negatively charged. The lives of such ions, especially those that are negatively charged, are very short as they are soon absorbed by the larger ions which have no charge.

Nature generates a constant and adequate supply of small ions through radiation from the sun and from the earth's crust. Under ideal conditions, such as exist in mountain areas, mineral springs, spas, etc., nature provides more ions with a negative charge than with a positive charge. A typical air sample might show about 1200 ions per cubic centimeter with 650 negative and 550 positive. Where air pollution is heavy, as in industrial centers, a typical ion count might be 100 negative and 300 positive, or even lower, as the air gets more polluted.

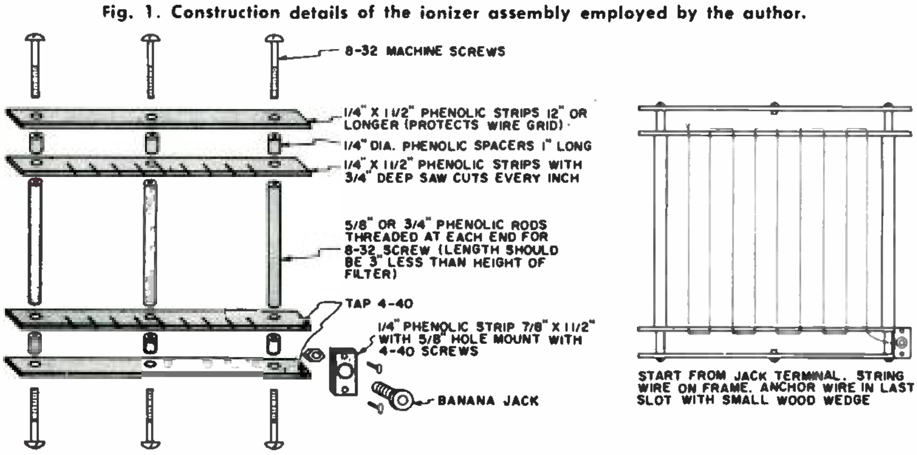
Dr. Kornblueh of the University of Pennsylvania, in cooperation with the *Philco Corporation*, has been conducting clinical tests and studies using measured concentrations of charged air ions—both negative and positive. It has been found that a predominance of negative ions in the air seems to promote a feeling of exhilaration and well-being and permits optimum functioning of the respiratory organs. If the proportion of negative ions is low, a depressed feeling results and respiratory functions seem to be restricted.

The Russians have been using high concentrations of negative air ions in the treatment of respiratory and other ailments and have reported not only temporary relief but, in some cases, permanent cures. Although the concentrations they used were much greater (in some cases 1000 times) than employed here, there were, according to their reports, no ill effects.

The upshot of all this is that we really have a new parameter to consider in evaluating the air in our rooms. Not only is it necessary during hot and humid weather to cool and dry the air but it would also appear to be desirable to inject negative ions as well. The negatively charged ions which, as pointed out previously, are short lived, are quickly depleted through the process of recirculating the room air, and must be replaced if the resulting "climate" is to have all the ingredients of nature's pure, fresh air. The same holds true in cold weather when the room air must be heated and humidified. Again, it is necessary to replace the negative air ions which have been lost during the heating and circulating process.

Hot-air heating systems tend to absorb a large number of negative ions as the circulating air passes through the heat exchanger and ducts. Replenishing these negative ions can be accomplished by means of the device whose construction is described here. Installed in your hot-air furnace, it will generate a fresh supply of negative air ions each time the blower comes on. In addition to gener-

Fig. 1. Construction details of the ionizer assembly employed by the author.



ating negative ions, this device will act as a precipitation filter by charging even the finest dust particles and cause them to be attracted to the metal filter in the furnace as the air is circulated through it. Smoke and most cooking odors resulting from minute air-borne particles, which ordinary filters cannot touch, are quickly dispelled by ionization and electrostatic precipitation.

Construction of Unit

The ionizer unit consists of a fine wire grid in close proximity to a flat expanded metal plate placed against the permanent type filter already installed in the blower compartment of the furnace. A d.c. potential of approximately 5000 volts is applied between the wire grid and the grounded plate and filter. By connecting the negative terminal of the power supply to the wire grid and grounding the positive terminal, the unit will give off negative ions to the air stream. The d.c. potential produced by the circuit to be discussed should not be exceeded by more than 20% and the spacing between the wire grid and the metal plate should be kept somewhere between ½" and ¾". By staying within these limits, ozone and other unwanted products will be kept to a negligible quantity. The a.c. input to the power supply is taken off the blower motor circuit so that the unit operates only when the blower is running.

The ionizer unit is constructed with a phenolic frame on which a fine steel wire, .003" or smaller, is strung. (Wire-recorder wire will do nicely.) The frame is made up of ¼"x 1½" phenolic strips with ¾" diameter phenolic rod as spacers. Details of the assembly are shown in Fig. 1A. Over-all dimensions are not given as they will depend on the size of the filter in the furnace. The height of the frame should be the same as that of the filter. The length need not exceed 15 inches even though the filter is longer than this. If the ionizer frame is over 10 inches long, a center support, made from the same round phenolic stock, should be used to prevent sagging. Saw cuts are made one inch apart and half way through both of the inner strips. Approximately 2 inches should be left uncut at each end of the strips. The two outer strips serve only to protect and isolate the wire grid.

After the frame is assembled and the input banana jack installed, the fine wire can be strung. Begin by attaching one end of the wire to the terminal on the banana jack and wind back and forth through the slots as shown in Fig. 1B. Do not put too much tension on the wire as it is being wound. Because of its small cross-section, very little tension is required to keep it straight. Make sure that the wire rests at the bottom of each of the slots. Anchor the wire in the last slot by driving a small wooden wedge or matchstick in the slot against the wire. Give the frame only two coats of clear Krylon, allowing one-half hour drying time between coats.

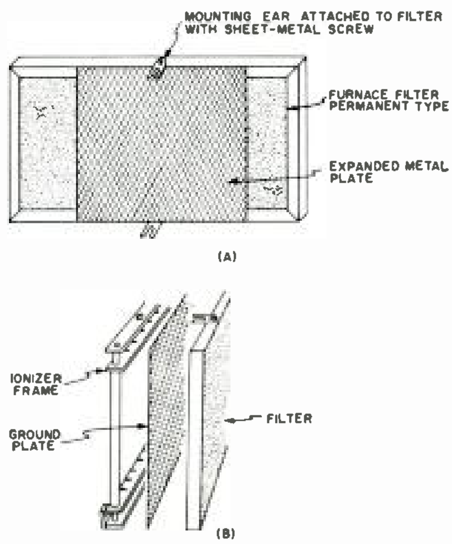
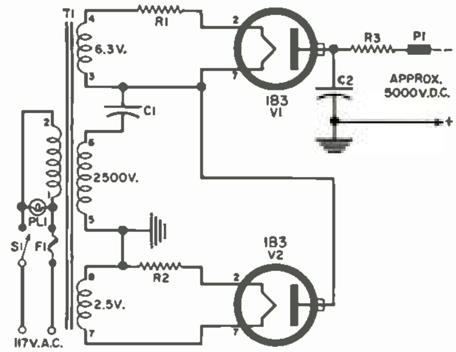


Fig. 2. Installation of ionizer to filter.

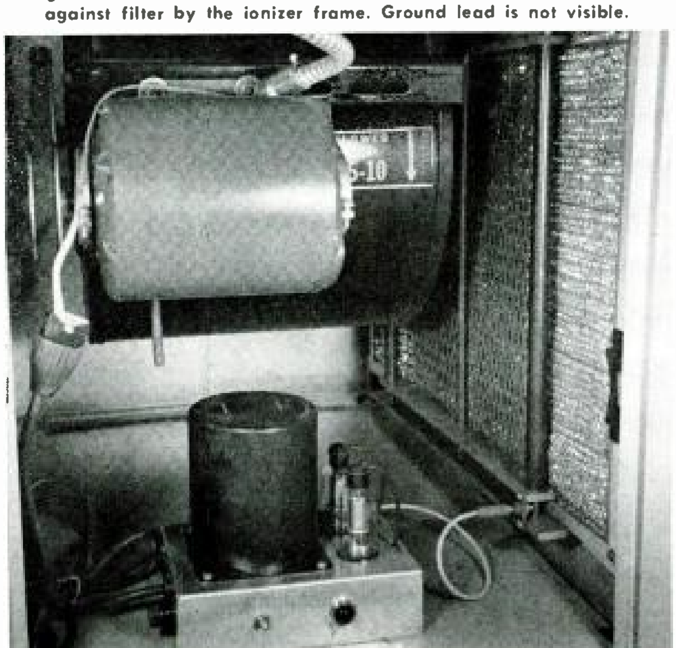


R_1*—25 ohm, 2 w. res.
R_2*—6 ohm, 1 w. res.
R_3—16.5 megohm res. (Five 3.3-meg., ½ w. resistors in series should be used.)
C_1,C_2—.005 µf., 6000 v. capacitor (Aerovox P84CM)
F_1—1½ amp fuse
S_1—S.p.s.t. toggle switch
P_1—Banana plug
PL_1—117-volt pilot lamp
T_1—Power trans. (Herbach & Rademan TM-9541 or equiv., see text)
V_1,V_2—1B3 tube (miniature 1X2 may be used)
*If transformer T_1, as specified, is used, R_1 and R_2 are required to drop filament voltage to 1.25 volts @ .2 amp for 1B3's. If other transformers having 1.25-volt filament windings are available, R_1 and R_2 may be omitted.

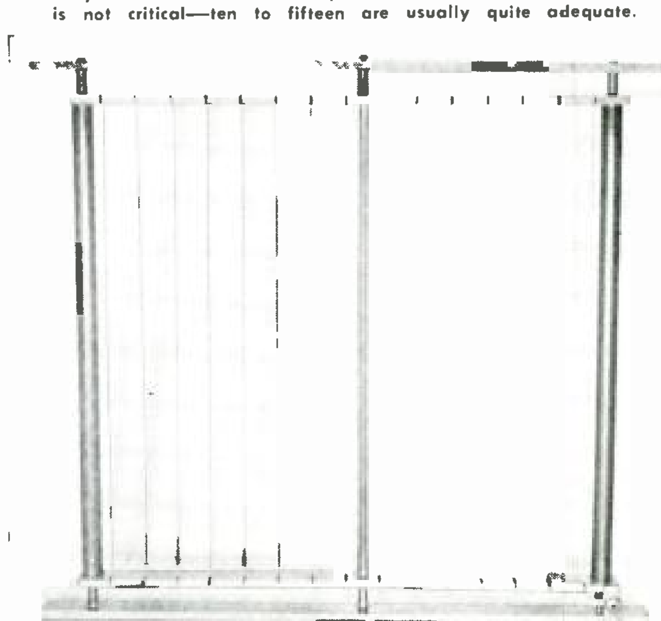
Fig. 3. Schematic of half-wave voltage-doubler power supply for the ionizer unit.

The unit is attached to the filter by thin metal straps cut to form mounting ears. These should be permanently attached to the top and bottom of the filter with sheet-metal screws, as shown in Fig. 2A. A piece of flat expanded metal, with ½" or ¾" mesh, is cut to the over-all size of the ionizer frame and is sandwiched between the ionizer frame and filter when the two are fastened together (Fig. 2B). This sheet serves as the positive ground element of the ionizer and the surface which faces the ionizer grid should be thoroughly polished with fine sandpaper or emery cloth to

Ionizer and power supply installed in blower compartment of gas-fired hot-air furnace. Expanded metal plate is held firmly against filter by the ionizer frame. Ground lead is not visible.



Ionizer grid is made with wire-recorder wire that runs vertically between the slotted strips. The number of wire "rungs" is not critical—ten to fifteen are usually quite adequate.



remove any sharp edges which would impair operation of the ionizer.

The Power Supply

The unit will work satisfactorily with any power supply that will provide a d.c. potential of from 4000 to 5500 volts. For this application, the positive terminal of the power supply must be at ground potential so that the high-voltage terminal will be negative with respect to ground. The current requirement of the unit is very small—less than a tenth of a milliampere (100 μa.).

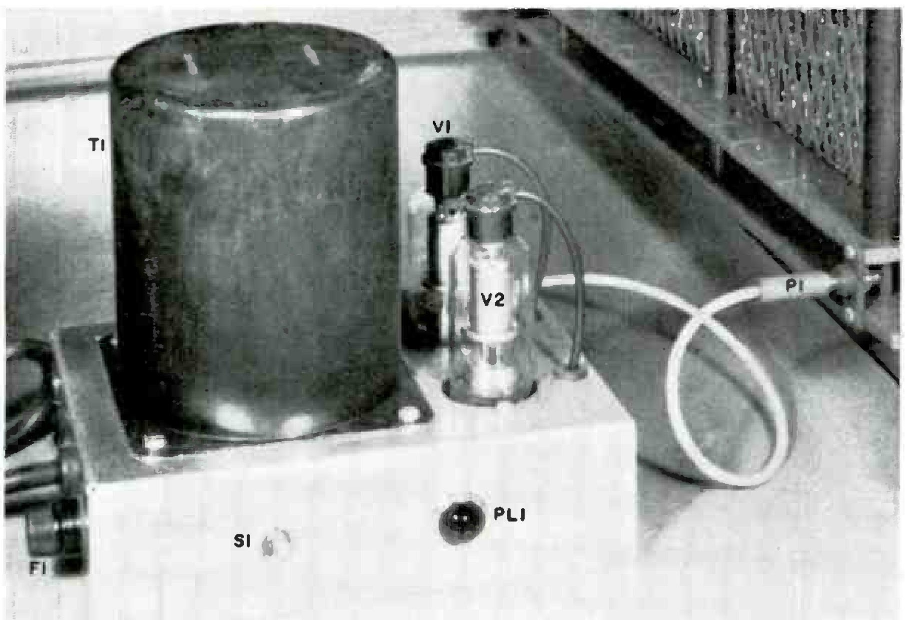
The power supply described here and shown schematically in Fig. 3, employs a half-wave voltage-doubler circuit. The power transformer has a 2500-volt secondary and three filament windings, only two of which are used. Although greatly over-rated, it was chosen because of its low price and excellent construction. Any transformer with a 2500-volt secondary and two well-insulated filament windings or with a 5000-volt secondary and one well-insulated filament winding will do the job. The current rating of the high-voltage secondary need not be more than 1 ma. If the latter type is available, only one rectifier tube is required and a simple half-wave rectifier circuit may be employed.

The filament requirement of the 1B3 rectifier tube is 1.25 volts @ .2 ampere, so the value of a series resistor with a 6.3-volt filament winding will be approximately 25 ohms. The series resistor required with the 2.5-volt winding is 6 ohms. Ordinary composition resistors of one to two watts rating (see parts list) are adequate in either case. Exact resistance values required may be obtained by using a pair of resistors hooked in series or parallel, as needed, to get as close to the values shown in the parts list as possible.

Specific chassis layout and details of construction will obviously vary considerably with the type of transformer used. The bottom view of the 2"x5"x7" chassis used by the author can serve as a guide in the placement of parts no matter what type of power transformer is employed. The builder can cut corners if he wishes by eliminating the pilot light and the switch. Likewise, the fuse and holder can be left off the chassis by substituting a fused plug in place of the regular a.c. plug.

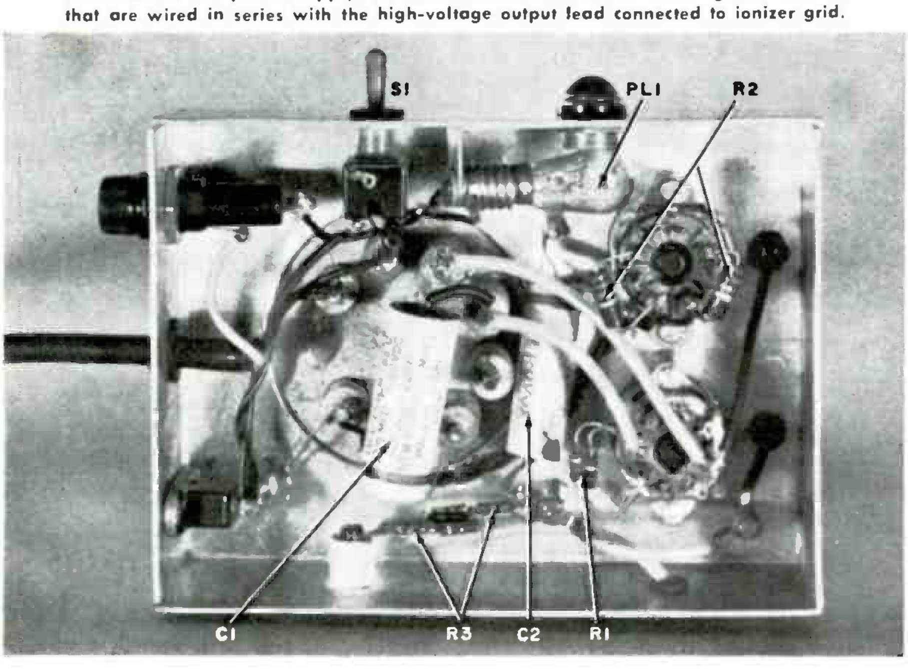
The high value of resistance in series with the high-voltage output lead (approximately 16.5 megohms) serves to limit the current (and voltage) in the event of a short in the ionizer or high-voltage lead. In addition to protecting the transformer secondary, it will lessen the severity of shock in case of personal contact. *This does not alter the fact that the power-supply plug must be removed before handling the ionizer or power supply and that extreme caution must be exercised in testing or working with the unit.* Five 3.3-megohm, ½-watt resistors connected in series are recommended here rather than a single resistor. The high-voltage lead should be of the type used in TV high-voltage or automotive-ignition circuits.

Carefully check the wiring of the power supply before applying a.c. Place a 1½-ampere fuse in holder; make sure the plug end of the high-voltage lead is clear of the chassis; plug the unit in and turn on the switch. Measure the output voltage with a high-resistance d.c. voltmeter or a v.t.v.m. with a high-voltage probe. If neither instrument is available, an approximate check can be made as follows: slowly and carefully bring the exposed end of the high-voltage lead (banana plug) toward the chassis *(do NOT touch the exposed end)*. A thin, continuous spark should be given off when the end of the plug is within approximately ⅛ inch of the chassis. Do not prolong this test. If a spark is obtained, you can be sure that the power supply is operating normally. If no spark is obtained before the plug touches the chassis, check the fuse and wiring for possible wiring error. *(Unplug the unit during checking process, applying power only when specific tests are to be made.)*



Close-up of the power supply showing power transformer and two rectifier tubes.

Underside of the power supply. At lower center are the five 3.3-megohm resistors that are wired in series with the high-voltage output lead connected to ionizer grid.



Installation

A short length of a.c. cord should be brought out from the junction box supplying the blower motor and terminated in a cord-type a.c. receptacle. This lead can be brought out from the motor terminals instead if they are easily accessible. Test the receptacle by plugging in a lamp and observe that it comes on when the blower motor starts.

Before putting the ionizer and power supply in the blower compartment, a piece of Masonite should be cut to size, sprayed with two coats of lacquer or enamel and fitted in place at the bottom of the compartment. This helps to keep moisture and dirt from the ionizer unit and power supply, and also makes it

(Continued on page 90)

CALIBRATION STANDARDS FOR THE V.O.M.

By TOM JASKI

This instrument can give you commendable accuracy—if you know how to calibrate it and what standards to use.

THE ACCURACY of ordinary volt-ohm-milliammeters is far from that of precision, laboratory instruments, particularly if we consider the worst inaccuracies that may be present within the limits of the manufacturer's guarantee. (See "Is Your Multimeter Accurate?" in ELECTRONICS WORLD, February, 1961.) There are doubtless many occasions when you want the assurance of better reliability than this although you are not interested in the ultimate in precision. Fortunately the inherent capability of the instrument is such that, with calibration, a relatively high degree of accuracy is possible.

The simplest way to calibrate is to compare the instrument's readings on various functions and ranges with those of another, precise instrument and to record the deviations. However a second instrument of this order is seldom available. The next best procedure is to use the v.o.m. for reading quantities that are already known precisely. The chances of finding such quantities to serve as standards are quite good.

The most readily available standards will be certain d.c. voltage sources. These permit a direct check of the meter's d.c. voltage readings. These same sources can then be adapted to check the instrument's current readings. From the knowledge thus obtained, it is possible to extend into a check of a.c. and resistance scales. In this article, we will be concerned chiefly with the available standards and their use for calibrating direct voltage and current ranges. Other meter functions will be left for subsequent articles.

Source Voltages

The first question is where to obtain reasonably precise voltages. A number of sources, all useful but some more accurate than others, are available. The order in which they are listed here reflects the author's preference. If you do not agree, you may re-order them to your liking. Your own choice may depend on many factors aside from which is the most precise, if you are not seeking the ultimate. For example, you may be swayed by which is the least expensive, most readily accessible, or easiest to use. Here are eight possible sources:

1. A calibrated *Weston* cell produces an output of exactly 1.0183 volts—if you can read this closely on your instrument. The calibration has been performed by the National Bureau of Standards. Sometimes these cells can be found in the laboratories of high schools and junior or senior colleges, sometimes in instrument repair shops. If you have access to the sources mentioned, you would not need a better standard.

2. An uncalibrated *Weston* cell is also rated at 1.0183 volts. However, without calibration, you have assurance that this source is accurate "only" to .1 per-cent. One of these may cost from $15 to $20, which may make it a worthwhile investment in some cases. Incidentally all *Weston* cells are designed to be used at a rated temperature of 20 C for the specified output, or 68 F. This is not a difficult condition to fulfill, and it is doubtful that any but unusual temperature deviations will introduce more error than you will tolerate.

3. *Mallory* has brought out a new voltage standard consisting of eight carefully selected mercury cells to make a total of 10.8 volts, in tapped steps of 1.35 volts each. This standard will hold to .5 per-cent accuracy over a number of years. The price of the assembly is about $40, so it is hardly worth an investment unless you have an unusual number of meters to calibrate!

4. Any new mercury cells, at their rated voltage (usually 1.35 volts, but this may vary—check manufacturer's data). These will show the voltage stability with time that is characteristic of cells of this type. The initial, rated voltage may not be so precise as that for the selected cells used in the *Mallory* standard. Even so, accuracy will be high.

5. Rechargeable nickel-cadmium cells under a specified condition. Fully charged units of this type tend to show a somewhat high voltage output early in the discharge cycle, then settle down to rated voltage and maintain it almost to the end of the cycle, at which point a rapid drop-off occurs. For example, a fully charged cell may read 1.3 volts or slightly higher. Put into service, it will soon settle down to a value usually between 1.2 and 1.25 volts, to which it will adhere closely until it approaches full discharge. A practical procedure is to charge the cell fully, then discharge it somewhat for use as a standard. The recommendation for certain *Burgess* nickel-cadmium cells, for example, is that they be charged fully, then discharged to half capacity, at which point output is very close to 1.2 volts. Capacity and output-voltage ratings may be obtained from manufacturers' specifications. Armed with this data, you can easily calculate how long you should permit a fully charged cell to discharge across a given resistive load to achieve reliable output.

6. A fully charged automobile battery is also a good source, if it is in good condition. The equipment for checking condition and state of charge is simple enough to use, if you have access to it. Output should be very close to 2.12 volts per cell. Thus, depending on the size of the battery, this single source can give you three check-points up to 6.36 volts or six points up to 12.72 volts.

7. A reasonably fresh flashlight battery that has never been used, accidentally shorted, overheated, or frozen is also useful. A good figure to assume for the output is 1.56 volts. Depending on whether the battery is right out of the factory or more than a year old and also depending on the size of the cell, there will be some variation around this value, but it is not likely to be more than 1 per-cent off. For greatest reliability, the literature of the particular manufacturer for the particular cell size should be consulted. For example, type 950 *Eveready* cells (size D), unused and properly stored, average 1.57 volts output 6 months after manufacture, 1.56 volts at the end of a year, and 1.55 volts after 18 months to three years.

8. *Sylvania* suggests the circuit of Fig. 1 as an accurate voltage standard. A low-voltage source and a potentiometer are used to adjust the current through a 1N34A diode to approximately 20 microamperes. Because of the nonlinear characteristic of the diode in this range, precision adjustment of the current in the circuit is not necessary to keep the voltage drop across the crystal very close to rated voltage. Thus a precise meter is not necessary to start out with. The chief disadvan-

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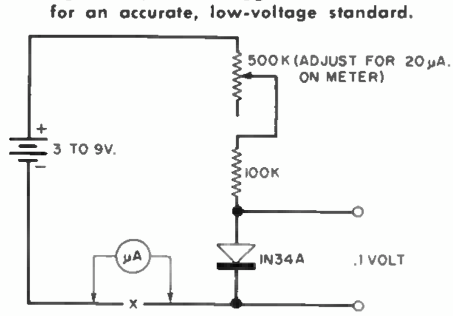
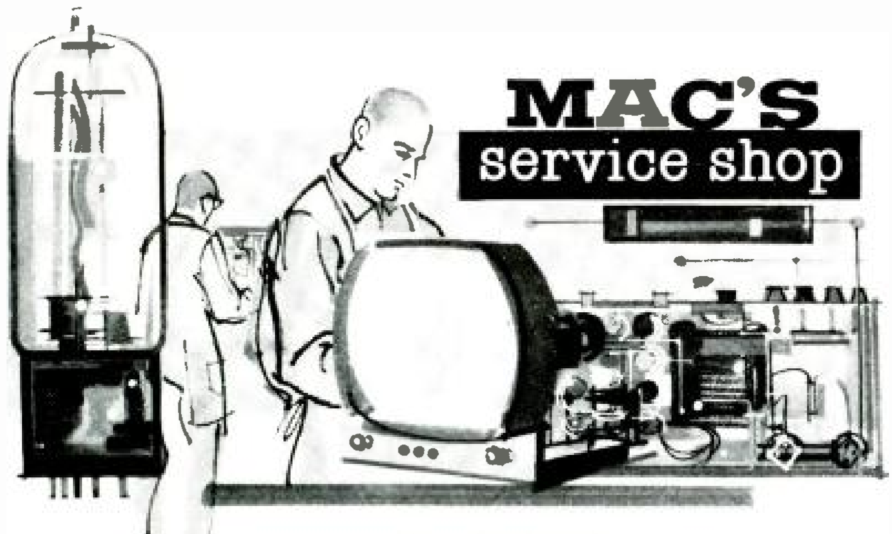
Fig. 1. Sylvania suggests this circuit for an accurate, low-voltage standard.





Bright Horizons in Service

BARNEY, the Number Two Man at Mac's Service Shop, listened a lot. Strictly speaking, this was not his idea. Things just worked out that way. He had a lot to learn, and he was bright enough to know he learned more listening than he did talking. Still and all, he was an Irishman with a natural love of talking; and he thoroughly enjoyed doing the "telling" when an opportunity presented itself.

Mac knew the youth pretty well; so he recognized the I've-gotta-talk-or-bust symptoms when Barney bustled into the service department and put on his shop coat.

"Say, Mac," the youth said with studied casualness, "how much of their disposable income do you suppose the American people spent for services last year?"

"I dunno; do you?" Mac asked innocently.

"Yes sir, I do," Barney said importantly as he pulled a little piece of paper from his shirt pocket. "I happened to run across a little brochure the other day that gave some figures especially interesting to anyone doing any kind of service work. The figures came from the Department of Commerce; so they should be reliable. Last year we spent around one hundred and thirty billion dollars for services. That compares with a hundred and fifty billion dollars spent for non-durable goods and forty-seven billion dollars for durable goods." He paused dramatically to let these figures sink in.

"What do you include in 'services'?" Mac asked.

"Aw, you know: electricity, gas, telephone, transportation by public carriers, film processing, radio and TV repairs, auto repairs, appliance repairs, and so on. I mean the same thing the panel of *What's My Line* does when it asks: 'Do you deal in a product or a service?' While those big figures shake you, the really significant thing is the way the percentage of disposable income spent for services is rising much faster than that spent for the other two items. Take last year, for example. For the first time in history, nearly forty per-cent of our disposable income went for services. During the ten years between 1949 and 1959, while total personal expenditure for goods was rising 58%, the expenditure for services rose a whopping 105%. With people channeling more and more of their income into services, it looks as though we're in the right business, doesn't it?"

"Maybe," Mac agreed cautiously. "When you remember that in this period Americans have had more money to spend for fun, more ways to spend it, and more time to enjoy spending it, the figures are not too surprising. However, those figures you gave include a whole lot of services. I'm wondering how our particular brand of service stands up to some of the others."

"I can tell you that, too," Barney offered eagerly as he consulted his paper. "Here are some of the increases in consumer expenditures for different kinds of service in the 1949-1959 period:

Airline Transportation	393%
Radio and TV Repairs	290%
Gas	180%
Electricity	159%
Telephone	132%
Auto Repairs	92%

As you can see, we're second in growth in that group; and those below us aren't exactly flyweights."

"Those figures are mighty encouraging," Mac commented; "but statistics are always dangerous if they are swallowed whole and not digested. That is what Disraeli probably had in mind when he remarked, 'There are lies, damned lies, and statistics!' Statistics are concerned with generalities or averages, and you probably have heard of the sad case of the man who drowned in a river that *averaged* only two feet deep. He stepped into a pothole that was ten feet deep.

"Those figures indicate that radio and TV service, as a whole, is marching ahead rapidly. More and more money is being spent on it. They *do not* mean that the individual service technician is going to share automatically in this prosperity. Whether or not he gets his fair share of the increase will depend on how willing he is to work and to study. Unless he is at least average in technical knowledge and business ability, he has no right to expect his business to keep pace with the national average."

"Yeah, and that thing of staying 'average' gets tougher all the time," Barney offered. "As the service business becomes more lucrative, more and more people will be attracted to it. The slobs won't last long, but the fellows who stick it out are going to have to be pretty good to get a foothold. Thanks to these eager beavers, the average ability will be constantly pushed up. We fellows already in the game are going to have to run a little harder just to hold our place in line."

"I'm glad you realize there's no resting on the oars in radio and TV servicing—especially from here on in," Mac applauded. "Not to change the subject, I've been doing a little interesting reading, too. A couple of months back *Time* published a story that paid an oblique tribute to the power and influence of service technicians on the buying public. The story discussed the outstanding success of one TV receiver manufacturer. A few years back when TV sales slowed down, this company refused to go along with the crowd in trying to find cheaper ways to manufacture TV receivers so the price could be cut. Instead, it published full-page advertisements saying it was refusing to adopt automatic manufacturing techniques that cut manufacturing costs but made the sets more difficult to service. It refused to cut either the quality of its receivers or their selling price.

"The story went on to say that service technicians, in appreciation of the consideration thus given them, enthusiastically plugged the products of this manufacturer. What was the result? Today that company is the nation's biggest maker of TV sets. Last year its sales amounted to $254,000,000, and its profits were $15,200,000. If I were a radio or TV manufacturer, I should ponder those figures and their significance very carefully. The good will of the service technician is a very tangible asset to any manufacturer.

"But it is important to realize the good will of the service technician in this case was not won *only* by making the sets easier to service. Equally important was providing him with a product he could recommend in good conscience and repair with pride and satisfaction. You know what I mean. You have seen the contempt with which a mechanic regards a device that, instead of using bolts, is cheaply put together with rivets so it cannot be disassembled for inspection or the easy replacement of worn or broken parts. As he will quickly tell you, 'This thing is junk. It was made to be thrown away, not repaired.'

"Well, the radio and TV technician feels exactly the same way about a radio or TV receiver that may have been easy and cheap to assemble but is

(*Continued on page 88*)

IMPEDANCE MATCHING IN PUBLIC-ADDRESS SYSTEMS

PART 2. HIGH-Z LOUDSPEAKER LINES

By MORTIMER S. SUMBERG, Director of Sales
Bogen-Presto Div., The Siegler Corp.

The installation of more complex sound systems by the audio technician is covered in this article.

LAST month the importance of impedance matching was stressed and the basic techniques commonly employed for properly connecting an amplifier to loudspeakers were explored. Simpler sound-system hook-ups were reviewed—those which did not require line-matching transformers and which permitted the use of low-impedance speaker lines. In this article (and the succeeding one), our concern will be with more complex sound-system arrangements where one or more factors dictate the use of high-impedance lines.

Matching with High-Z Lines

As pointed out earlier, high-impedance transmission lines (*e.g.*, 250 or 500 ohms) should be used in a sound system where the loudspeakers are: (1) located at considerable distances from the amplifier, and (2) driven to unequal levels.

In the first instance we must avoid low-impedance lines because of the excessive line losses which result; the requirements of the second system would be virtually impossible to satisfy without the installation of a line-matching transformer at each speaker. High-impedance lines are usually terminated at a 500-ohm tap on the amplifier output terminal strip. Sometimes the equipment manufacturer provides 250 ohms and other output impedance values on the amplifier. The other end of the high-impedance line is brought to the primary of one or more line-matching transformers whose secondary connects to the loudspeaker voice coil. This method of providing proper impedance match between load and amplifier is sometimes referred to as the constant-impedance method—to differentiate it from the constant-voltage method.

For a clear understanding of the manner in which the line-transformer type and its correct primary impedance tap are determined, the same matching

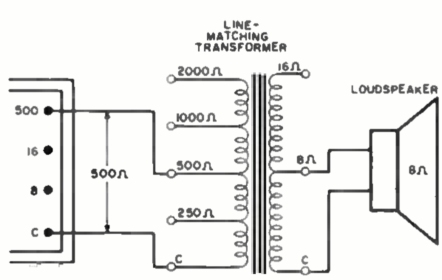
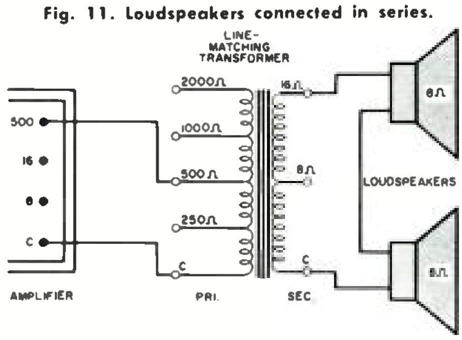


Fig. 10. Sound system using 500-ohm line.

Fig. 11. Loudspeakers connected in series.



problems shown in Figs. 4 through 9 (Part 1) will be re-examined and it will be demonstrated how high-impedance speaker lines (*i.e.*, constant-impedance method) and line-matching transformers may be used instead of direct connections between amplifier and loudspeaker voice coils.

Single Loudspeaker: The sound system in Fig. 10 employs a 500-ohm speaker transmission line to interconnect an 8-ohm loudspeaker with the amplifier. The primary of the line-matching transformer (usually mounted directly on the loudspeaker) provides several taps at different impedance values.

In this instance, the 500-ohm tap is connected to the amplifier output tap of the same value to present a perfect impedance match. Since the loudspeaker voice-coil impedance is 8 ohms, the line-matching transformer secondary tap of the same value is used. If a 16-ohm loudspeaker were to be connected, then the 16-ohm tap on the secondary of the line-matching transformer would be hooked to the voice coil.

Referring back to Fig. 2 (Part 1), we find that this 500-ohm transmission line may be as long at 1300 feet if #20 A.W.G. conductors are installed. In the system shown in Fig. 4 (Part 1), a low-impedance line was required for connecting an identical speaker to the amplifier. With #20 A.W.G. conductors (see Table 1 in Part 1), the low-impedance line can be no longer than 60 feet before losses be-

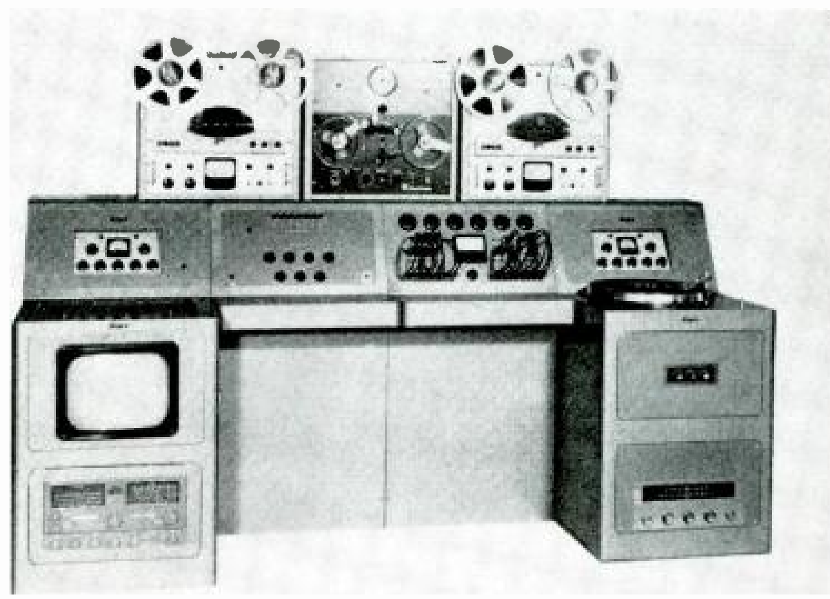
A 3-channel sound system for schools, industry, and small institutions.

come excessive. To save the few dollars which the line-matching transformer costs, the sound installer would have to pay considerably more for the extremely heavy conductors required for a run of 1300 feet. Aside from cost considerations, the latter cable would be very difficult to work with because of its size and almost impossible to pull through small-diameter conduits. Obviously, the high-impedance line and transformer are selected as the practical impedance-matching method.

Loudspeakers in Series: This arrangement is somewhat unusual and not frequently found in actual field practice. Its only recommendation is the saving of one line-matching transformer. As shown in Fig. 11, two loudspeakers are wired in series and connected across the secondary of a single line-matching transformer. Since two 8-ohm loudspeakers in series constitute a 16-ohm load, the 16-ohm tap on the secondary of the line-matching transformer is used. The 500-ohm primary tap is then connected to a tap of identical value on the amplifier output terminal strip.

This arrangement would be used only where the two loudspeakers are mounted relatively close to each other. The line-matching transformer would have to be rated to carry the power delivered to both loudspeakers. In other words, if each speaker were driven to a 5-watt level, then the line-matching transformer would have to be capable of handling 10 watts of power. The set-up to be described in the following paragraph is much more widely used where two or more loudspeakers constitute the load.

Loudspeakers in Parallel: (Driven to identical levels). Fig. 12 shows the conventional hook-up where several loudspeakers are connected in parallel through line-matching transformers to an amplifier with a 500-ohm output-impedance tap. The three line-matching transformers are identical and the 1500-ohm primary taps have been selected since the combined impedance equals 500 ohms.



An elaborate school sound system that is also utilized for speech instruction.

If four loudspeakers were to be connected across the 500-ohm output tap of the amplifier, then the 2000-ohm primary tap would be used on each line-matching transformer. As in the earlier diagrams, a secondary tap on the line-matching transformer is selected to correspond with the loudspeaker voice-coil impedance. It is important to note that each loudspeaker will be driven to the same output level, in this instance to one-third of the amplifier output rating.

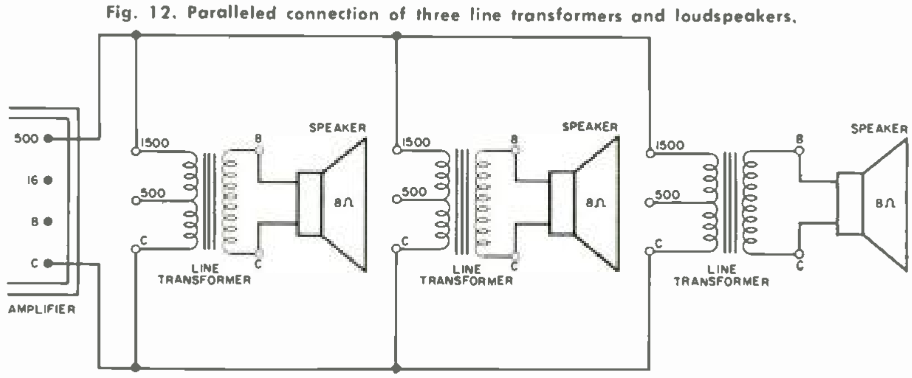
If four loudspeakers were connected with identical line-matching primary impedance taps, then each speaker would be driven to one-fourth of the amplifier output rating.

Line-matching transformers are available with primary taps in the order of 15,000 ohms, making it possible to connect as many as 30 loudspeakers to a 500-ohm amplifier output tap. With a transformer providing a 15,000-ohm primary it would be possible to set up a system with as many as 60 loudspeakers —provided the amplifier had a 250-ohm output tap.

Loudspeakers in Parallel: (Driven to different levels). In all of the multiple speaker arrangements outlined previously, the speakers have been wired to receive equal power. In many installations, however, it is highly desirable to be able to set up a multiple speaker arrangement so that the individual speakers operate at different power levels.

In a typical industrial installation, for example, it might be necessary to drive 15 reflex trumpets to a 15-watt level for each, 25 corridor cone loudspeakers to 3 watts each, and 6 flush-mounted small cone speakers to a level of 1 watt each. The difference in level is usually dictated by the background noise and the area of coverage required from each loudspeaker. As noted in Fig. 12, equal amounts of power were delivered to several loudspeakers by employing identical primary tap values on the line-matching transformers. From this it follows that unequal amounts of power may be delivered to loudspeakers if dissimilar primary taps are employed. Since the load impedance (represented

Fig. 12. Paralleled connection of three line transformers and loudspeakers.



by the several line-matching transformers in parallel) must match the amplifier output-tap impedance, the need arises here for understanding how to compute the combined impedance of several paralleled transformers and the relationship between the value of the line-matching transformer primary tap and the amount of power delivered to its loudspeaker.

In Fig. 12 it was shown that one-third of an amplifier's rated power would be delivered to a loudspeaker through a line-matching transformer if a primary tap on the latter were three times the amplifier output impedance. In Fig. 13 we consider a typical practical impedance-matching problem which is easily solved by application of this relationship. It is noted that a total of five loudspeakers is required in the system and that, because of the varying background noise levels and extent of the areas to be covered, varying amounts of power must be delivered to each speaker. A preliminary sketch is drawn indicating the amount of power to which each speaker must be driven. From this we find that a total load of 40 watts is required—so a 40-watt amplifier is selected.

Loudspeaker No. 1 is to be driven to an output level of 20 watts which represents one-half the total amplifier output power rating. We must therefore select the impedance tap on the primary of the line-matching transformer which is double the amplifier output tap. Since, in this instance, we are using the 250-ohm tap on the amplifier, the correct primary tap on the line-matching transformer is 500 ohms.

Loudspeaker No. 2 is to be driven to a 10-watt level or one-fourth of the amplifier output rating. To do this, we deliberately mismatch upward by a ratio of 4 to 1, arriving at a value of 1000 ohms for the proper primary line-matching transformer tap.

Loudspeaker No. 3 is to be driven to a 5-watt output level which represents one-eighth of the amplifier output power. Mismatching upward by a ratio of 8 to 1, we find that the correct primary impedance tap on the line-matching transformer is 2000 ohms.

Loudspeaker No. 4 is to receive 4 watts of power or one-tenth of the available output power. Deliberately mismatching upward 10 to 1 from the 250-ohm output on the amplifier, we find that the 2500-ohm tap on the line-matching transformer should be used.

Loudspeaker No. 5, used in a very quiet office, is to receive only 1 watt of power or one-fortieth of the available amplifier output power. As above, we deliberately mismatch upward by a ratio of 40 to 1 and arrive at a value of 10,000 ohms for the correct primary tap on the line-matching transformer.

The five loudspeakers in combination will draw 40 watts of power from the amplifier. The total load impedance is 250 ohms, representing a perfect match to the 250-ohm output tap on the amplifier. To double-check the correctness of the computations, it is a good idea to apply the following formula which enables us to determine the combined speaker load impedance:

$$\frac{1}{Z_T} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} + \frac{1}{Z_4} + \frac{1}{Z_5}$$

where: Z_T = combined impedance of loads (this should equal amplifier output impedance); Z_1 = impedance of Load #1 (transformer T_1); Z_2 = impedance of Load #2 (transformer T_2); Z_3 = impedance of Load #3 (transformer T_3); Z_4 = impedance of Load #4 (transformer T_4); and Z_5 = impedance of Load #5 (transformer T_5).

$$\frac{1}{Z_T} = \frac{1}{500} + \frac{1}{1000} + \frac{1}{2000} + \frac{1}{2500} + \frac{1}{10,000}$$

Z_T = 250 ohms (combined impedance of load)

$Z_{AMP.}$ = 250 ohms (impedance of amplifier output tap)

In the above example we have chosen the 250-ohm output on the amplifier rather than the more commonly used 500-ohm tap. A simple calculation will reveal that had we used the 500-ohm tap, the required primary tap value on the line-matching transformer for the 1-watt speaker would have been 20,000 ohms. Since transformers with primary taps ranging this high are uncommon, the 250-ohm tap was decided upon.

It should be noted that each of the five line-matching transformers discussed here is required to handle a different amount of power. For instance, transformer T_1 must include a 500-ohm primary tap and be husky enough to pass 20 watts of power to Loudspeaker No. 1. Transformer T_5, however, must provide a 10,000-ohm tap on the primary and handle only 1 watt of power. Obviously, the transformers will vary in both size and cost.

Line-matching transformers, which will be discussed later, are readily available in ratings of 4, 8, 12, 15, 20, and 25 watts. In each instance, consideration should be given to the impedance value of the loudspeaker voice coil to make certain that it will present a proper match to the secondary of the transformer with which it is used.

Matching with Available Transformers: It is not always possible to provide a perfect impedance match and it was pointed out earlier that a mismatch of up to 25 per-cent is usually acceptable.

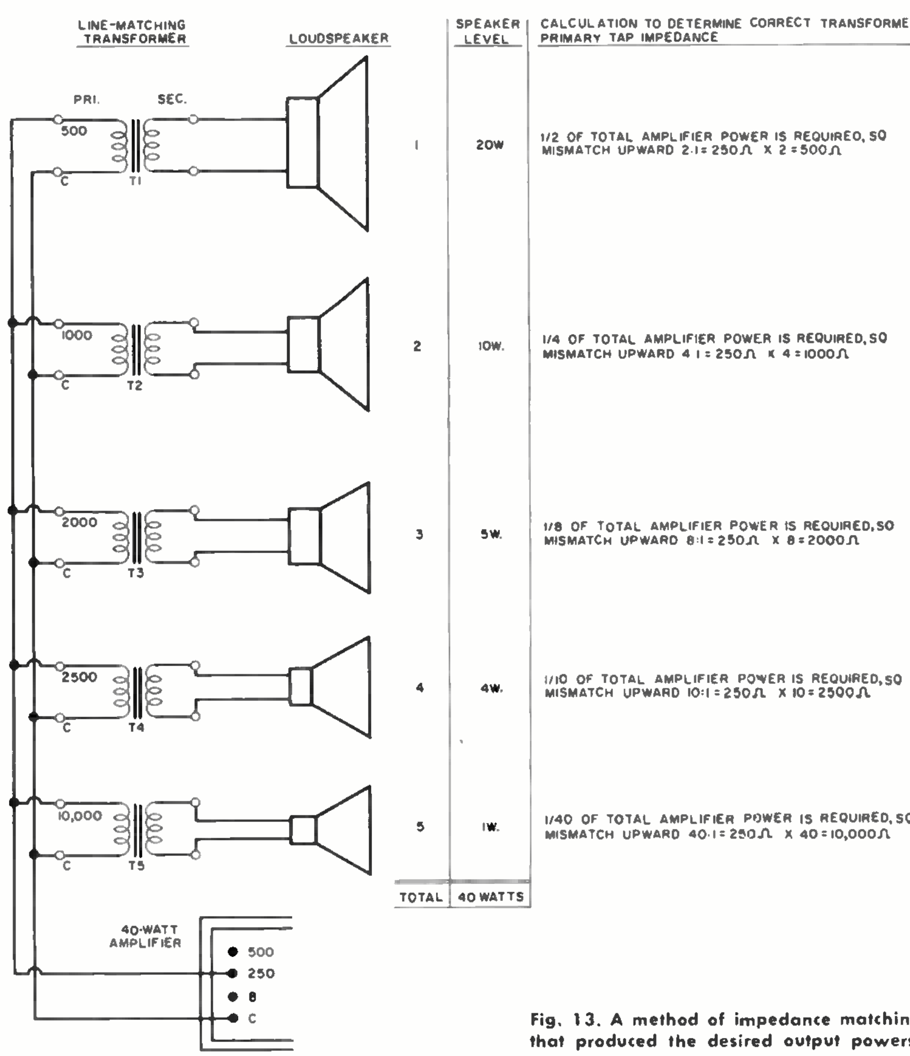


Fig. 13. A method of impedance matching that produced the desired output powers.

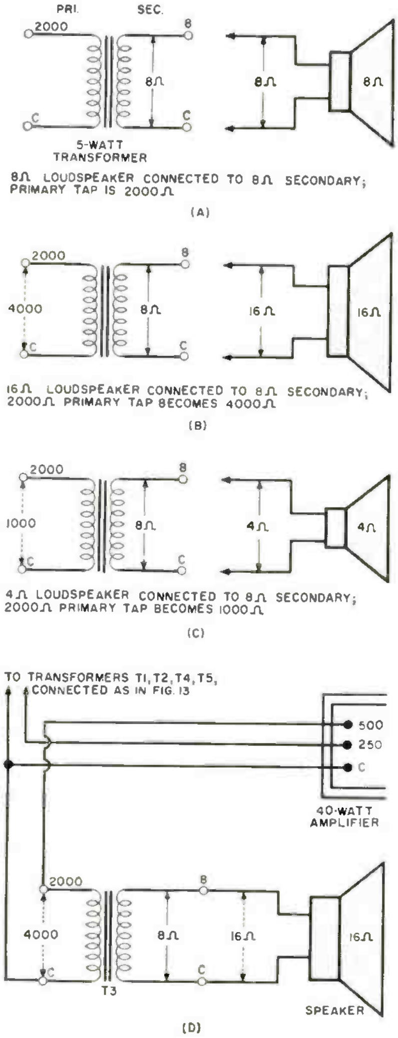


Fig. 14. An example of the mismatch produced by using available transformers.

If the only available line-matching transformers do not provide the exact impedance taps required, the closest one is selected. For example, had we used a small line-matching transformer which provided only a 12,000-ohm primary to drive Loudspeaker No. 5 in Fig. 13, we would have mismatched upward 48 to 1 and would, therefore, have driven the loudspeaker to .8 watt. The loss of 2/10th of a watt would have been impossible to notice.

Had we used a line-matching transformer with a 2500-ohm tap for matching Speaker No. 3 to the amplifier, the upward mismatch would have been 10 to 1 and the loudspeaker would then have been driven to a level of 4 watts (rather than 5). Again, the ear could not have detected the difference in levels.

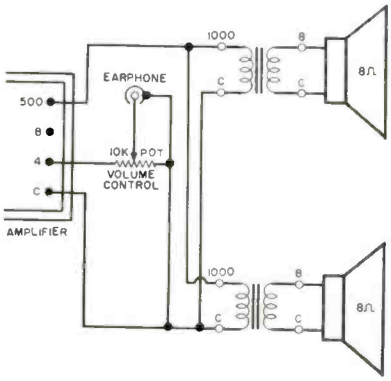
Care should be exercised when selecting the closest available taps to make certain that the total drain in watts by the loudspeakers does not exceed the amplifier output rating. When one considers that the ear can barely recognize a 2 to 1 change in power, concern over perfect impedance matching lessens. Loudspeakers driven to 5 and 3 watts respectively will have sound of almost equal loudness.

Frequently the sound installer, on a job, finds that he has several line-matching transformers whose secondary impedance values do not match the loudspeaker voice coil impedance. In a typical installation (see Fig. 14), a 5-watt line-matching transformer with an 8-ohm secondary is available for matching an 8-ohm loudspeaker to an amplifier through a 2000-ohm primary tap. From the 250-ohm output tap of a 40-watt amplifier (see Fig. 13) this arrangement would drive the loudspeaker to a 5-watt level. If the 8-ohm speaker were not available, however, and the installer had no choice but to connect a 16-ohm loudspeaker to the 8-ohm secondary of the transformer, a 2 to 1 mismatch would result and reflect a 2 to 1 mismatch in the primary. As shown in Fig. 14B, the primary impedance value would then become 4000 ohms.

In Fig. 14C, we have a similar arrangement where the loudspeaker presents a 2 to 1 mismatch to the secondary of the line-matching transformer. In this instance, however, the load is one-half of the transformer's secondary impedance. As a result, the reflected impedance to the primary of the transformer becomes 1000 ohms.

Since we have already determined that a 2000-ohm primary on the line-matching transformer is required to drive the loudspeaker to 5 watts, it becomes apparent that a 4000-ohm primary will drive the loudspeaker to 2½ watts and that the 1000-ohm primary will drive the loudspeaker to 10 watts. If we use the arrangement of Fig. 14C, we may exceed the amplifier output rating by 5 watts and overload the line-matching transformer by 100 per-cent (*e.g.*, passing 10 watts of power through

Fig. 15. Circuit showing method of incorporating earphones for the hard of hearing.



a 5-watt transformer). The use of a 16-ohm loudspeaker would, therefore, be preferable since neither the amplifier nor the line-matching transformer would be overloaded.

By use of another method we could still drive the 16-ohm loudspeaker to a 5-watt level (through a transformer with an 8-ohm secondary) if there were no objection to running a separate transmission line between the amplifier and this loudspeaker. In Fig. 14D we see exactly how this is accomplished. The 16-ohm loudspeaker is connected to the 8-ohm secondary of the line-matching transformer T_3. A 2 to 1 mismatch is reflected to the primary which has been marked "2000 ohms" by the manufacturer. Since the secondary mismatch is 2 to 1 in an upward direction, the primary impedance reflects this 2 to 1 change upward and becomes 4000 ohms. The 40-watt amplifier is connected to loudspeakers Nos. 1, 2, 4, and 5 (see Fig. 13) from the 250-ohm output tap. Loudspeaker No. 3 is connected through the line-matching transformer to the 500-ohm tap—which presents a deliberate mismatch of 8 to 1. From a 40-watt amplifier, the 8 to 1 mismatch drives the 16-ohm loudspeaker to a 5-watt level, precisely what the installation requires. In this illustration it will be seen that the 4-ohm loudspeaker (Fig. 14C) may likewise be driven to a 5-watt level, if the amplifier provides a 125-ohm output impedance tap.

Wherever possible, line-matching transformers should be used where the secondary impedance value exactly matches the loudspeaker voice-coil impedance. When we load a line-matching transformer with a loudspeaker having an impedance value higher than its designated value (as in Fig. 14B), we tend to impair the low-frequency response. Similarly, when the loudspeaker impedance is lower than the line-matching transformer secondary value (Fig. 14C), we tend to impair the high-frequency response. In a wide-range sound system, it is best, therefore, to limit mismatches of this kind to no more than 2 to 1, as in the illustrations above. For sound systems used only to make paging announcements, the need for wide frequency response is not great and we may, therefore, mismatch as high as 4 to 1.

Earphone Connections

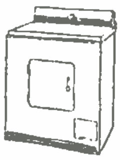
The sound-system installer is sometimes called upon to provide earphones for use in schools, libraries, prisons, and other institutions and it is important, therefore, that he understand something of their characteristics and their requirements.

In a church sound system—a typical illustration—it is common practice to

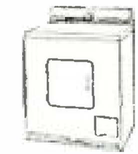
(*Continued on page* 82)

ELECTRONICALLY CONTROLLED CLOTHES DRYER

By *JOHN C. BRITSON*



A simple circuit using few components eliminates guesswork by "feeling" fabric moisture directly.



EDITOR'S NOTE: *The electronics industry, with one voice, strongly proclaims its limitless future, but unanimity ends with the question, "What directions will that great future take?" For the technician engaged in consumer service, the question is eminently practical. Will activity in his present field fall off? Should he get into some "industrial" aspect? Many foresee as much expansion in consumer electronics as anywhere else. Our crystal ball is no more reliable than any other. However, the subject of this article suggests what could happen. Who could have predicted that a control system, relatively simple but genuinely electronic, would have popped up in such an out-of-the-way home device as the clothes dryer? It can happen anywhere.*

WITH SOME seventeen major brands of clothes dryers on the market, there are bound to be more ways than one of doing the same thing. The object of all such automatic devices is obviously to bring washed clothes and linens to a degree of dryness that will suit the needs of the user and to do so with the least amount of effort or supervision on the part of that user. This is accomplished by blowing heated air through the clothing for an appropriate length of time.

However, the degree of dryness is an important factor. Even "dry" linens have a certain, normal moisture content. If they are overdried, they may be stiff and wrinkled. They may also be inadequately dried. The right degree differs from one type of fabric to another. It also depends on what the user wants to do with the dried clothes. Depending on whether they are going to be folded up and put away, ironed, or are of the wash-and-wear type, the proper amount of residual moisture will be quite different.

The simplest way of controlling dryness is with an automatic timer that shuts off the machine after a pre-set period. This requires experience and guesswork on the part of the user, and leaves much room for over- or underdrying. Another method, essentially thermostatic, relies on the fact that temperature inside the dryer rises when the contents are dry. However this technique is also subject to variables, such as the size and type of the load, humidity, outside temperature, and line-voltage fluctuations. A new control system developed by the *Maytag* Co., found in its Models DE701C (all-electric) and DG701C (gas-heated) automatics, uses a relatively simple electronic arrangement, involving few additional parts, to overcome the difficulties mentioned. It is certainly the most direct method: the clothes themselves are "felt" by "electronic fingers" to sense their moisture content.

The control dial for these models, shown in Fig. 1, is relatively simple. It provides two conventionally timed cycles: "Air Fluff" (without heat) for any period up to 30 minutes and "Time Dry" up to 50 minutes. The three positions that will be most used, however—"Damp Dry," "Wash 'n' Wear," and "Regular Fabrics"—have no timing adjustment. These rely on the "electronic fingers" or moisture-sensing elements.

The only evidence the consumer can see of the new method consists of three baffles mounted inside the dryer drum. One of them is shown in Fig. 2. It consists of a series of separated but closely spaced electrodes that are wired in pairs. That is, every other electrode is connected to one lead and those in between are connected to another lead. Not visible to the ordinary viewer is a "little black box" that includes a printed board and a handful of components.

The basic circuit used for the three automatic positions, somewhat simplified, is shown in Fig. 3. When the dryer is set to one of these positions, the timer actually operates the machine for the first few minutes, allowing the drum to come into regular rotation and also permitting the interior to heat. Then the timer is disconnected and the control circuit takes over. Diode *SR* rectifies a.c. voltage and begins to charge *C*, a large Mylar capacitor, through resistor *R*. Since the time constant is very long, the flow of charging current is low.

However, the flow of current through a parallel path, the sensing electrodes, prevents the capacitor from developing an appreciable charge during most of the operating cycle. During this time, the circuit looks like a conventional constant-current "B+" supply, based on a half-wave rectifier, that is loaded by the electrodes.

"B+" is applied to one of the two sets of electrodes through a slip ring

(*Continued on page* 91)

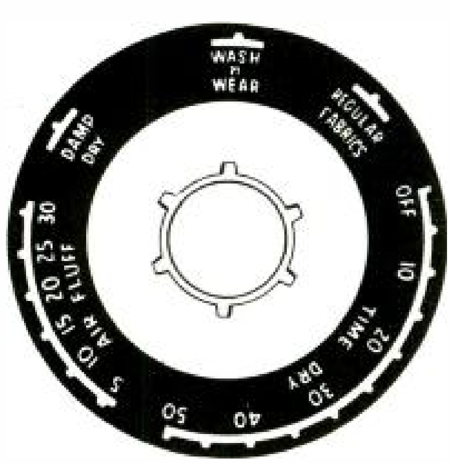


Fig. 1. Single control offers choice of 2 regularly timed or 3 "automatic" cycles.

Fig. 2. One of 3 baffles in dryer drum on which "electronic fingers" are mounted.

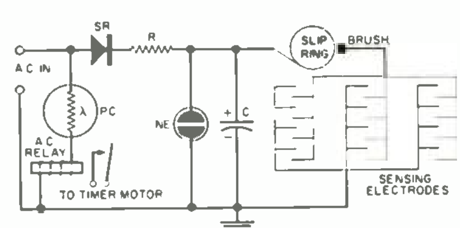


Fig. 3. Dry clothing blocks electrode current, lets C charge to cut off cycle.

Electro-Mechanical Switching in Automation

By **KEN BRAMHAM**

MODERN industrial automation depends almost entirely on effective methods of combining mechanical and electrical equipment. Automation in industry and accounting is often nothing more than the adaptation of manually operated machines to electrical operation. To make this adaptation we must duplicate those parts of the human operator that are used to control the machine in which we are interested.

If the human operator is required to pull a lever when one of a group of lights flashes on, we can devise an electro-mechanical linkage to pull the lever and an electrical circuit to sense the correct light. Combining these gives us a robot that will pull the lever when the correct light is on. We are, in effect, duplicating the operator's arm and muscles to pull the lever, his eyes to see the indicator light, and his brain to decide when the lever should be pulled.

If it were necessary to synthesize the complete human operator, automation would be impossible. Fortunately we are concerned with duplicating only a few, specific functions. We do not have to reconstruct that part of the human brain used to appreciate the blond at the next machine. Our robot is interested only in the light, the lever, and the single bit of business in which these two elements are involved together.

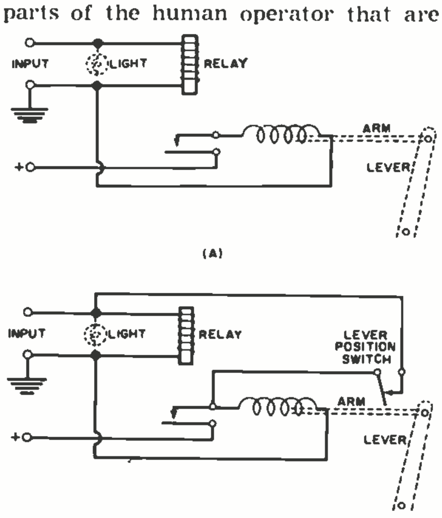


Fig. 1. Electro-mechanical "robot" (A), wired to original light circuit for signaling human worker, operates lever on command. Circuit can be elaborated (B) with added switch to improve reliability.

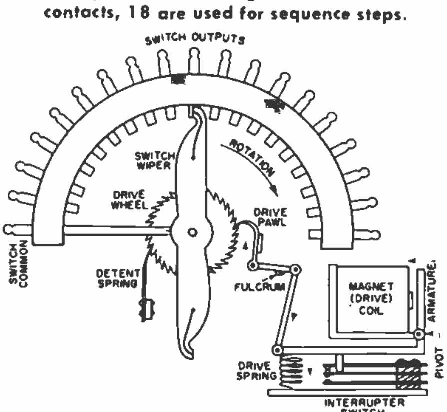


Fig. 2. This rotary stepping switch is a composite developed from versions by several manufacturers to illustrate typical operation. Although there are 19 contacts, 18 are used for sequence steps.

Single-Function "Robot"

We know what our one-purpose mechanical operator must do; now let us see how simply it can be built. We can not give it eyes. Instead we will remove the light bulb and substitute a relay energized by the light circuit. Its arm will be steel and its muscle an electromagnet wired through the relay contacts. The light circuit now energizes the sensitive relay, which takes no more current than the original bulb. This in turn closes the circuit to the magnet coil to actuate the arm and pull the lever. When the light circuit is de-energized, the relay will drop, open the magnet circuit, and release the lever. The electro-mechanical schematic for our robot is shown in Fig. 1A.

Our robot at this point is not very "bright." If the indicator light flashes on but goes out before the lever has been pulled all the way, the human operator would know to continue pulling the lever to the end of its travel. Our robot, not knowing this, would release the lever before the operation was complete. In Fig. 1B a switch is added to sense when the lever travel is complete and make the robot a little more intelligent. This locking circuit holds the relay energized until the lever-sensing switch is actuated. With this circuit, the lever must complete its travel once the light circuit has energized the relay for the five to ten milliseconds needed to transfer the contacts.

The example described is a very simple application of electro-mechanical automation, but it does have the basic features characteristic of automatic control systems. These are (1) the ability to start a mechanical operation on command and (2) feedback from the mechanical components to control the operation once it has been started.

In automatic office systems, it is very seldom that an operation as simple as the one just described is complete in itself. It is more likely to be used as one of a sequence of operations following a pre-determined program. We may, as an example, require to press certain keys on a calculating or adding machine in a pre-set routine, or we may wish to punch holes in a paper tape or card as part of a batch of information to be fed to a computer. In these and many other applications, a rotary stepping switch can be used to energize a number of solenoids sequentially.

Many Steps—Automatically

Fig. 2 shows a simplified rotary stepping switch. It consists of an 18-position switch with two wipers spaced 180 degrees apart to give a continuous switching action over the 18 outputs as the wiper shaft is rotated. A ratchet (drive) wheel is keyed to the wiper shaft, and a drive pawl is provided to hook into the notches of the wheel and rotate the wiper. When the magnet coil is energized, the armature is attracted, transferring the interrupter switch contacts and, through the mechanical linkage, pushes the drive pawl to the next notch in the wheel. When the coil voltage is removed, the armature is forced back to its normal position by the drive spring, restoring the interrupter contacts and drive pawl to pull the drive wheel round 10 degrees. This moves the wiper to the next switch position. A detent spring is also added, in position to act on the drive wheel and hold the wiper in position until the next operating cycle. It is important to remember that this type of switch "steps" to the next position when the coil is de-energized—no

How multi-position switches can replace human operators in performing tasks that involve many steps in specific sequences.

movement of the switch wiper occurs when the coil is energized.

Rotary Contact Protection

To prevent damage to the switch contacts, it is important to work within the current ratings set by the manufacturer. Although these contacts may be rated to carry several amperes, the maximum current that may be safely switched (made or broken) is often limited to 50 or 100 ma. In order to stay within the current switching limit and still take advantage of the full current-carrying capacity, some special circuitry must be used. The interrupter contacts shown in Fig. 2 are of heavy-duty tungsten and are used to protect the switch wipers and contacts. These interrupter contacts transfer each time the coil is energized and restore just before the wipers move to the next contact, making it practical to use the wiper contacts in series with the interrupter switch. Current in a series circuit of this type will flow only when the switch wiper is stationary and the drive coil is energized. A simple circuit for this switch protection is shown in Fig. 3.

The Switch Put to Work

A possible use for a rotary stepping switch as a means of controlling a sequence of operations is shown in Fig. 4. In this example, six solenoids are to be energized in the sequence 1, 2, 3, 4, 5, 6, 2, 3, 4. A ten-position switch is used, which has normally open interrupter contacts. The mechanical action initiated by each solenoid includes the rotation of a shaft on which we can mount a cam-actuated switch to provide feedback from the machine to the stepping switch.

When the switch is in position 1, current will flow through the cam-actuated switch (S_1) to energize the drive coil. This in turn cocks the drive pawl and also closes the interrupter contacts to complete the circuit to solenoid 1. This solenoid and the drive coil remain energized until the mechanical action started by the solenoid is complete. The cam shaft then rotates, opening the switch contacts, de-energizing the drive coil and allowing the armature to restore. Restoration of the armature opens the interrupter contacts in the solenoid circuit and then rotates the switch wiper to position 2 while no current is flowing in the circuit. The cam-shaft rotation continues during this time and finally allows S_1 to close and repeat the cycle, this time energizing solenoid 2. The sequence continues as long as power is applied to the circuit.

Controlling Stop and Start

In the last example, we have a continuous, free-running type of operation. In practice, it is more likely that the sequence would be started on command and would stop when the solenoids had all been energized. A circuit to include start and stop relays is shown in Fig. 5.

In this circuit, the "command" signal to start the sequence energizes the "start" relay, which in turn holds through its own (upper) contacts and through the normally closed contacts of the "stop" relay. A second pair of contacts (lower) on the "start" relay applies voltage to the stepping-switch circuit. The stepping action proceeds in the same manner as in the previous example, controlled by feedback from the cam-switch, until the last step is reached. When the coil is energized on this step, the output is taken to the "stop" relay coil, which energizes and opens the holding circuit to the "start" relay. The "start" relay now restores, opening the circuit to the stepping-switch drive coil and interrupter contacts. When the drive coil de-energizes on this last step, the switch wiper moves to position 1 and the circuit is ready for another cycle when the command signal is received again.

Rotary stepping switches were originally developed for use in automatic telephone exchanges, but high-speed exchanges are now being designed in which transistors replace the electromechanical components. Many automated applications, however, do not require high speeds; and for these stepping switches are used. Most low-cost stepping switches will operate at speeds up to 60 steps per second without feedback, but this is seldom required when mechanical operations are being controlled. Thus we see the stepping switch becoming obsolete in one field, but taking a leading position in another, that of automation and control. ▲

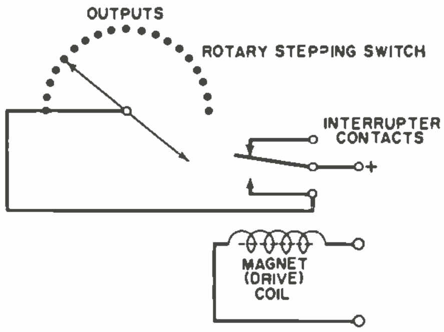


Fig. 3. Incorporation of an interrupter switch protects rotary-switch contacts.

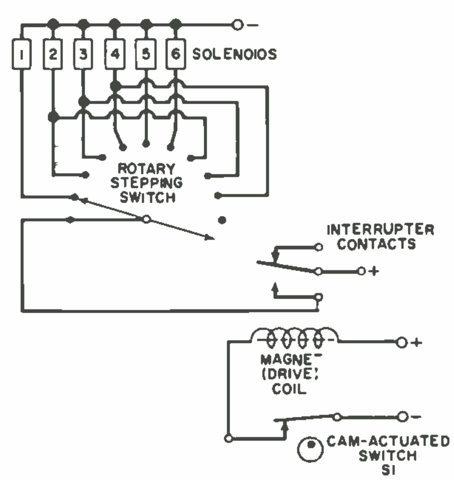
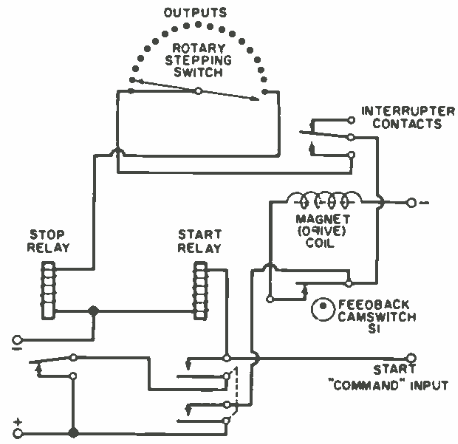


Fig. 4. Simple automated circuit. Six solenoids are pulsed in a pre-set order.

Fig. 5. Switched sequence starts on command, stops automatically on completion.



MARINE ELECTRONIC SERVICE:

DEPTH SOUNDERS

A GENERAL picture of how the various depth sounding and indicating instruments work and what basic elements they include has already been presented. Next is an investigation, in some detail, of the arrangements used for keying, displaying, and phasing.

Indicators: The arrangement for keying the transmitted pulse in a flasher using cam-operated contacts is shown in Fig. 8. The detent on the cam closes the contacts once in every revolution. The disc or arm carrying the neon lamp may be driven directly, by gears, or by a belt. The motor, frequently called the scanning motor, may be a.c. or d.c.

Two methods of "contactless" keying have been developed to eliminate the need for contact maintenance in shallow-water flashers, which run at higher speeds. In one, the pulse generator is triggered by the voltage developed when a small permanent magnet carried on the rotating arm passes over the iron core of a stationary inductance. Another type produces the triggering voltage by the meshing and unmeshing of the plates of a variable capacitor. In this case, one set of plates is fixed to the frame of the indicator and the other to the end of the rotating arm opposite the neon lamp.

Many flashers use small, bayonet-base neon lamps; however special *U*-shaped tubes are used in many of the higher-grade models to give greater illumination.

The spacing of the dial graduations is determined by the motor speed. Since calibration is necessarily limited to the 360 degrees of rotation, the neon lamp must rotate at a slower speed in deep-water units than in shallow-water types. Flashers incorporating an efficient electronic system will frequently sound deeper than can be indicated on the dial's calibration. Consider a flasher calibrated to read from 0 to 120 feet in 360 degrees. If the depth increases beyond 120 feet and the echoes are still being amplified sufficiently to fire the lamp, the flashes will start a second course around the dial. An indication at the 40-foot mark would then occur at a depth of 160 feet.

Recorders: In this type, a motor-driven, rotating arm (Fig. 9) swings arcs across a separately driven chart paper. The arm carries a stylus mounted at the end that sweeps across the paper. At the other end of the arm is a wiper that bridges gaps between segments on a stationary commutator. The top view of Fig. 10 further illustrates the arrangement of the parts, with two variations being shown. The output segment of the disc-type commutator in Fig. 10A is connected to the amplifier output, and is at a positive potential high enough to fire the thyraton in the pulse generator but not sufficient to burn any marks on the paper. The keying segments are connected to the control-grid circuit of the thyratron. When the gap is bridged, the grid goes positive enough to cause firing and, if the stylus is over the chart, a zero mark will be burned at that point. When the echo returns, the wiper will still be on the output segment, and the echo will be marked a proportionate distance down the chart.

In the drum-type commutator of Fig. 10B, a continuous output ring is used instead of a segment, and the rotating, arm-mounted wiper is used only to pick up the signal from the amplifier, not for keying. A separate keying wiper on the other end of the arm rides over the keying segments of the fixed commutator. It fires the pulse generator by shorting out the grid bias. Obviously other mechanical arrangements are possible.

Suppose now that the electronic elements of such a recorder are designed for 120 fathoms. If the length of time it takes the stylus to move from the top of the chart to the bottom is equal to the round-trip travel time of the pulse at 120 fms, the zero line will be burned at the top of the chart and the depth indication will be burned at the bottom.

Were the stylus moving three times as fast, the depth indication would be at the bottom of the chart in only 40 fms. This would result in a 3:1 magnification of the contours of the bottom, which is important in many types of fishing, but the maximum depth at which the recorder could be used would be only one-third of the former value.

Now assume that the stylus is still moving at this faster rate but that, when the recorded depth reaches 40 fms, the keying point is changed to occur, not at the top of the chart, but one chart width earlier. The position where the zero line would be is now above the chart, and the 40-fm depth indication is at the top of the chart. This shifting of the keying point is termed *phasing*, and each position is called a *range*. It is apparent that, in this hypothetical recorder, the second range would cover 40 to 80 fms. If the keying were again advanced one chart width, the third range would cover 80 to 120 fms. This illustrates how the magnification on any given width of chart may be increased without sacrificing maximum depth indication.

Fig. 11 illustrates two types of recorders in which the stylus is carried on an endless belt instead of an arm. It will be noted that the range in the conductive-belt type of Fig. 11A is determined by the location of the contacts

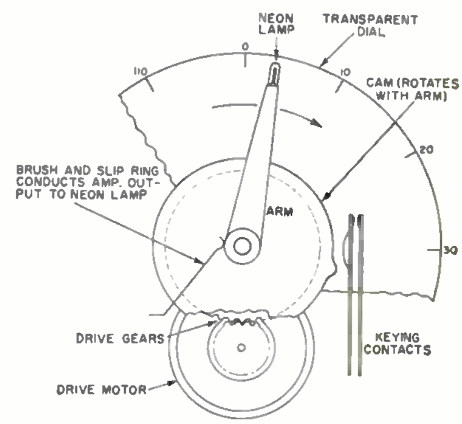


Fig. 8. Transmitted pulse is keyed by cam-operated contacts in this flasher.

affected by the carrier or wiper on the belt.

Most recorders use a separate motor similar to the electric-timer or clock type to drive the chart paper, which may be 2 to 12 inches wide; however, at least one manufacturer employs a mechanical linkage between the stylus-drive motor and the chart-feed rollers instead.

Scopes: Consider a scope with a 0- to 50-foot scale on the face of the CRT. As with a recorder, when the bottom-indicating blip (horizontal deflection) reaches the 50-foot mark, the keying point could be advanced one scale length. The spot would then be at the top of the tube when the depth was 50 feet and the bottom of the scale would then indicate 100 feet.

The scope, however, is intended primarily to show fish and sea life above the bottom, so it is desirable to use the entire face of the tube, insofar as is possible. In other words, when the depth indication reaches the bottom of the scale, it should be maintained there. To accomplish this, the keying is made continuously variable. Thus, when the depth indication moves past the bottom of the scale, it can be brought back only just as far as is desired instead of jumping to the top of the tube, as would occur with a fixed point keying.

A depth-indicator dial may be attached to the scope's keying control so that, when the depth exceeds the maximum shown on the tube face, the dial will read the correct depth whenever the keying point is adjusted to make the bottom indication coincide with the bottom of the scale.

Many scopes include a means of reducing the sweep speed so that the face of the tube represents the full depth of water in which the instrument is capable of sounding. This enables the operator to "see" everything in the water from the surface (transducer position) to the sea bed, but at greatly reduced magnification.

Troubleshooting

Assuming a check of the tubes, transistors, and voltages does not disclose the source of a defect, the next step is to determine which element of the sounder is faulty.

Motors: If an a.c. motor fails to run, check for a defective motor capacitor, if any, and also for a bad capacitor across the 117-volt transformer winding supplying the motor. Also inspect for tight bearings or gears; the motors used in sounders seldom have any torque to spare and are easily stalled. On d.c. motors, make sure that the brushes are seating properly and that the governor is not binding. If the motor windings are shorted or open, it will have to be replaced, since necessary rewinding would be extremely difficult if not impossible.

Failure of the chart paper to move on a recorder is not always the fault of the chart-drive motor. Determine if the motor itself is running and, if so, look for slippage between the motor shaft and its pinion or roller, or for insufficient pressure of the paper rollers.

Part 2. Keying, display, and phasing arrangements used in various types of instruments, including an extensive troubleshooting section covering all kinds.

By R. C. ROETGER

Sea 'Lectronics

No Zero and No Echo Indications: When no zero flash appears on an indicator or no zero line on a recorder, first check the keying. If cam-operated contacts are used, see that they are closing properly; if the manufacturer's adjustment specifications are available, set accordingly. With commutator-type keying, be sure that the wiper or brush is bearing on the commutator during the entire revolution. If necessary, clean the commutator with carbon tet and remove any foreign matter from between the segments. In extreme cases of corrosion or roughness, use a very fine abrasive paper.

On recorders where keying is done by fingers on the stylus belt riding over fixed contact bars (or fixed fingers on moving contact bars), revolve the belt by hand and watch for proper contact. Fig. 12 illustrates how maladjustment of a pair of contact fingers could prevent keying. Use a fine file to dress burned or out-of-square contact fingers. If a keying bar is used, file out any grooves that may have been cut by the wire stylus.

Most scopes have a means of bringing the zero blip down onto the face of the tube for test purposes. If not, it may be brought into view with the vertical centering pot or a permanent magnet held near the tube.

Note that, if the circuitry of the sounder is such that the pulse generator includes a capacitor discharged through a magneto-striction transducer, no zero indication will be obtained unless the latter is connected. A 10-watt resistor of 5 or 10 ohms may be substituted for the transducer when shop-testing the keying of such a unit.

In connection with a keying check on indicators, consider the possibility of trouble with the brush or slip-ring arrangement supplying the neon lamp, the lamp itself, or the secondary of the output transformer, if one is used. The lamp seldom fails completely, but may age to the extent that its light output is very low.

Remember, too, that multi-range depth recorders will not produce a zero indication unless the range switch is in position for the shallowest range.

With the keyer known to be functioning, next consider the pulse generator. If it is operating, a v.o.m. set on the lowest a.c. scale and connected across the transducer terminals will show an appreciable kick each time the keying contacts close. If not, first determine that the keying signal is reaching the generator, *i.e.*, the grid bias is being shorted to ground or bucked out by a positive voltage. Sometimes limiting resistors open, and broken connections are a possibility. The 0A5's and 2D21 thyratrons used in many pulse generators are best checked by substituting known good tubes. Isolate the discharge capacitor and check for an open as well as leakage, for the tube socket voltages are rarely an indication of its condition.

In vacuum-tube generators, check the transformers with any tuning capacitors paralleling the windings removed,

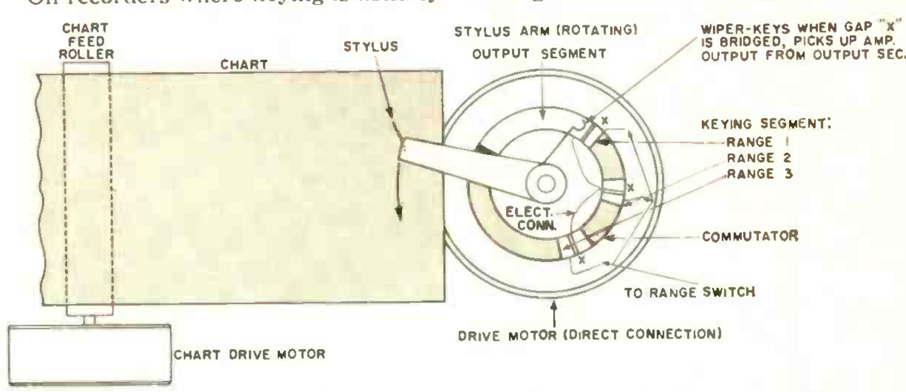


Fig. 9. Mechanics of one type of arm-and commutator recorder. Arm sweeps stylus across separately driven chart paper. Arm wiper picks up signal from commutator.

for either component could be defective without causing an appreciable discrepancy in tube voltages.

The amplifier is the remaining element that could prevent the zero indication from appearing. The checking procedure to be followed is the same as it would be for a low-frequency i.f. amplifier. However, irrespective of voltage readings, be suspicious of coupling coils shunted with capacitors or resistors, coupling capacitors, and fixed-tuned capacitors across first-stage coupling coils. Windings of uncased, iron-cored coupling transformers are also prone to open.

It is also possible that ill-considered tinkering by the owner has mis-aligned the unit to the point where nothing could get through. Obviously, this necessitates a re-alignment job as will be described later.

Zero Indication but No Echo: This condition can usually be attributed to a faulty transducer; however, other possible causes are an insensitive amplifier, low output from the pulse generator, and improper stylus adjustment on recorders. The best way to learn if the transducer is responsible is to substitute a known good one. (See section on transducer checking.)

On recorders, examine the stylus to make sure it is riding on the chart all the way from top to bottom. If the recorder has a fix marker switch, depressing it will produce a black line from the top to the bottom of the chart when the stylus is correctly set.

Zero Indication and Weak Echo: If the echo flash is dim or the echo trace is gray rather than black; or if the echo disappears as the depth of water increases, the trouble is, again, very likely to be with the transducer. Nevertheless, do not overlook the possibility of amplifier difficulties.

Transducer Checking: As mentioned before, the best way to check for transducer trouble is by substitution. However, this does not mean that the substitute has to be mounted in its actual operation position. (Due mainly to frequency differences, transducers of various manufacturers are seldom interchangeable, even though they are of the same type.) Connected to a sounder in proper working condition, a good transducer will give an audible click each time the keying contacts make. Held two feet above and with its active face parallel to the deck or floor, it will cause a depth indication of eight feet. This is due to the fact that the speed of the

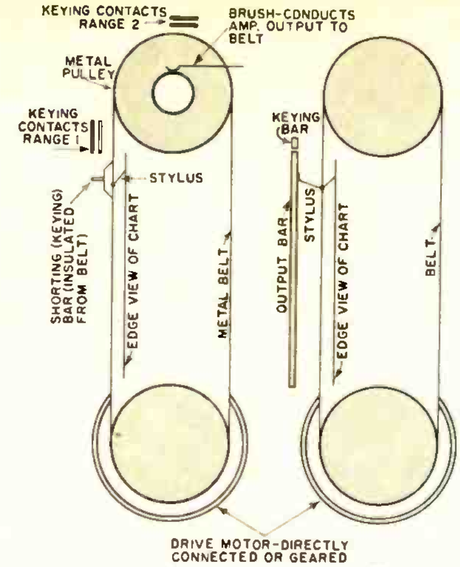


Fig. 11. Two of the stylus-and-belt arrangements in recorders. Conductive (A) and non-conductive (B) belts are used.

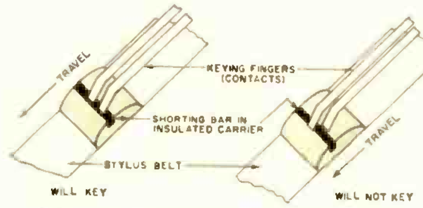


Fig. 12. Misaligned contact fingers (as at right) may prevent proper keying. Proper alignment is at left.

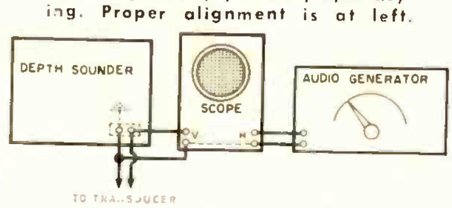


Fig. 13. Equipment arrangement for frequency alignment where a vacuum-tube oscillator serves as the pulse generator.

supersonic pulse is only one-fourth as great in air as in water.

To convince a customer that his transducer is bad, the good substitute may be held over the side of the boat on a temporary bracket.

A good crystal transducer connected across a v.o.m. set on its highest resistance scale will cause a slight kick, and the meter will return to infinity. These transducers will often function, at reduced sensitivity, even though the residual reading indicates a megohm or less. If the owner is satisfied with the maximum depth at which a transducer in such condition will operate, it need not be replaced.

Ceramic transducers that have a series capacitor incorporated will show a typical capacitor kick on the v.o.m.; any residual resistance reading is usually due to capacitor leakage. Some makes may be partially disassembled to permit replacement of this capacitor.

Magneto-striction transducers will show a very low resistance across the winding. When making a resistance check on these, the meter range must be low enough to distinguish between the actual coil resistance and a possible short between the cable shield and the winding.

Any check of a transducer should include an inspection of the cable for mechanical damage. If such damage has occurred inside the hull, it can usually be spliced out without bad effect.

If the transducer is mounted inside the hull in a cofferdam, it is essential that it be covered with water. Likewise, where a sea chest is used, it must be filled with the acoustic fluid recommended by the manufacturer. The screws holding the transducer in the chest should be loosened slowly so that, if the diaphragm has ruptured, this can be detected without danger of flooding the boat.

Since transducers are priced from about 30 to several hundred dollars, it is unlikely that the service technician will wish to purchase a test unit for every type of sounder he is liable to encounter. Eventually he will learn which transducers it will pay to own, based on the work in his area. In the meantime, when a transducer is suspected, the sounder should, if possible, be tested on another boat having the same model. This is another way of showing a customer that his transducer is defective. Such boat-to-boat substitution is not difficult. Many sounders have plug-in connections for both power and the transducer; otherwise a pair of #12-wire clip leads will suffice for temporary power and, if the transducer cable will not reach the unit being tested, a shielded two-wire clip lead will serve as a jumper.

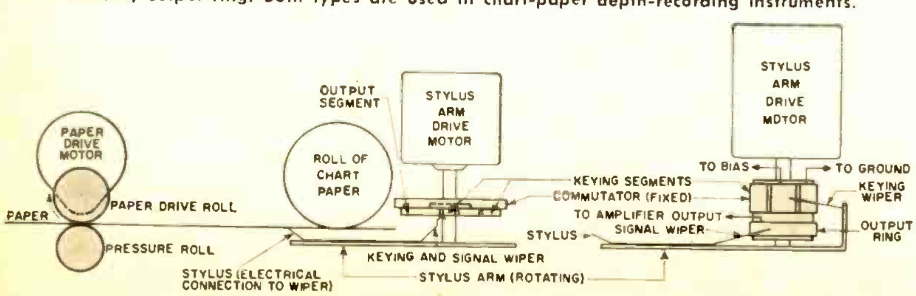
Alignment: Some manufacturers include alignment instructions in their manuals. If not, the following procedure will result in a satisfactory job provided the operating frequency is known.

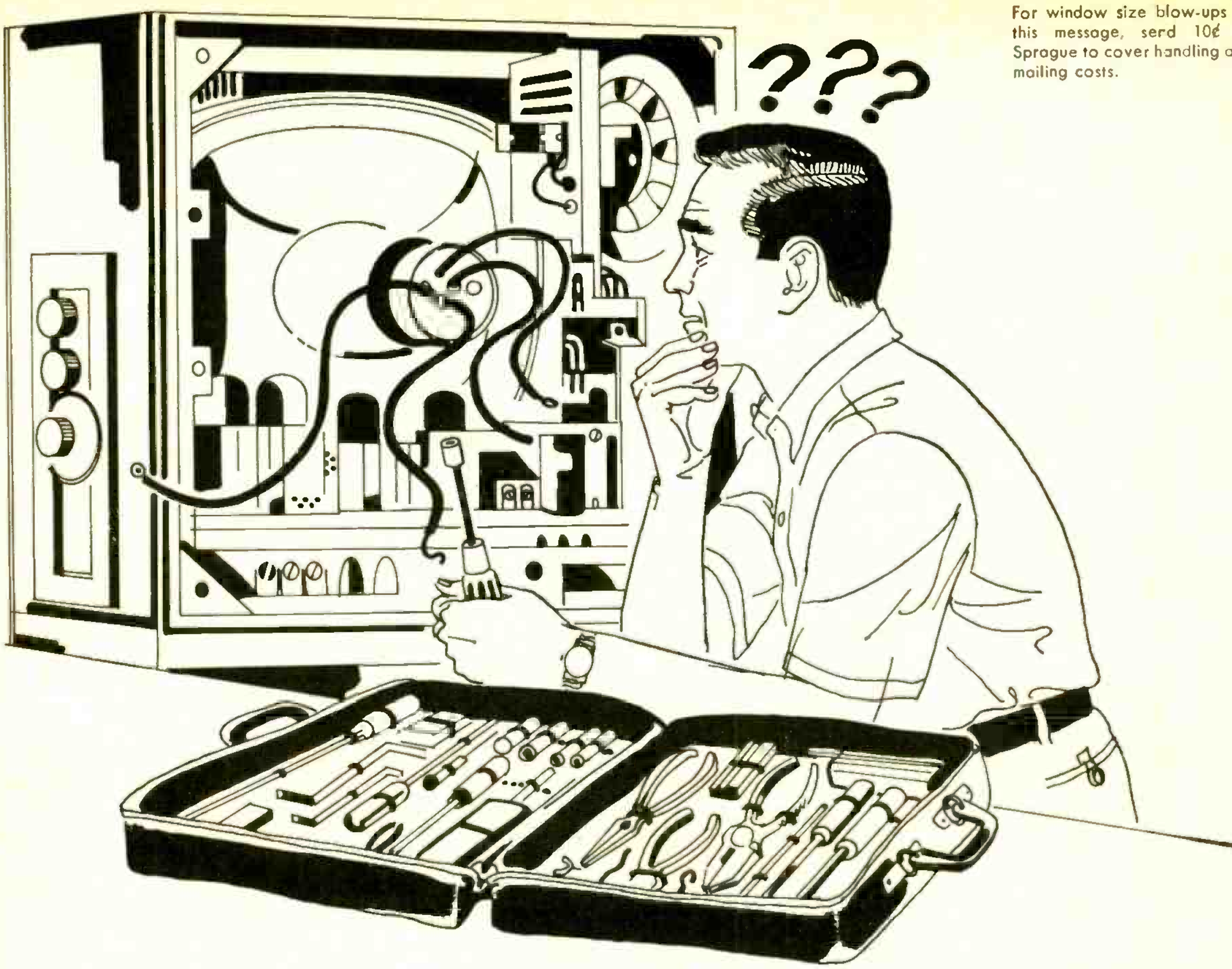
If the sounder employs a capacitor-discharge type of pulse generator, first disable the generator. This may be done by pulling a cold-cathode discharge tube, removing the stylus, or disconnecting some part of the keying circuit; but not always by removing a thyratron, owing to series-parallel heater circuits.

Connect an audio generator, set to the proper frequency, across the transducer terminals, and a v.t.v.m. or scope to the amplifier output. The latter is the point feeding the neon lamp (on flasher types) or the stylus (on recording versions). On recorders, load the amplifier with a 10,000-ohm, 2-watt resistor and bend or remove the stylus so that it will

(*Continued on page* 109)

Fig. 10. Top views of (A) disc-type and (B) drum-type commutator with separate, continuous, output ring. Both types are used in chart-paper depth-recording instruments.



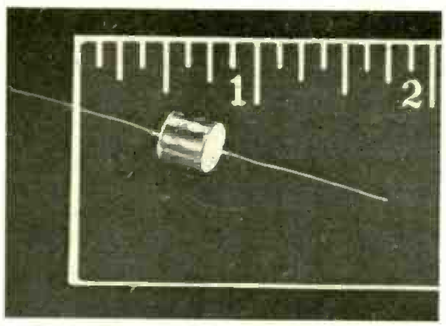


SOLID-STATE I.F. TRANSFORMER

Pea-sized ceramic filter introduced to take the place of the conventional bulky i.f. transformer.

A UNIQUE ceramic filter has been developed to take the place of conventional bulky i.f. transformers. Two models will be introduced initially by the *U.S. Sonics Corp.* of Cambridge, Mass. Both are 455-kc. i.f. filters, one for transistor circuits, the other for use with vacuum tubes. Because of the small size of the device, it is expected to find use in personal-portable receivers. The cost of the new i.f. filter is expected to be about 31 cents per unit in 10,000-unit runs. This compares favorably with conventional i.f. transformers, which currently cost the receiver manufacturer around 25 to 35 cents per unit in the same quantities.

In addition to i.f. applications, these ceramic filters can be supplied with a variety of other characteristics. For example, ceramic filters may be designed for center frequencies from 100 kc. to 1 mc., bandwidths (at 6 db down) from 1 to 20 per-cent of the center frequency, and a wide range of input and output impedances. Ceramic filters can be designed to have characteristics equal to, or better than, those of many currently available quartz filters at prices as low as one-third of the quartz-filter prices.



The solid-state i.f. transformer is shown above practically full size. The two leads are for input and output connections, while the ground connection is made to the case.

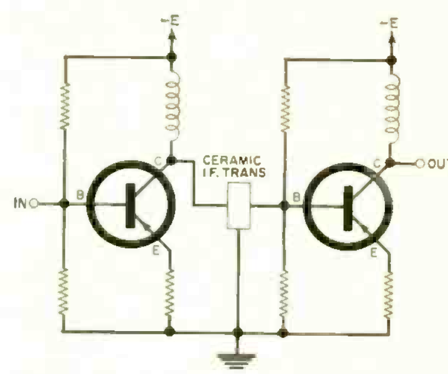
In addition to its small size, the pea-sized zirconate device has many other advantages. The filters are permanently tuned to design characteristics. For the receiver manufacturer this means that the bandwidth and shape established during prototype design remains constant through production and the unit does not get out of alignment for the life of the set. Time-consuming tuning and alignment of i.f. strips is completely eliminated. On the other hand, circuit capacitance must be fairly carefully controlled in order to use fixed-tuned i.f. transformers. This should not pose too much of a problem with printed circuitry and with uniform electrical characteristics in tubes and transistors.

Once the unit has been installed, no access is needed as there are no adjustments to be made. This simplifies set design. Because of the size and shape of the unit and its axial leads, it may be assembled automatically on circuit boards by the same standard production equipment now used for resistors and capacitors.

The ceramic i.f. filter can withstand repeated high shocks and vibration, and it is far less susceptible to microphonics than conventional i.f. transformers or mechanical filters.

Typical power loss of the ceramic unit is only 1 db compared with up to 12 db for conventional transformers. Low loss is in part due to the filter's high tolerance to impedance mismatch. A typical unit may be used with output impedances varying from 500 to 5000 ohms without appreciable change in resonant frequency or power loss.

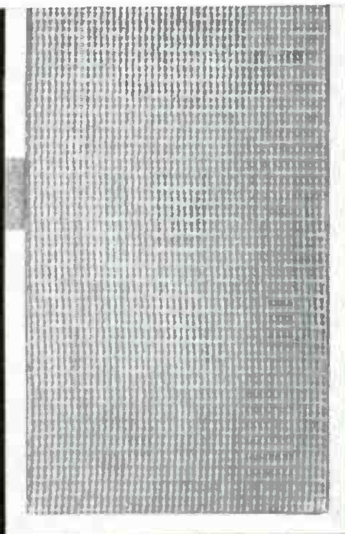
The unit designed for transistor circuits has the following characteristics: input impedance, 10,000 ohms; output impedance, 1000 ohms; center frequency, 455 kc., ±1 kc.; power loss at rated frequency, 1 db; working voltage, 500 volts d.c. between any two terminals and signal voltage, 10 volts (r.m.s.) at resonance. Bandwidth is 6 kc. at −3 db, 9 kc. at −6 db, and 50 kc. at −20 db. The unit designed for vacuum-tube circuits has these characteristics: input impedance, 25,000 ohms; output impedance, 200,000 ohms; center frequency, 455 kc., ±1 kc.; voltage loss at rated frequency, 1 db; working voltage, 500 volts d.c. between any two terminals and signal voltage, 10 volts (r.m.s.) at resonance. Bandwidth is 2 kc. at −3 db, 4 kc. at −6 db, and 24 kc. at −20 db. ▲

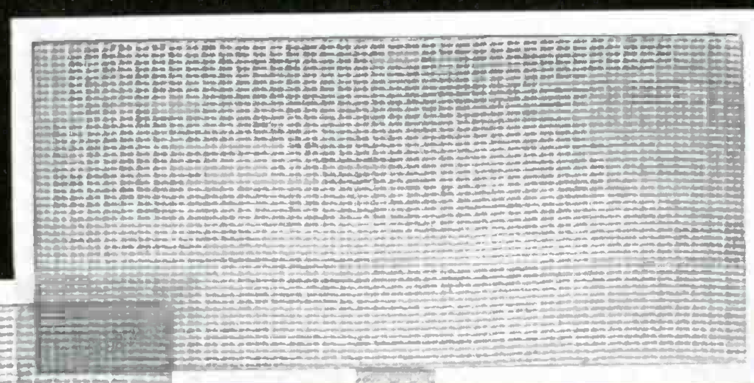


Simple circuit diagram showing the use of one of the new ceramic i.f. transformers for interstage coupling in transistorized broadcast receiver. A higher impedance model is also made for vacuum-tube circuits.

THE A.E.S. *Gigolo*

ONE OF THE MOST SOUGHT AFTER PRODUCTS IN THE HIGH FIDELITY INDUSTRY

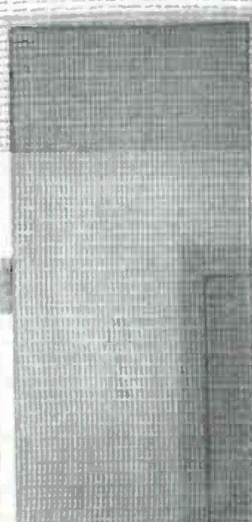




At our present rate of sales and production, A. E. S. will sell nearly 100,000 Gigolos this year.

Imagine, now you can own a speaker with this quality for only $15.00.

TRY IT — WE GUARANTEE IT
100,000 PEOPLE CANNOT BE WRONG



DESCRIPTION:

The Gigolo is constructed with a resonant resistant all wood product of at least ¾" thickness throughout. Its outside dimensions are 24" long, 12" high, 9½" deep. The heavy construction and the fine workmanship suggest a value far exceeding its low, low price. All units sold on 100% MONEY BACK GUARANTEE.

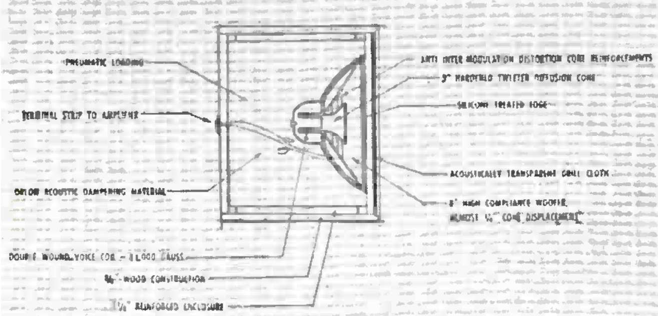
Price $15.00. Unfinished only.
F.O.B. Factory

SPECIFICATIONS:

Frequency response	500 Tone bursts 3500
Maximum frequency response	19-21000 cps
Frequency response ±8 db	45-18000 cps
Harmonic distortion	less than 3% 70-21 kc
Impedance curve	within −0 +200% of 8 ohms 20-20000 cps
Flux density	11000+ gauss

Frequency response curve run at continuous 10 watts.

Power handling capacity, the Gigolo may be used with small economy amplifiers of very low wattage, as well as with the highest power component amplifier with satisfactory results.



A.E.S., Inc.
3338 Payne Avenue, Cleveland, Ohio

Gentlemen please ship ______________ GIGOLOS.

I understand these units are guaranteed and if I am not satisfied I may return for a full refund of sales price, $15.00 each.

Name ______________________________

Address ______________________________

City and State ______________________________

Enclosed find check ______________ money order ______________

TV Music and the Technician

(*Continued from page 47*)

trol, the operator has his choice of any combination of reverberation and original signal, without any appreciable level variation. Fig. 6 is a diagram of the circuit.

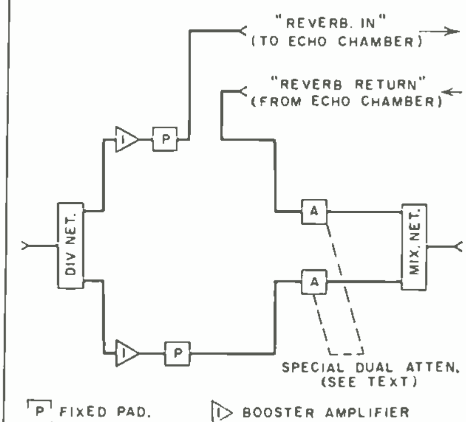


Fig. 6. Block diagram of reverb circuit.

cuit. This circuit may be patched into the output of any single input device or it may be inserted after the mixing network to provide reverberation for any entire channel.

Another item of interest is the use of the *Ampex* 375 60-cycle amplifier. This is primarily designed to provide stable tape machine capstan rotation where power-line frequency regulation is poor. The unit uses a 60-cycle tuning fork which drives a power amplifier of sufficient capacity to supply the capstan motor. The amplifier circuitry has an external input available so that any oscillator capable of 4 volts sine-wave output may be used in place of the built-in oscillator to drive the capstan motor. This is the way it is used in this particular setup.

The *Hewlett-Packard* audio oscillator in the right-hand rack is connected by a patch cord to the *Ampex* 375 external input. The output is then connected to the capstan motor of one of the tape machines. This enables the operator to correct for improper pitch in a recording and for small tempo or timing changes by setting the oscillator slightly above or below the normal line frequency of 60 cycles and, consequently, altering tape speed. The limiting factor is the capstan motor which can only be operated over a frequency range of 40 to 100 cps, or damage will result.

Tempo Changes

For tempo changes *without* pitch change, the unique device used is the Tempo Regulator. Through the use of an ingenious capstan drive system and a revolving head drum, this machine can increase or decrease the tempo of a previously recorded tape by up to 20 per-cent without any change in pitch.

A complete analysis of this device is beyond the scope of this article but a brief explanation of the principles of operation is in order. As can be seen in Fig. 5, the tempo regulator is used with one of the regular tape machines, taking the place of the capstan and playback head. The reeling motors of the regular tape machine are used. The tempo regulator head assembly consists of four heads, mounted in the periphery of a small drum. These heads are connected in parallel and wired to slip rings. The brushes that bear on these slip rings connect by a short cable to the playback preamplifier, the output of which is connected to either of the recording buses at the console. In use, the tape to be played is threaded off of the left-hand reel, is guided around the head drum by an idler, past the capstan of the tempo regulator, then onto the right-hand, or take-up, reel. The tape wraps around the head drum slightly more than 90 degrees so that one head is always in contact with the tape. This head drum is capable of rotation in either direction, determined by the internal drive mechanism.

The tempo regulator capstan is driven through a variable-ratio idler drive which is adjusted by the technician for the percentage of timing change, or correction, required. When the capstan speed is adjusted to run *faster* than the standard 15 ips, the head drum rotates *with* the capstan, in the same direction as the tape movement. When the capstan is set to run *slower* than the standard speed, the head drum rotation is *counter* to the capstan rotation and the movement of the tape. The important factor here is that no matter what the capstan speed, the head-to-capstan difference is always 15 ips, therefore maintaining proper pitch. At the same time, the actual tape speed past a fixed point has been changed, thereby altering the tempo and, consequently, the timing.

There is still another function of this machine that became apparent during its operation. By using the rotating head only, in conjunction with the regular tape machine capstan, it is possible to achieve a pitch change *without* a tempo change. While the tempo regulator isn't in constant use, it is invaluable when there is no other simple solution to a music scoring problem. This machine is built by *Telefonbau and Normalzeit* of West Germany.

The combination of these components results in a flexible dubbing system incorporating many ideas of the technicians in the Television Music Department. This is a small department, employing only a few men, but it provides an important segment of the final product and, as a result, imparts a feeling of achievement to the technicians involved. ▲

▶ TOP VALUE

Value is a relative thing. In electronic kits it relates to quality of design, components, ease of assembly, performance and price. Heathkit is world-famous as the value standard.

▶ BEST QUALITY

Quality begins with design and continues through performance. Heathkit engineering reflects our greater experience and no-compromise quality components. Result: quality performance.

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Millions of satisfied Heath customers attest to the superiority of Heathkit construction manuals . . . so easy to follow, so complete that we guarantee you can build any Heathkit!

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of electronic kits. Since 1927, Heath has been producing do-it-yourself equipment. Today, the Heathkit line includes over 250 different kits for your every need, interest and budget.

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It's easiest to buy Heathkit! No-money-down terms on your Heathkit order of $25 to $600! Take as long as 18 months to pay . . . reasonable carrying charges. Details in our '62 Catalog. These new, relaxed terms, coupled with our guarantee that you can build any Heathkit, are your assurance of complete satisfaction.

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Super-Power U.H.F. Tubes

(Continued from page 37)

shown on the cover, and require no neutralization in grounded-grid operation. The structural elements are arranged for r.f. operation in the fundamental coaxial mode with a voltage maximum occurring at the center of the electronically active portion of the tube. Such an arrangement permits double-ended operation with portions of two adjacent r.f. quarter-wavelengths in the active region of the tube. The double-ended arrangement provides twice as much plate current from a given peak-drive voltage, and power output may be as much as four times that obtained from a single-ended tube with the same load resistance. The d.c. supply voltage would have to be increased accordingly.

Double-ended construction also permits the tube structure to be considerably longer physically for a given operating frequency. Consequently, increased area is available for dissipation of d.c. power that is not converted to r.f. power, and structural limitations are less severe than those imposed by the compactness required for a single-ended device. In addition, a more rugged structure can be achieved by avoiding the cantilever support of tube elements so common in single-ended power tubes.

Applications

At present, these new super-power u.h.f. amplifier tubes are being used in seven types of government end-use equipment, including most of the types listed in the first paragraph. All of these applications use external-cavity circuits that were successfully designed by the equipment manufacturers. Careful cavity-circuit design to reduce voltage gradients and to locate spurious modes outside of the operating-frequency region has resulted in reliable operation at power outputs of 5,000,000 watts. Although it is premature for reports of extremely long life, one tube has already accumulated 6000 hours of service life and another has operated for 4800 hours.

Acknowledgements

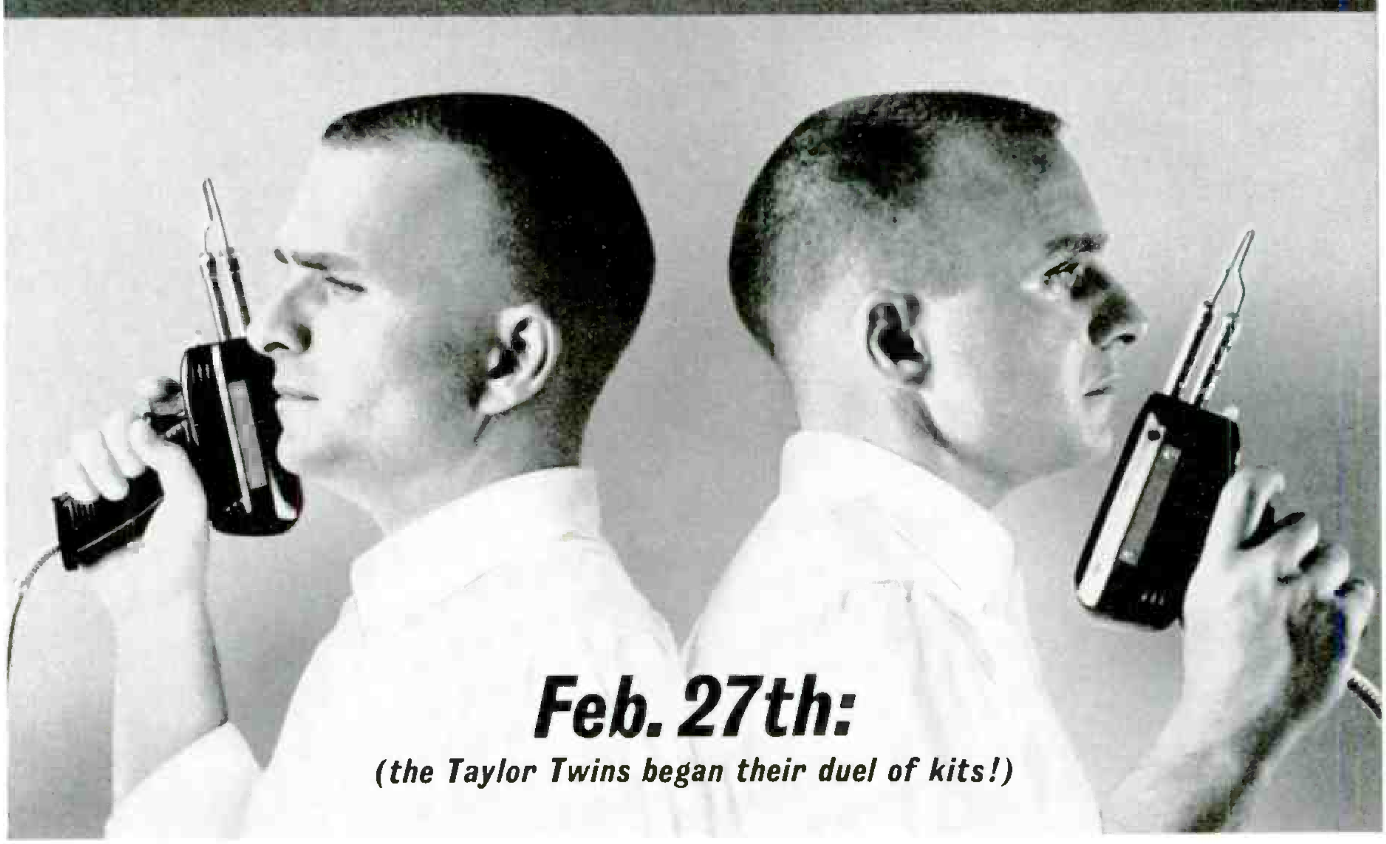
Much of the tube development work described was done under the sponsorship of the Air Force. The Air Research and Development Command of the Rome Air Development Center contracted originally with *RCA* to engage in an electron-tube development program that produced the new design concept. Subsequent Air Force-sponsored programs for the device resulted in the commercial *RCA*-7835 and *RCA*-2054. Much of the credit for these developments should be given to the team efforts of numerous other engineers and technical specialists at *RCA*.

REFERENCES

1. *Vennard, J. K.: "Fluid Mechanics," 1947, p. 126.*
2. *Hoover, M. V.: "Advances in the Techniques and Applications of Very-High-Power Grid-Controlled Tubes," Proceedings of International Convention on Microwave Valves, May, 1958.* ▲

Feb. 5th:

(Paco ran this ad in The New York Times)



Feb. 27th:

(the Taylor Twins began their duel of kits!)

Don and Larry Taylor, with twin backgrounds and skills, have competitively built kit after kit, Paco vs. other makes. In one test Don built the Paco, in the next Larry did. Net results: Paco kits proved faster, easier, and better in performance. **For a typical Twin-Test report turn the page.**

HERE ARE JUST A FEW OF PACO'S NEWEST KITS:

V-70 VACUUM TUBE VOLTMETER KIT: Employs balanced vacuum tube bridge circuit for all voltage and resistance measurements plus 3-way probe for accurate, rapid test. Includes: 7 DC voltmeter ranges, 7 AC voltmeter ranges (RMS) from 0 to 1500 volts, and 7 AC voltmeter ranges (peak to peak) from 0 to 4000 volts. Also 7 decibel ranges, −6 to +66 db and 7 electronic ohmmeter ranges from 0.2 ohms to 1000 megohms.

V-70 Kit with "Twin-Tested" operating assembly manual .... **$31.95 net**

V-70W: Factory-wired ...... **$49.95 net**

C-25 IN-CIRCUIT CAPACITOR TESTER KIT: Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Electrolytic Dial.

Simple Sequential Test: reveals open or shorted capacitors, even electrolytics. **Electrolytic Dial:** indicates in-circuit capacity from 2 to 400 mfd: condenser is proved non-shorted and not open if capacity reading can be obtained.

Model C-25 Kit: with Paco-detailed operating assembly manual ... **$19.95 net**

Model C-25W: Factory-wired **$29.95 net**

SA-40 STEREO PREAMP-AMPLIFIER: Power: 20W (RMS) per channel, 40W total. **Peak,** 40W with 80W total. **Response:** 30 cps to 90 Kc, within 1.0 DB. **Distortion:** within 0.5% at 20W per channel. **Includes:** 14 inputs and 14 Panel Controls, black and gold case.

SA-40 Kit with enclosure, "Twin-Tested" operating assembly manual ...... **$79.95 net**

SA-40W: Factory-wired, ready to operate .... **$129.95 net**

SA-50: Stereo Kit as above with different styling, 25w per channel .... **TBA***

ST-25 FM TUNER: Sensitivity: 1.5 microvolts for 20 DB quieting. **Harmonic Distortion:** less than 1%. **Includes:** Dual Limiters, AFC and AFC Defeat, "Eye" type tuning indicator, Multiplex jack. Black and gold case or walnut enclosure at slight extra cost.

ST-25 Kit with fully-wired prealigned front end. "Twin-Tested" manual .... **$42.95 net**

ST-25W: Factory-wired, ready to operate .... **$59.95 net**

ST-26 Tuner-Amplifier Kit: Same as ST-25, with built-in amplifier .... **$54.95 net**

ST-26W Tuner-Amplifier: Factory-wired, ready to operate .... **$69.95 net**

DF-90 TRANSISTORIZED DEPTH FINDER KIT: Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Locates hard-to-find schools of fish, too.

Fully Transistorized: 5 transistors, low battery drain for very long battery life.

Fast, Easy Readings: over-sized scale with 1-ft. calibrations from 0-120 ft.

DF-90 Kit: Complete with "Twin-Tested" assembly operating manual .. **$84.50 net**

DF-90W: Factory-wired .... **$135.50 net**

G-15 GRID DIP METER: Major Functions: 1-Variable Frequency Oscillator covering 400 Kc up to 250 Mc in 8 bands; 2-Absorption Wavemeter, 400 Kc to 250 Mc; 3-Modulation Indicator. **Applications:** antenna tuning, standing wave checks, neutralizing. TVI suppression, carrier monitoring, etc: RF signal source for visual alignment marking between 400 Kc and 250 Mc. Weighs only 3 lbs.

G-15 Kit: Complete with 8 plug-in coils, "Twin-Tested" manual ...... **$31.95 net**

G-15W: Factory-wired ...... **$39.95 net**

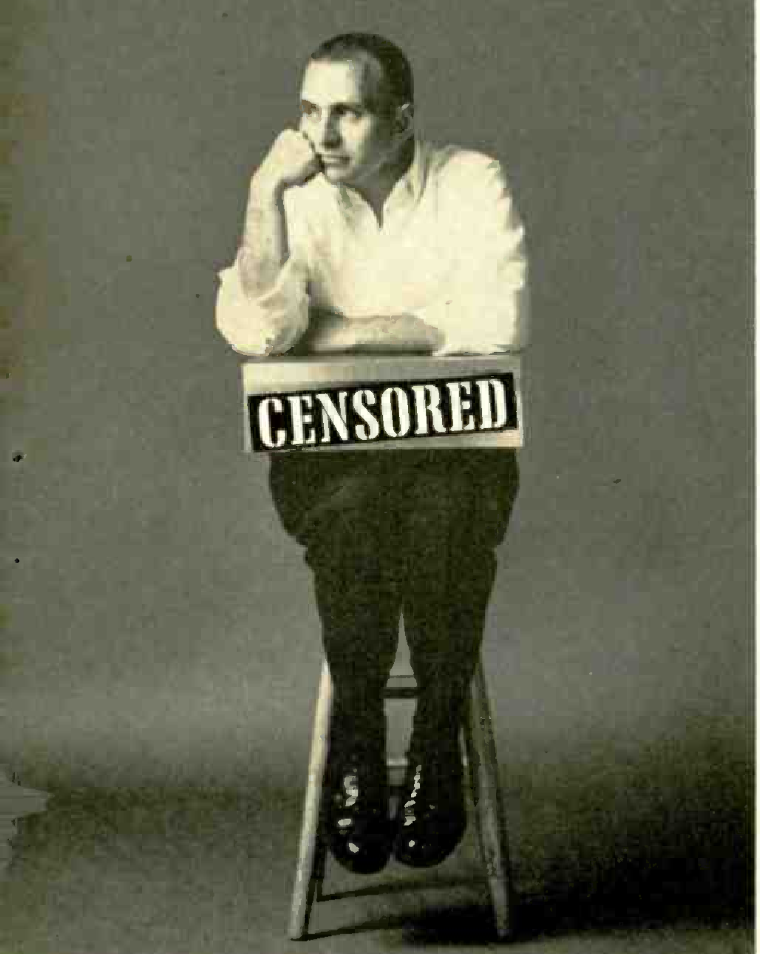
 ALL PRICES INCL. F.E.T. *Price to be announced

"I built the Paco SA-40 Stereo Preamp Amplifier."

Larry Taylor, 8 Stevens Place, Huntington Station, N. Y. "It took me one-third less time to build the Paco kit than it took Don to make the almost identical preamp-amplifier by another kit maker. But it wasn't just the time; it was knowing you're using the right part, and that you understand the instructions completely. Paco parts are all pictured and labelled, the resistors are neatly mounted on cards for easy identification. And Paco's instruction book doesn't leave you guessing. The fold-out diagrams and drawings are always right beside the instructions, so you're not reading one part of the book and following a diagram in another part. Photographs in Paco's book show how each assembly should actually look. I enjoyed building Paco kits, because I wasn't wasting time or worrying."

"I built a competing Stereo Preamp Amplifier."

Don Taylor, 39 Cross Street, Smithtown, N. Y. "Neither Larry nor I are speed demons because we're very meticulous about wiring and soldering. So I was even more surprised when it took me 50% more time to finish my kit. My problem began when I tried to separate the parts. The resistors were in boxes, but not in any logical way: identical resistors often wound up in different boxes. The instruction book was clumsy to work from. It caused wasteful mistakes. Once I lost 20 to 25 minutes because I misread a tiny key letter that meant not to solder a certain connection. A lot of the fun of kit-building was lost when I had to spend time making up for shortcomings of the packaging and the instruction manual."



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Modesto Inland Electronic Suppliers†
Monterey Monterey Electronic Supply†
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North Hollywood Arrow Sales, Inc.†
Honig Distributing Co.†
Palo Alto Peninsula Electronics Supply
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Sacramento Lombards Electronics*
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(Continued on next page) →

BUILD A HI-FI MUSIC WALL! Don Brann's new book **How to Build a Hi-Fi Music Wall** gives you step-by-step instructions for building a decorator styled cabinet or an entire music wall. Send 50c and your name and address to: PACOTRONICS, INC., Dept. EW-10 70-31 84th Street, Glendale 27, New York.

Within the Industry

W. F. WELLS has been appointed senior vice-president and general manager of *Midwestern Instruments, Inc.*, joining the firm from *General Electric Company* where he had served as manager of manufacturing engineering in the Phoenix plant since 1957.

In his new post, Mr. Wells will exercise administrative control over the firm's engineering, manufacturing, and marketing functions. He holds a B.S. in mechanical engineering and took graduate work in advanced marketing at Harvard Business School.

* * *

RAYTHEON recently dedicated a 116,500-square-foot semiconductor plant in Lewiston, Maine which will eventually employ approximately 1500 persons in the production of high-reliability transistors . . . **E. F. JOHNSON COMPANY** has opened a new general-office and manufacturing facility at 10th Avenue, Southwest in Waseca, Minnesota . . . **MOTOROLA**'s Semiconductor Products Division has added 315,000 square feet to its manufacturing facilities in Phoenix, Ariz., which more than doubles the size of the present plant . . . **HEATH COMPANY** is building a 70,000-square-foot addition to its plant on Hilltop Road in St. Joseph, Mich. Completion is scheduled for October 1st . . . **FILTORS, INC.** has purchased a 22-acre industrial site in Huntington, Long Island and will begin construction of a 61,700-square-foot plant which is scheduled to go into operation early next year.

* * *

ROBERT E. LEARNED has been promoted to the new post of production manager for diodes at *Motorola's* Semiconductor Products Division in Phoenix, Arizona.

Previously, he had been chief electrical engineer for diode products manufactured by the company. In his new position he will be responsible for diode and rectifier production and final testing.

Mr. Learned joined the firm in 1957. He is a 1952 engineering graduate of the Colorado School of Mines.

* * *

BERNE N. FISHER has been named president of *Gonset Division*, West Coast manufacturer of amateur radio equipment and mobile radio for CB and business applications. He was formerly vice-president of *Telecomputing, Inc.* . . . **RAY F. SPARROW**, executive vice-president of *P. R. Mallory & Co. Inc.*, died recently at the age of 63. He was an early pioneer in the electronics industry, joining *Mallory* in 1929. He was also active in EIA affairs . . . **FRANK N. KIRBY** has been named engineering manager for the Riverdale, Md. plant of *ACF Electronics Division*. He was formerly with *Raytheon* . . . **JOHN E. O'HANLON** is the new national sales manager of *Fanon Transistor Corporation* . . . *Pacotronics, Inc.* has named **SIDNEY SOLOMON** to the post of sales manager of *Paco Electronics Company, Inc.*, its electronic kit manufacturing subsidiary . . . **FRANK A. COMERCI** has joined the staff of *CBS Laboratories* as manager of the Magnetics Research Department. He will make his headquarters at the Stamford, Conn. plant. . . . *Triad Transformer Corp.* has appointed **JEANN C. NIELSEN** to the post of sales promotion manager. She joins the firm from the *ITT* Distributor Division where she headed the advertising department.

* * *

THOMAS A. BRENDEL has been appointed to the new position of manager of electronic development at the Instrument Division of *American Optical Company*.

A native of Green Lane, Pa., Mr. Brendel was graduated in 1942 from Carnegie Institute of Technology. He was an engineer with *Western Electric* from 1943 through 1949 and subsequently served in various engineering posts with *Blaw-Knox*, *Westinghouse*, and *Curtiss-Wright*.

* * *

L. BERKLEY DAVIS, vice-president of *General Electric* and general manager of the firm's electronic components division, has been re-elected president of the Electronic Industries Association, Washington, D.C.

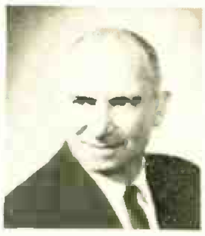
He will serve his second one-year term as head of the national association of electronic manufacturers. Serving with Mr. Davis will be Leslie F. Muter, president of *The Muter Co.*, who was re-elected to his 26th term as treasurer; James D. Secrest, re-named executive vice-president for the 12th successive year; and John B. Olverson, re-elected general counsel.

Heading the various divisions within the association are: George W. Keown, vice-president of *Tung-Sol Electric Inc.*; Robert S. Bell, president of *Packard Bell Electronics Corp.*; Sidney R. Curtis, senior vice-president of *General Dynamics/Electronics;* Ben Adler, president of *Adler Electronics, Inc.;* and W. S. Parsons, president of *Centralab*, Division of *Globe-Union, Inc.*

New directors named were: L. M. Sandwick, vice-president of *Pilot Radio Corp.* and G. B. Mallory, president of *P. R. Mallory & Co., Inc.*

* * *

EUGENE DANIEL POWER has been elected president and a director of *Components Corp. of America*, replacing Russell Maguire who has been president since 1939.



The new president began his career as an attorney in New York in 1936 and in 1940 joined *Auto-Ordnance Corp.* as executive vice-president. In 1951 he took over management of *Components Corp. of America*, then known as *Maguire Industries*.

He is a graduate of St. John's University where he received his Bachelor of Laws degree in 1935 and a Master of Laws degree in 1936.

* * *

BENDIX CORPORATION has established a separate semiconductor operation with headquarters in a new multi-million-dollar plant at Holmdel, New Jersey . . . **CAMBRIDGE SCIENTIFIC INDUSTRIES, INC.** has been established in Cambridge, Maryland to design and manufacture electromechanical devices for the electronic and aircraft industries . . . The formation of **MULTIPLEX CORP.** to develop and produce radios capable of receiving multiplex has been announced. The new corporation, a wholly owned subsidiary of **AUTOMATIC RADIO MFG. CO., INC.,** will have headquarters at 122 Brookline Ave., Boston . . . **SEG ELECTRONICS CO.** of Brooklyn has acquired **SOLAR ELECTRONICS CORP.** for an undisclosed sum. Operations of the new subsidiary are being transferred to 12 Hinsdale Street, Brooklyn, headquarters of the parent company . . . **ESTEY ELECTRONICS, INC.,** of Torrance, California has merged with **ORGAN CORPORATION OF AMERICA** of West Hempstead, New York. The surviving corporation will be known as **ESTEY ELECTRONICS, INC.** . . . **CBS ELECTRONICS** has announced that it will discontinue its receiving tube operations in Danvers and Newburyport, Mass. **RAYTHEON,** which will purchase part of the remaining tube inventory, plans to offer sales and service of these products to **CBS** customers . . . **UNITED COMPONENTS, INC. OF NEW ENGLAND** has been organized in Worcester, Mass. to expand the parent firm's line of semiconductors. Corporate headquarters are in Orange, N.J. . . . **MELPAR, INC.** has acquired **TELEVISION ASSOCIATES, INC.** and its wholly owned subsidiary, **TELEVISION ASSOCIATES OF INDIANA, INC.,** both located in Michigan City, Ind. . . . **RODNEY D. CHIPP & ASSOCIATES,** a consulting engineering firm with headquarters at 15 Ward Street, Bloomfield, N.J., has been established by Rodney D. Chipp, former engineering executive at **ITT.** ▲

EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship at our risk one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER

FEATURES:

- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

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.

2 **RESISTANCE RANGES:** 0-10,000 Ohms, 0-1 Megohm.

3 **D.C. CURRENT RANGES:** 0-15/150 Ma., 0-1.5 Amps.

3 **DECIBEL RANGES:** —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms:** $3.85 after 10 day trial then $4.00 monthly for 3 months.

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms. 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries. 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms:** $8.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!

SPECIFICATIONS:

- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. **Price is $42.50. Terms:** $12.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:

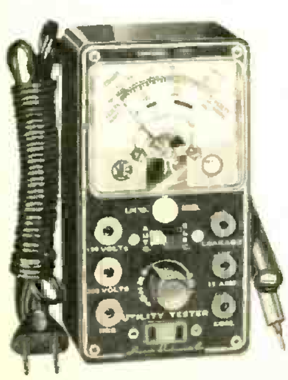
7 **D.C. VOLTAGE RANGES:** (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
6 **A.C. VOLTAGE RANGES:** (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
3 **RESISTANCE RANGES:** 0 to 2,000/200,000 Ohms. 0-20 Megohms.
2 **CAPACITY RANGES:** .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
5 **D.C. CURRENT RANGES:** 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 **DECIBEL RANGES:** —6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. **Price is $42.50. Terms:** $12.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ★ AUTOMOBILES



INCLUDED FREE

64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

As an electrical trouble shooter the Model 70:
• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. **Price is $15.85. Terms:** $3.85 after 10 day trial then $4.00 monthly for 3 months.

DID YOU EVER?

- ▶ Order merchandise by mail, including deposit or payment in full, then wait and write... wait and write?
- ▶ Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- ▶ Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business... We ship at our risk!

SHIPPED ON APPROVAL
NO MONEY WITH ORDER — NO C. O. D.

We invite you to try before you buy any of the models described on these pages. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate.

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

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CO-MAKERS
EMPLOYER NOTIFICATION

The simple order authorization included in this offer is *all* you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A

MULTI-SOCKET TYPE

TUBE TESTER

SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable case.
Price is $36.50. Terms: $6.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL

TUBE TESTER

- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes —in the carton —out of the carton —in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE

TUBE TESTER

- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (*, +, ●, ▲, ■;) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. **Price is $52.50. Terms: $12.50 after 10 day trial then $8.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER
7 Signal Generators in One!

- ✔ R.F. Signal Generator for A.M.
- ✔ R.F. Signal Generator for F.M.
- ✔ Audio Frequency Generator
- ✔ Bar Generator
- ✔ Cross Hatch Generator
- ✔ Color Dot Pattern Generator
- ✔ Marker Generator

A versatile all-inclusive **GENERATOR** which provides **ALL** the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS

AS A TRANSISTOR RADIO TESTER
An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER
The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC., DEPT D-909 3849 TENTH AVENUE, NEW YORK 34, N.Y.

Vertical Antenna Base Insulator

By HOWARD S. PYLE, W7OE

Cheap and effective way to support insulated verticals.

WITH the growing popularity of vertical antennas, 30 to 35 feet high and constructed of ¾" or 1" water pipe or conduit, a bit of a problem is encountered in providing a satisfactory base insulator at low cost.

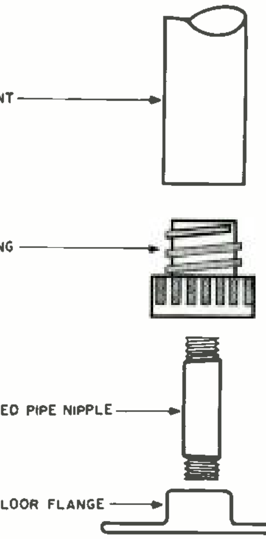
The insulator described and illustrated here has been used by the writer for several years and on powers up to 250 watts. There has never been evidence of leakage or mechanical failure. The cost is substantially less than a dollar, the parts were readily procured locally, and the assembly was but a matter of minutes.

The insulator itself is nothing more than a common, glazed porcelain bushing, available from any electrical dealer. The galvanized floor flange and pipe nipple are everyday items in your local hardware or plumbing shop. Fasten the floor flange to the roof or to a stub post set in the ground with wood screws or small lag screws, as you see fit. Screw the pipe nipple into the floor flange, drop the porcelain bushing over the nipple, and set your radiator over the bushing as shown. That does it!

If you are using ¾" pipe or conduit, get a ¾" bushing from your electrician. If it's ½" or 1" pipe, procure a bushing of appropriate size. Just be sure that the hole in the bushing is of a diameter which will fit the pipe nipple.

Such a base insulator is giving very satisfactory service currently at the writer's station, W7OE, to provide base insulation for a *Gotham* V-80 vertical radiator. Such an insulator will, of course, serve just as well on any similar factory-built antenna or a home-made job of similar type. ▲

Here is how an ordinary electrical bushing is utilized as the base insulator for the vertical antenna at the author's ham station. This method has been in use for several years without showing any failure.



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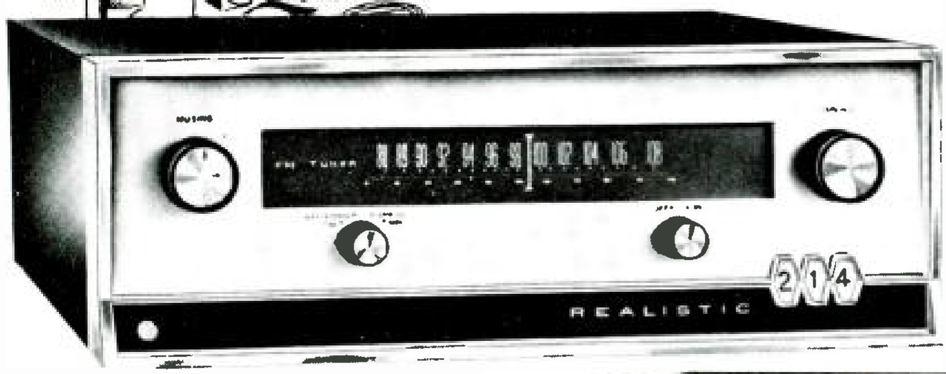
Exclusive years-ahead designs

Radio Shack's whole new family of audio and test equipment kits employs the most advanced designs and engineering concepts known today! They meet the most exacting requirements in performance and appearance. They're easy and fun to build! Critical areas are pre-wired, factory-aligned. Even a novice can follow the simplified assembly manuals. And they're easy to own on No Money Down credit terms. Every kit backed by a money-back guarantee. We show here six kits newly introduced in our exciting 1962 Catalog.



FM Stereo Multiplex Tuner Kit. Highest standards of excellence with deluxe built-in integral multiplex section. It features wide band circuitry for exceptional sensitivity: 2.2 μV, drift-free selectivity. Frequency response 10-20,000 cps ±1 db. 3 I-F stages, 3 limiters. 11 tubes plus rectifier. Muting, tuning, function selector. Tape recorder output. 90LX092—$149.95

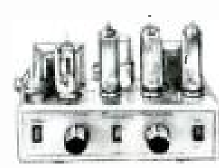
Matching Units-unexcelled anywhere

50-Watt Stereo Amplifier Kit — the powerful, all-transistor HK-208. Unique 18-transistor circuit eliminates hum, noise, output transformers and heat. Absolutely flat —1 db 10-15,000 cps at full power. Truly a breakthrough in semi-conductor stereo design, the only amplifier of its kind in the world! 90LX093—$139.95

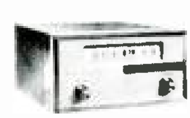
Radio Shack's 1962 Line of Kits Includes All These:

- Stereophonic Preamplifier Kit
- Stereo 140W Basic Amplifier Kit
- 40 Watt Stereo Amplifier Kit
- Complete Stereo System Kits
- Universal Multiplex Adapter Kit
- Hi-Fi 12 Watt Amplifier Kit
- FM Adapter Kit
- Stereo Balance Meter Kit
- Wireless Intercom Kits
- Deluxe Signal Generator Kit
- Deluxe VTVM Kit
- Standard VTVM Kit
- Ultra-Modern Tube Tester Kit
- 500W Variable AC Supply Kit
- VOM Kit with 4½" Meter
- Signal Generator Kit
- AC VTVM Preamplifier Kit
- Electronic Photo Relay Kit
- "Novatherm" Thermometer Kit
- 5-Tube Teakwood Radio Kit
- 2-Transistor Home Radio Kit
- 6-Transistor Portable Radio Kit
- Transistor Experimental Lab Kit

See complete specifications of these fine kits in Free Catalog



Stereo Amplifier Kit. Terrific value! Converts mono phono to stereo. Easy to build. 90LX079—$10.95



The HK204—Quality FM Tuner Kit. Incredible value! Simple assembly. 90LX070—$19.95

Dual Trace Oscilloscope Kit. Flat response from 10 cycles to 3 megacycles. 94LX072—$79.95

Tube Tester Kit. Superbly engineered — priced low. For octal, loctal, 9-7 pin tubes. 94L061—$15.95

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Matching in P.A. Systems

(Continued from page 56)

install as many as 10 lorgnette-type earphones for members of the congregation whose hearing is impaired. These earphones usually are high-impedance devices—on the order of 2000 ohms. Very little power is required to drive them, approximately 25 milliwatts being sufficient. Considering the case of the church system where a 50-watt amplifier is used to drive four loudspeakers and 10 lorgnette hearing aids, we find that the 2000-ohm impedance of a hearing aid, when connected directly to the 4-ohm output of the amplifier, presents an upward mismatch of 500 to 1. From this it follows that each hearing aid will be driven to 1/500th of the amplifier output—or .1 watt.

As noted previously, this is more than enough to provide a comfortable listening level. Ten such hearing aids, each driven to a .1-watt level, will require a total of only 1 watt from the amplifier. This power is so low that we may disregard it completely in our impedance-matching computations for the four loudspeakers. Adjust the earphone conveniently to the desired level.

Manufacturers of hearing aids also provide a compact box which incorporates a phone jack, potentiometer with knob, and a means for hanging up the hearing aid when not in use. The entire assembly attaches easily to the rear of the pew. The potentiometer (usually 10,000 ohms) permits convenient adjustment of the volume required to suit individual needs.

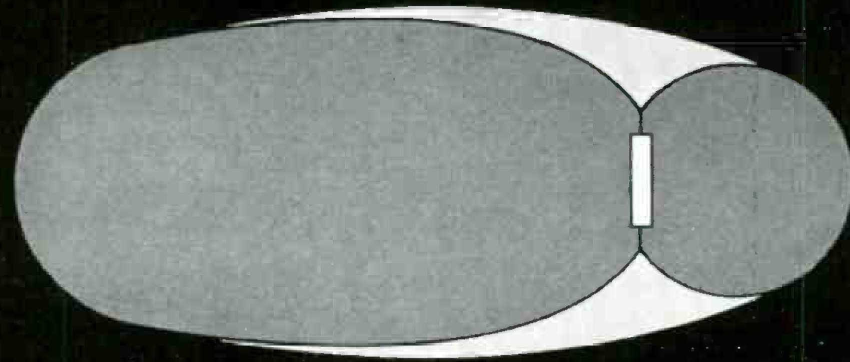
To simplify installation, all hearing aids should be located in the same section of the church so that a single transmission line may be run from them to the 4-ohm output tap on the amplifier. The transmission line between a suitable amplifier output tap and the several loudspeakers should be routed in any desirable manner; the primary impedance tap values on the line-matching transformers would then be determined without giving any consideration to the fact that the earphones are being used. The wiring diagram for a system of this type is shown in Fig. 15.

Impedance matching by means of transformers and a high-impedance transmission line often entails computations which require some understanding of mathematics. In the concluding article we will review a more widely used technique—the constant-voltage distribution system—which enables even inexperienced sound installers to arrive at a perfect match between amplifier and loudspeaker with speed, accuracy, and confidence—and with recourse only to simple arithmetic.

(Concluded next month)

sound solution

new sound columns reduce acoustic feedback and reverberation to insignificant levels... offer the highest power-handling capacity and widest frequency response in the industry.



NEW UNIVERSITY UNILINE acoustically-tapered p.a./hi-fi sound columns

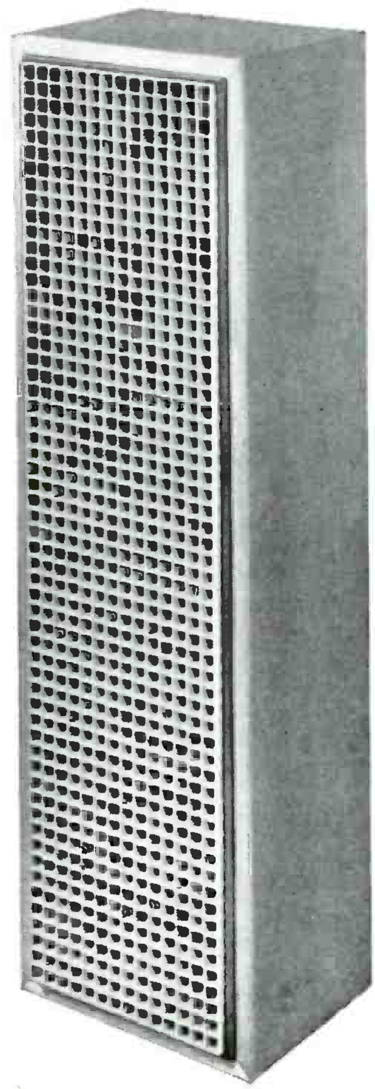
BUT FIRST THINGS FIRST. WHAT IS A SOUND COLUMN?

THEORY: Essentially, a sound column is an in-line radiator using multiple speakers, one above the other, to provide broad horizontal dispersion and narrow vertical dispersion. The shape of the beam is similar to that of a fan held horizontally, its apex representing the source of the sound. As a result of its restricted vertical dispersion pattern, the sound is placed **only where it is needed,** avoiding reflections from the ceiling and floor to reduce acoustic feedback and reverberation.

PRACTICE: Theoretically, all sound columns should perform with equal success—**but they don't.** What makes the difference? The degree of uniformity of the beam in the upper frequency range. In ordinary sound columns, the higher the frequency, the narrower the beam. Consequently, some means must be provided to reduce excessive high frequency beaming.

Only UNILINE offers **acoustic tapering,** the most perfect method yet devised for preventing uneven high frequency dispersion! UNILINE reduces acoustic feedback and reverberation to virtual **non-existence,** thus solving your difficult microphone and speaker placement problems. And only UNILINE offers power-handling capacity **up to 150 watts**... with frequency response ratings as wide as 35-17,000 cps! (Special voice frequency model available.)

For optimum dispersion at **all** frequencies, for uniform sound level within the beam, for music and speech, indoors and out ... for **all** high reverberation areas ... specifications and performance reveal that there is only one **best** line of sound columns—it is UNILINE.



MODEL UCS-6—MUSIC & SPEECH
60" Column
(6 extended-range 8" speakers)
Frequency Range: 35-17,000 cps
Power Capacity: 150 watts IPM
Impedance: 16 ohms
Vertical Angle: 15°
Horizontal Angle: 120°
Dimensions: 58½" x 10" x 7"

MODEL CSO-6
Same as above, but completely weather-proof for outdoor installations.

MODEL CS-4—MUSIC & SPEECH
40" column
(4 extended-range 8" speakers)
Frequency Range: 45-17,000 cps
Power Capacity: 80 watts IPM
Impedance: 8 ohms
Vertical Angle: 22°
Horizontal Angle: 120°
Dimensions: 39¼" x 10" x 7"

MODEL CS-3—SPEECH
40" column
(Special, multi-design speakers for speech applications)
Frequency Range: 150-10,000 cps
Power Capacity: 40 watts
Impedance: 8 ohms
Vertical Angle: 22°
Horizontal Angle: 120°
Dimensions: 39" x 8" x 6"

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Desk S-10U
University Loudspeakers, Inc.,
80 S. Kensico Ave.,
White Plains, New York.

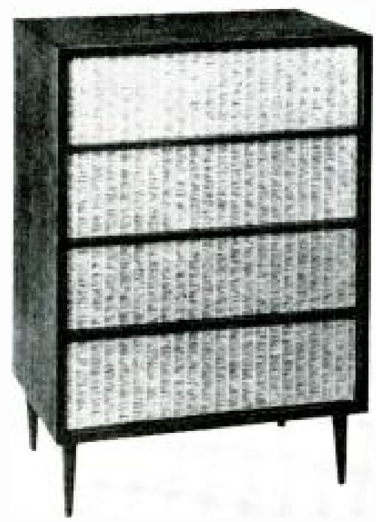
UNIVERSITY
A Division of Ling-Temco Electronics, Inc.

EW Lab Tested

(*Continued from page 24*)

comment on the principles of operation of this speaker, in the absence of more specific information. The actual performance data is interesting enough.

(EDITOR'S NOTE: *The driver used in the system is a single, wide-range 10-inch speaker whose cone is made of molded tripolymer plastic material. A hemispheric dome at the cone apex aids in*



high-frequency radiation and dispersion. Applied to the voice-coil form, but insulated from the coil, is a film of magnetic material which has the appearance of oxide coating on magnetic tape. This film, working in conjunction with the speaker's magnet, supplies much of the speaker's restoring force, thereby improving damping and linearity. As a result the voice-coil spider is not relied upon to restore the speaker diaphragm to its normal, resting position. Specially formed pole pieces are used to produce the optimum flux configuration. The enclosure is a completely sealed infinite-baffle type. An unusual arrangement of two types of sound-proofing material is used in the enclosure to completely absorb the speaker's rear wave. The arrangement is such that 70 square feet of sound-absorbing surface is available.)

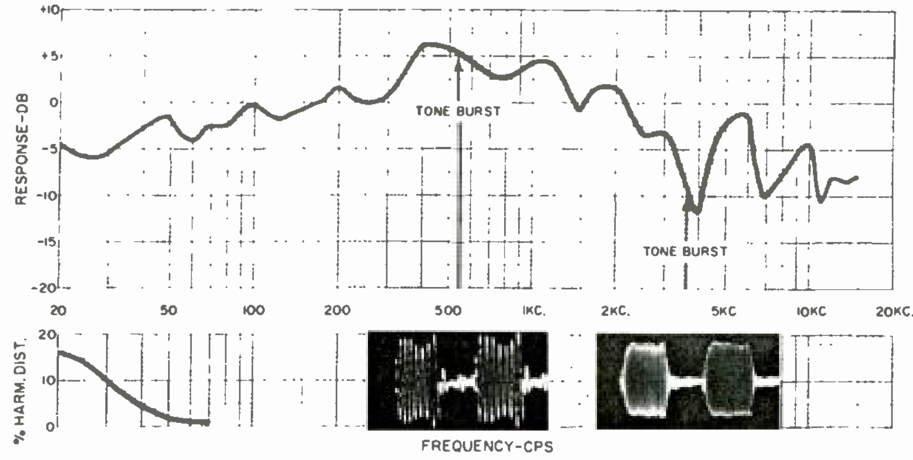
We measured the frequency response of the speaker in a room approximately 11 feet x 30 feet. The speaker was set up first on a short wall of the room and then on the long wall. In each position frequency-response measurements were made with the *Altec* 21BR150 microphone in four different locations in the room. All eight sets of readings were averaged and plotted. Harmonic distortion was measured from the acoustic output at low frequencies, with 1-watt input to the speaker. The transient response was checked by means of tone bursts whose frequency was swept throughout the spectrum. Oscilloscope photos were taken of typical tone-burst responses.

The frequency response curve shows an unusual smoothness in the low and middle frequencies. Unlike most speakers, which drop off appreciably at low frequencies, the *Hartley* maintained nearly full response down to 20 cps. This is mostly true bass response as the distortion curve shows very low distortion down to 40 cps and only moderate distortion at 20 cps. The absence of peaks or holes in the response is also noteworthy. The holes at 4 kc. and 7 kc. are apparently due to a mechanical crossover cancellation in the speaker. The general trend of the high-frequency response, like the low end, is toward a gradual drop-off rather than an abrupt cut-off.

The tone burst photos, taken at 530 cps and 3600 cps, are among the cleanest we have seen. They show practically no hangover or ringing and no spurious frequencies were generated during our tests.

In listening tests, the *Hartley* proved to be as distinctive as its measurements hinted. It is a tight, crisp-sounding speaker, virtually devoid of boom or boxy sound. The highs are very well dispersed, with practically no directional effects being audible. The lows seem to be missing much of the time but this is normal in a speaker whose low bass distortion does not allow false or exaggerated bass response caused by doubling. Unless there are truly low frequencies in the program, the speaker doesn't put out any sound in that region. Like the higher frequencies, the low-frequency reproduction is very tight and has a distinctly different character from the sound of most other speakers.

The *Hartley* "magnetic suspension" speaker is a very easy one to listen to although it does take a while to get used



TO LEARN ABOUT THE 1962 ALL-TRANSISTOR CAR RADIOS AT THE DELCO RADIO NEW PRODUCT CLINIC

Very soon now the Delco Radio New Product Clinic will be in your area. It offers you and your employees the opportunity to become familiar with the all-new, all-transistor radios for the 1962 General Motors cars. ▪ The Delco Training Course offered includes a wealth of information—transistor fundamentals plus the testing and servicing of 1962 Delco Radio all-transistor circuits. It requires only two hours and is tuition-free. ▪ The date this clinic will appear in your area is an important one! Circle it on the list below, and make it a "must"—because this course will mean extra profits for you, especially when servicing the all-transistor radios for the 1962 models. We look forward to seeing you. Contact your Delco electronics parts supplier for further information.

DELCO RADIO ELECTRONICS SCHOOL SCHEDULE

School Dates	CITY
Sept. 11	Indianapolis, Ind.
Sept. 18	Harrisburg, Pa. Grand Rapids, Mich. South Bend, Ind. Denver, Colo. Shreveport, La.
Sept. 20	Philadelphia, Pa. Marion, Ind. Nashville, Tenn. Chicago, Ill. Cheyenne, Wyo. Dallas, Tex.
Sept. 25	Wilkes-Barre, Pa. Louisville, Ky. Memphis, Tenn. Davenport, Iowa Salt Lake City, Utah Houston, Tex.
Sept. 27	Cincinnati, Ohio Little Rock, Ark. Madison, Wis. Beaumont, Tex.
Oct. 2	Union, N. J. Toledo, Ohio Birmingham, Ala. Milwaukee, Wis. Los Angeles, Cal. San Antonio, Tex.
Oct. 4	Tarrytown, N. Y. Detroit, Mich. Atlanta, Ga. Green Bay, Wis. San Diego, Cal. Corpus Christi, Tex.
Oct. 9	Hempstead, L. I., N. Y. Fresno, Cal. Midland, Tex.
Oct. 11	Wallingford, Conn. San Francisco, Cal. Lubbock, Tex.
Oct. 16	Providence, R. I. Cleveland, Ohio Minneapolis, Minn.
Oct. 16	Portland, Ore. Amarillo, Tex.
Oct. 18	Boston, Mass. Columbus, Ohio Chattanooga, Tenn. Moorhead, Minn. Seattle, Wash. Oklahoma City, Okla.
Oct. 23	Youngstown, Ohio Charlotte, N. C. Sioux Falls, S. D. Spokane, Wash. Wichita, Kan.
Oct. 25	Pittsburgh, Pa. Durham, N. C. Omaha, Neb. Kansas City, Kan.
Oct. 30	Buffalo, N. Y. Altoona, Pa. Greenville, S. C. Des Moines, Iowa
Nov. 1	Rochester, N. Y. Mason City, Iowa
Nov. 6	Syracuse, N. Y. Jacksonville, Fla.
Nov. 8	Albany, N. Y. Tampa, Fla. Long Beach, Cal. El Paso, Tex.
Nov. 13	Dayton, O. Miami, Fla. Decatur, Ill. Tucson, Ariz.
Nov. 15	Huntington, W. Va. St. Louis, Mo. Sacramento Cal. Phoenix, Ariz.
Nov. 16	Mobile, Ala.
Nov. 20	New Orleans, La.
Nov. 27	Washington, D. C.
Nov. 29	Richmond, Va.

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Every car radio service shop needs this new Delco power supply! Plugs into 110-volt outlet, converts power to 6 or 12 volts to facilitate bench servicing without batteries. Features: Output 0-8V DC, 0-16V DC ▪ Rating 8a at 6V, 5a at 12V ▪ Maximum instantaneous current 20a ▪ Maximum ripple .01% ▪ No LC filter, instant response ▪ Light, portable ▪ Rugged—3 Delco power transistors ▪ Best for transistor radios ▪ Also operates "Wonder Bar" tuners at 12 volts.

DELCO RADIO
DEPENDABILITY RELIABILITY

Division of General Motors, Kokomo, Indiana

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to it. It sounds different and may not appeal to everyone, but it deserves serious consideration by anyone trying to achieve natural sound reproduction.

The price of the "Holton" system is $245 and it is available in walnut, mahogany, and korina. The loudspeaker is also available separately at $135.00. ▲

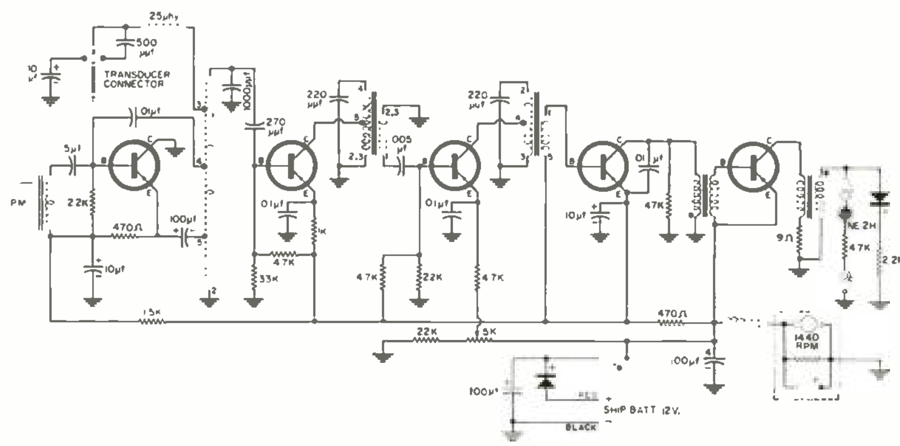
Columbian Hydrosonics "Aqua-Probe" Depth Finder

For copy of manufacturer's brochure, circle No. 59 on coupon (page 130).

ALTHOUGH the boating season is coming to a close shortly in our area, we feel that there are many individuals who continue their electronic interest in boating all year round. We have had considerable enjoyment in experimenting and testing a new depth finder that is completely transistorized. It is housed in a non-metallic enclosure which is of extreme importance in salt-water areas. It is compact in design, can be mounted in any position, and all depth pips are easily recognized. Ultrasonic pulses at the rate of 1440 per minute are used and, although the limit of our test was only to a depth of 80 feet, it can be used in waters exceeding 100 feet. It is designed for use with an external 12-volt battery or, as in our case, connected directly to a 12-volt marine power system. It was used with a Mercury 70-horsepower outboard motor, and we found no need for extra shielding. Since its power requirements are below 1 watt, excessive battery drain was not encountered.

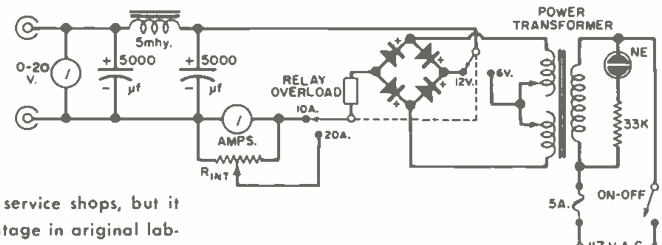
Depth finders, in general, are not only interesting devices to have aboard, but in many areas where you are in shallow, unknown waters, it becomes imperative as a safety measure to have one available aboard ship. It is interesting in a sense that all depth finders, when properly designed, provide one with an identifying signal indicating rocky or muddy bottoms and, when one becomes accustomed to using such a device, one can develop great skill at interpreting readings. In some cases, even the size and type of fish can be determined.

We found the depth indications extremely accurate and we were able to differentiate between muddy and rocky bottoms and, on many occasions, became aware of either fish or floating objects below the boat. Someday we hope to be able to tell the size of these fish or objects. This unit is manufactured by *Columbian Hydrosonics, Inc.*, a subsidiary of *Columbian Bronze Corporation*. It is available at $99.50 .... E.W.



Eico Model 1064 Low-Voltage Power Supply

For copy of manufacturer's brochure, circle No. 60 on coupon (page 130).



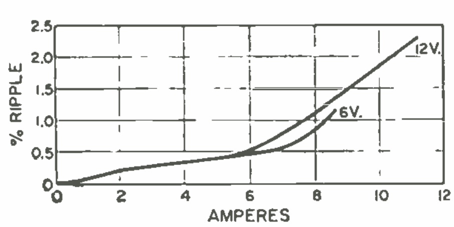
A WELL-designed, low-ripple, low d.c. voltage power supply is an absolute necessity in the servicing and testing of transistorized equipment. Not only is such a device important in service shops, but it can be used to great advantage in original laboratory design work. Not only does *Eico's* Model 1064 fulfill these needs, but this particular unit can be used as a battery charger for either 6- or 12-volt batteries. This design provides two continuously variable ranges: 0-8 volts at 10 amperes continuously or 20 amps. intermittently and 0-16 volts at 6 amps. continuously and 10 amps. intermittently.

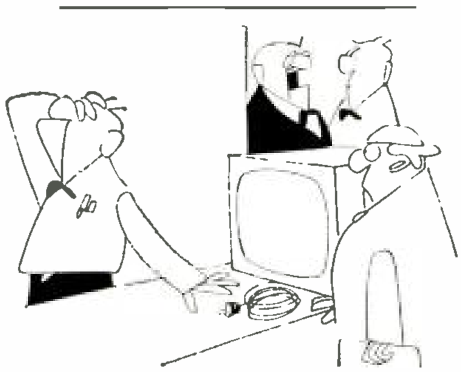
As noted in the schematic diagram, the transformer has two secondary windings, both of which are in parallel for 0-8 volt operation and in series for 0-16 volt operation. An automatic reset overload relay, in the secondary of the transformer, provides the necessary protection against damage due to excessive current drain. The relay opens when the current exceeds 20 amperes and automatically resets itself when the overload is removed.

A pi-type LC filter is used and, as a result, the output has an extremely low ripple content. The accompanying graph shows the results we obtained on our unit. The ripple content is shown for both 6- and 12-volt operation, and the figures are slightly less than those published by the manufacturer.

Another feature which is more than just a convenience to the user is the incorporation of a voltmeter and ammeter connected in the output circuit that allows simultaneous observation of both the output voltage and current without the need of switching. Obviously, these meters have small scales and are not intended to provide readings of calibration accuracy. They should certainly suffice for any kind of service or maintenance applications but, for original design work, it might be advisable to connect, externally, meters of greater accuracy.

This new unit is extremely rugged and designed especially for hard use. It is housed in a grey perforated steel cabinet. Its over-all size is 10½"x 7¾"x 8¾", and the over-all weight is 16 pounds. It is, in all sense of the word, professional in appearance, and is particularly designed in style and shape to match the company's Model 260 d.c.-volt-watt meter, and Model 1078 power-line voltage regulator. This unit is available at $43.95 in kit form and $52.95 completely assembled. E.W.





"Farnsworth has a nice technique when they mention the trouble."

Mac's Service Shop

(*Continued from page 52*)

difficult to repair. Even though he can make it work by spending enough time on it, he takes no pride or pleasure in the job; and some of his dissatisfaction is very likely to spread to the owner, especially when the technician justifies his service charge by pointing out how difficult it is to locate and repair trouble in the receiver.

"I know it is almost heresy to say this," Mac concluded; "but I still believe there is a very substantial demand for good quality merchandise at a fair price. There is a growing rebellion against the shoddy 'competitive' type of product that many manufacturers seem convinced is what the public wants. I hear this discontent on every side. 'I would rather pay a little more and get something decent,' people tell me; 'but how can I? All too often the expensive model is actually the same thing as the low-cost model with just more gadgets added. I don't want only to pay more! I want to get more—more that really counts.'"

"Say," Barney interrupted as he glanced at the clock, "this is all pretty fascinating, but I wonder if you could come down to earth and help me with a little problem that has been bugging me lately. What am I supposed to do with transistor sets that develop bad on-off switches? I'm running into more of these all the time, and I'm not having much luck fixing them. In the first place, I don't see why they should give trouble. After all, they handle only a few mils of current, while a tube receiver switch usually controls a current of an ampere or so; yet the latter seldom gives trouble unless lightning gets at it."

"Very likely the low current through the transistor switch is partly the cause of the trouble," Mac suggested. "Any relay manufacturer will tell you 'dry' contact points are the hardest to keep operating dependably. By 'dry' I mean contact points handling no appreciable amount of current, such as those transferring a receiver from one antenna to another. In the case of contacts handling relatively heavy current, tiny arcing takes place during making and breaking and burns off insulating oxide and dirt. The voltage necessarily present also helps penetrate any thin insulating film. Where there is no voltage and current, this does not happen. Increased contact pressure and a wiping action of the contacts will usually help in a relay; and so will sealing them off from dirt."

"I think I'm beginning to get the picture," Barney broke in. "Most of these transistor switches are pretty crude affairs right out in the open. Two little brass or bronze tongues are held in contact by their own spring tension until a cam on the volume control rotor pushes one of them away. There is not much pressure, no wiping action, and no protection against dust and lint except that afforded by the receiver case. No won-

der they give trouble. I've tried contact cleaner on them without much luck. In some cases, this seemed to make things worse."

"I found that out, too," Mac confided. "Most of those cleaners are intended to work on sliding contacts. In the case of transistor switch contacts that simply touch together and pull apart, the cleaner acts more as an insulator in itself and as a binder for dirt to accumulate between the contacts. I've had the best luck using this stuff to clean the contacts first and then wiping them completely dry with a pipe cleaner. After that I carefully bend the contact tongues so they are held together with considerable tension when the receiver is turned on and are not spread very far apart when the receiver is turned off. So far—knock on wood!—every switch I've repaired in this fashion has continued working."

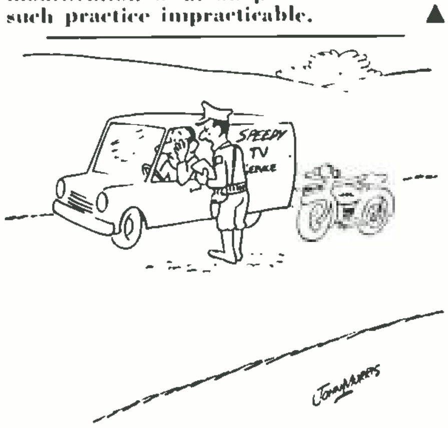
"Thanks for the tip," Barney said as he picked up a set of jeweler's screwdrivers, took the case off a little transistor receiver, and screwed a jeweler's loupe into his eye. "I'll soon let you know if it works for me!" ▲

HOME-BUILT & SURPLUS EQUIPMENT FOR CB

According to a recent FCC release, there is no objection to the use of home-designed and home-constructed Citizens Radio equipment provided that such equipment is built to specifications that insure its operation according to the rules. Further, the equipment must have been "checked out" by or under the direct supervision of the holder of a first- or second-class radio operator's license, not an amateur ticket holder. Factory-assembled or certified kits do not require the services of a licensed radio operator.

On the other hand, military surplus equipment is not suitable for use for the following reasons: (1) It is not normally able to maintain the required frequency stability. (2) The equipment usually uses FM rather than the AM required. (3) Power inputs over the 5-watt limit are frequently employed. (4) The equipment, in general, cannot maintain the emission within the authorized 8-kc. bandwidth when used on AM.

In general, it is the experience of the Commission that the expense involved in making such modifications as may be necessary to make military gear conform to the rules—in those cases where such modification is at all possible—renders such practice impracticable. ▲



"That's 34 service calls you owe me."

Ion Generator & Air Filter

(*Continued from page* 50)

rather easy to keep the area clean.

The actual installation consists simply of sliding the filter, with ionizer frame attached, into its normal place and inserting the high-voltage lead into the banana jack on the ionizer unit. The ground lead should be run from the power-supply chassis to the filter frame. You can now plug the power supply into the receptacle you have provided and the job is completed.

You may notice a faint, sweet smell close to the warm-air registers when the unit is first turned on. This will appear to lessen or go away after a week or so —not because the unit is working less effectively, but because you are becoming accustomed to the smell.

Cleaning

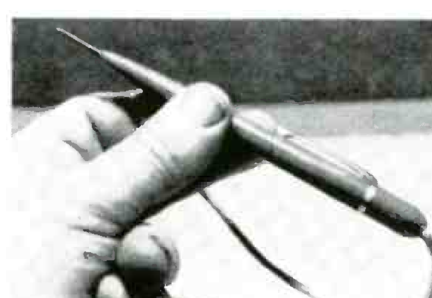
The filter should be cleaned after the first two weeks of operation and then once a month thereafter. To clean, loosen the two screws at the top and bottom center of the ionizer frame and slide it away from the filter. Draw as much dirt as possible with a vacuum cleaner, then wash with warm water and detergent. Rinse with clean water and let dry thoroughly. Run a soft camel hair brush up and down the wire grid to remove any dust that may have accumulated on the wire. Make sure the expanded metal ground plate is clean before installing the ionizer frame in the filter.

Because of the electrostatic action, it will be unnecessary to use oil in the furnace's regular metal filter. This will result in freer movement of air through the filter and an increase in the efficiency of the entire heating system. ▲

HANDY TEST PRODS

By G. F. STILLWELL

If you can use an extra pair of handy electrical prods, you can make them in a minute from discarded ballpoint pen sleeves. The pen sleeves must be of plastic and since many of them are, this is no problem. Remove the pen mechanism then solder the bare end of a length of insulated wire to a sharpened nail. This, of course, will be the prod. Remove the cap from the pen sleeve and insert this prod through cap and sleeve. Fasten the prod in some way (by flattening) to keep it from backing out. Most inexpensive ballpoint pens come in various colors and a red one can be used for the positive prod. Happily cheap pens are better for this purpose than expensive ones.



Electronic Clothes Dryer
(*Continued from page 57*)

near the revolving drum. A brush on the drum connects the ring with the set of electrodes. The path to the other set of electrodes is completed through the wet clothing, which makes a good conductor and is always in contact with these "fingers" mounted on the baffles inside the rotating drum. The path to dryer ground is completed through the metal of the drum itself.

The current flow, limited by the resistor, is only a few microamperes. While this avoids any hazard, it is enough to prevent the low-current supply from charging capacitor *C*. As the contents of the drum dry however, conduction through the electrodes is reduced. Voltage across the capacitor can now build up. When the latter charge reaches 74 volts, it is up to the firing point of *NE*, a neon glow lamp. The lamp ionizes and glows instantaneously as the capacitor discharges through it. Brief as the glow is, it is enough to activate the photoelectric device, *PC*.

Maytag calls the cell a light-decreasing resistor, which provides the clue to its behavior. Ordinarily it exhibits a very high resistance. Under these conditions, it limits current to the a.c. relay, preventing the latter from being energized. However, when light strikes it, resistance of *PC* drops to a negligible value. This lets the relay pull in, closing the circuit to the timer motor. The latter then continues drum rotation for a short "cool-down" period. Another set of contacts on the relay, not shown, holds the latter until the completion of the cycle. The role of the built-in timer during this operation is strictly secondary. The length of the over-all drying period is primarily dependent on the moisture content sensed in the clothes.

Actually either of two resistors is used for *R*. When the machine is set to "Regular Fabrics," a 30-megohm resistor is switched into the circuit for maximum drying. In the "Damp Dry" position, used for materials that will be ironed, a 330,000-ohm component permits earlier build-up of the capacitor charge. For wash-and-wear fabrics, instead of using a third resistor to permit termination at still another level of moisture content, the low-value resistor is used and other changes are made during the full cycle. These include the use of higher internal temperatures.

The control system, on which the manufacturer has made extensive patent applications, appears to offer many of the attributes considered desirable in a home appliance. It is simple, using only a few components housed in a box about the size of two packs of cigarettes. It avoids a system of moving parts that may wear out or break down. It is relatively inexpensive. In addition, it is more than a mere gadget: it fills a need felt by the consumer who wants fully automatic operation that is not met in other ways. ▲

Calibration Standards

(*Continued from page* 51)

tage of this standard is the low level of the output. At only .1 volt, it may not be as convenient to use as most of the other standards. Furthermore, it is not a good idea to stack several diodes for greater output. In such a series arrangement, the exact voltage output is not easy to predict as a simple sum or product based on the number of diodes. Nevertheless, this standard may have some auxiliary value. To check for proper tracking or meter linearity, this source is useful at the low end of a low-voltage d.c. scale after one or more check-points have been established higher up the scale.

Check Procedures

Having made your choice of calibrating voltage (more than one is preferred), checking the d.c. voltage scales is relatively simple. As to exact procedure, there is more than one way. If your first standard gives you a check-point close to 1.5 volts, you can proceed to noting and marking the voltage outputs of a random handful of dry cells. These can then be connected in series with their voltages added to give you various higher voltages for checking higher scales.

You might begin with more than one low-voltage standard to check different points on your lowest d.c. voltage scale. This will give you an idea of the meter movement's linearity, which is generally quite good. If it is somewhat off, recording deviation in one scale will give you a correction you can apply to all d.c. scales, since this nonlinearity will be constant. It would then be necessary to have only one check-point on each of the higher scales to chart accuracy across each. Another possibility is to compare the reading of the same known source voltage or voltages on two or more scales.

With methods such as these, you should be able to develop a broad picture of accuracy for all d.c. voltage ranges and calibrate accordingly. Once this is done, you are in a position to check current scales. You can now apply an accurately measurable voltage across a precision resistor and calculate the current through the latter very closely.

If you know the internal resistance of the meter on a particular current range, usually not very high, simply put the meter in series with the precision resistor across the known voltage source, add the meter resistance to that of the precision resistor, and divide this sum into the voltage. The answer is the current the meter should be indicating. The higher the voltage source and value of the precision resistor, the more accurate this method is likely to be. In the first place, loading of the source voltage will be minimized. In the second place, the effect of any inaccuracies in the meter's resistance will be reduced.

With a high enough external resistor, say 300,000 ohms or more, and a source voltage in the vicinity of 10 volts, it would be practical to ignore internal resistance, if the latter is not known, even on the lowest current scale, which is likely to be in the range of 50 microamperes. Although this current scale is the one on which meter resistance will be highest, the error it introduces is likely to be less than 1 per-cent. On higher current scales, meter resistance becomes negligible so that one or more lower-value external resistors can be used with assorted voltages to provide check-points. Once more, if meter linearity is already known, only a single check-point on any d.c. current scale is needed to calibrate the entire range.

The calibration of a.c. and ohmmeter scales is another matter altogether, since factors other than inherent linearity of the meter affect accuracy. These will be discussed separately, in other articles. As to calibration for reading of direct current and voltage, the chief problem is the choice of the voltage source you feel you can trust most for your starting point. With one of the more accurate ones listed earlier, or with a choice of more than one to double check, and with care in using them, you should be able to calibrate your instrument so that you can rely on reading within a narrow range of percentage variation anywhere on any d.c. scale. ▲

FM STATIONS PLAN FOR STEREO

ACCORDING to a survey by the NAB among its FM station members, a total of 79 stations will be airing stereo FM programs by the end of this year, and 178 by the end of 1962.

Of the 384 stations replying to the questionnaire, 140 stations have no plans at all for FM stereocasting, 32 stations are undecided, while 24 stations already broadcast AM/FM stereo and have no plans for multiplexing.

As to the proposed number of hours to be devoted to stereo programs, the responses varied from 2 to 130 hours a week. Some of the stations reported delays because of lack of equipment, while others are waiting for wider availability of FM stereo receivers to the general public. ▲

INEXPENSIVE DIODE WITH HIGH BACK RESISTANCE

By JIM KYLE

EXPERIMENTERS and others have need of a crystal diode with extremely high reverse resistance. While such an item is available (at a price almost as high as its reverse resistance), the base-emitter junction of any common transistor, such as the CK722, the 2N108, or the 2N229, has a reverse resistance higher than any easily obtainable diode—at a price of less than a dollar for any of the types mentioned.

To use the transistor in this application, clip off the collector lead and use the base (for a "p-n-p" type) as the diode cathode. Polarity will be reversed with an "n-p-n" unit. ▲

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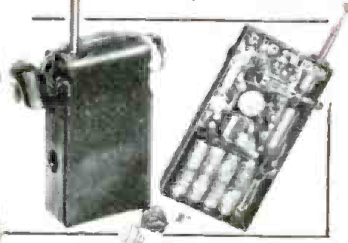
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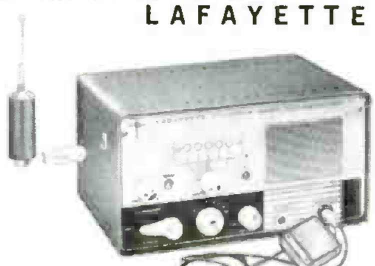

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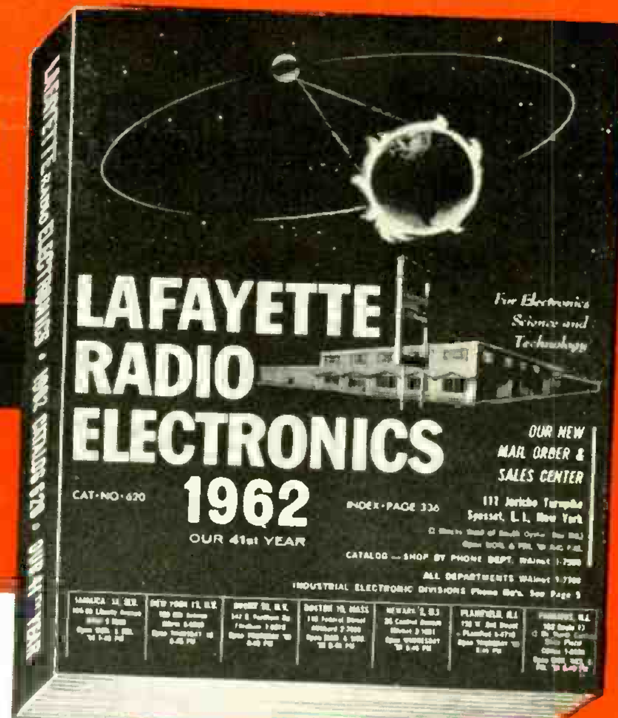

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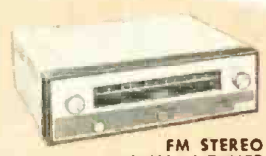

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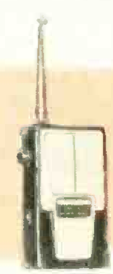

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Speaker Testing & Measurement

(Continued from page 44)

radiated from the speaker rather than sound pressure at any particular angle.

Following the same reasoning, peaks and dips caused by diffraction around the cabinet edges—variations in response which do not change the total amount of energy radiated—are of very small significance in a listening room, although they will show up in an anechoic chamber reading.

Interpreting Response Curves

The most important information that a speaker response curve can convey relates to smoothness of response which, in turn, is an accurate index of transient response. Peaks which reflect speaker resonance predict ringing or hangover—the tendency of the speaker cone to continue to vibrate after the signal has stopped. In the bass this makes for boomy sound; in the midrange and treble it makes for harsh, blurred sound, often with a sort of nasal quality. Tone-burst tests are an excellent indication of transient response. They predict the degree of smoothness of frequency response even more accurately than the prediction of transient performance by frequency response curves.

Roughness in a response curve, which is the result of interference or diffraction, is not associated with resonant hangover and is not important. One way of identifying roughness caused by speaker resonance is to find the same peaks and dips in the response curve at various angles from the axis of the speaker.

Harmonic Distortion

Very little is ever said about speaker bass distortion, possibly because it is an embarrassing subject. When bass distortion studies are made and published, the percentage of distortion in the octave below 60 cycles (at moderate sound levels) generally ranges from about 5 to 50% and sometimes higher. Fortunately those speakers whose distortion is at the high end of this range often exhibit severe bass attenuation as well so that there isn't as much distorted bass to contend with, but clean bass is just as significant in speakers as it is in other components.

A loudspeaker may make a loud sound when a 30-cps signal is fed to it, but unless the distortion is reasonably low, the speaker cannot be said to have useful response at 30 cycles. The major part of the sound output may be at 60 and 90 cps, with little of the fundamental energy which gives a deep organ tone its "feel." All speakers have 30-cycle response in the sense that they do something when stimulated at this frequency; a two-inch portable speaker may respond by having the cone fly out into the air. To be meaningful a frequency response curve must be accompanied, particularly in the bass range, by a distortion curve. An alternative is to have non-fundamental components filtered from the microphone output before the level is recorded.

Meaning of Speaker Measurements

Speakers are very imperfect devices and the state of the art has not achieved the level of transparency of electronic circuitry. There is a large subjective element involved in evaluating loudspeakers, even with the most reliable test results available. This is because one must make a choice among various types of speaker deficiencies—the tendency to shrillness of one speaker, to boominess of another, or to distortion of a third. In all cases one must decide which aberration intrudes itself least into the illusion of musical reality. To one person a particular defect will mar the naturalness of sound more than will another.

Taste is an important element in evaluating a creative musical performance, but it does not help in evaluating the accuracy of *re*-creation, that is, the degree of fidelity of sound reproducing equipment. Perception and understanding of the degree of similarity to the original sound, rather than likes and dislikes, should be the key in judging loudspeakers.

Objective test results give more information on loudspeakers and, to the experienced person who knows how to interpret such results, the actual sound of the speaker can be predicted before the speaker is ever connected to a hi-fi system. As long as the test conditions for objective measurements are correctly interpreted in relation to what they have to say about musical realism, they are extremely useful to the consumer and indispensable to the designer. They have the advantage, of course, of being unaffected by the tester's musical preferences, his current mood, or what he had for lunch.

REFERENCES

1. If the anechoic chamber is a very large one, such a curve can be interpreted. Each time the solid angle is cut in half the bass range of the response curve is lifted in a predictable manner, by 3 db. See Beranek, Leo L.: "Acoustics", McGraw-Hill Book Company, Inc., New York, 1954, page 320.

2. Correction of the response curve to account for a further reduction of solid angle can be avoided by using a lower amplifier damping factor, which accomplishes the same result. ▲

REDUCING FM BACKGROUND NOISE

By ELWOOD C. THOMPSON

TO REDUCE background noise in FM receivers when no station is tuned in, try adding fixed bias to the limiter tube. Sufficient bias should be used to cut the tube off, plus enough to keep the noise voltage from drawing limiter grid current. ▲

SERVICE INDUSTRY NEWS

Interest in color grows; more developments noted.

WHETHER CURRENT excitement will be reflected in sales figures, where it counts, won't be known for at least several months, but color TV has surely been responsible for much talk—and activity, too—on the manufacturing end. In recent months, we have noted the introduction of an improved, shadow-mask CRT by *RCA* and the serious entry of both *G-E* and *Zenith* into receiver production, with innovations in circuit design. Other manufacturers have elected to market *RCA*-built chassis in their own cabinets. Since our last report, at least five more "names" have entered the color derby in one way or another.

Motorola, although not about to market a set, created the greatest stir with a successful demonstration of a 90-degree, 23-inch, rectangular tube. The *CRT* is otherwise a conventional three-gun, shadow-mask type not likely to effect a significant cut in set prices, at least initially. What, then, are its advantages? The manufacturer sees at least two, the first based on the conviction that receiver cost is *not* the chief deterrent to sales. Present round, 70-degree tubes, large and bulky, have necessitated cabinets that are correspondingly ungainly. The squared-off tube not only displays a picture of the same, familiar size and shape as that obtained on monochrome types, but also permits more acceptable housing. *Motorola* made its point by demonstrating an operative receiver in one of the furniture-styled cabinets used for its monochrome line. It feels people will pay for a receiver that meets their requirements.

Motorola has not attempted to alter the basic structure of the triple gun in the re-designed CRT, which is already five inches shorter than the round tube. An additional effort in this direction, it is felt, might result in a "short-necked" type that would reduce depth still more.

Another claimed advantage is that, whereas production of the round CRT requires heavy investment in all-new equipment, the rectangular version may be built with existing black-and-white production facilities, plus a relatively modest investment in add-on equipment. CRT makers other than *RCA*, with no assurance of appreciable demand, have been notably reluctant to take a costly gamble heretofore. *Motorola* reports several leading tube makers interested in its design, for which it will make technology available. If more tube sources thus become available, a competitive situation will exist for the first time.

The new CRT, using less glass and reported easier to make, should be less expensive than the one now in use. However, since it will require more sophisticated convergence and deflection circuitry, it is not likely to inaugurate an immediate drop in over-all receiver prices.

Motorola is confident that, in no more than a year, it will be selling sets using the 23-inch color tubes, which it will obtain from at least one CRT manufacturer.

Other Names in Color

Sylvania has joined *Zenith*, *G-E*, and others who are making and selling color TV receivers. *Philco* is also officially in the picture, but with less enthusiasm than other manufacturers have shown. Bowing to dealer demand, it will market sets built for it by *RCA*, but is not planning a heavy effort. It is saving its energy for a set designed around its own "apple" tube which, it still feels, holds early promise for a good, inexpensive set. *Sears Roebuck* is also entering a "Silvertone" color receiver, made for it by *Warwick Mfg. Co.* This adds another manufacturer.

Finally a set made by *Chromatic TV*, using an improved version of the rectangular, single-gun, Lawrence tube, was demonstrated. Greatly enhanced picture brightness was reported. *Paramount* notes interest in this design, which does not require much modification of existing monochrome circuits, by leading set manufacturers. If no one else undertakes production, a *Paramount* affiliate may start turning out the sets. Estimated prices will be no greater, initially, than those for conventional color sets, with mass production holding out the possibility of significant cuts.

Michigan Loses Leader

TSA members in Detroit and Michigan, as well as others in the independent service industry elsewhere, suffered a serious loss when Karl Heinzman, active in local and national association affairs for more than seven years, succumbed to a heart attack recently. A brilliant and sometimes controversial leader, he is mourned by those who were often at odds with him as well as by supporters. Only 52, his alert and dynamic personality gave the impression of a much younger man. An office-holder in TSA and other groups from 1955 to the time of his death, Karl was a key figure in many notable industry efforts of recent years. He was intimately involved in the "Unite to Fight" and IDEA programs, in addition to other plans to inhibit manufacturer activity in service. A determined exponent of licensing, he played an important role in making Detroit a pioneer city in service licensing with functioning legislation that still stands today as a model for other areas. We had the privilege of knowing him and seeing him in action. In addition to serving TSA as president for three terms and in other capacities, he was a prominent civic leader and Chamber of Commerce official.

Hoosiers Honor Teskey

It will take a constitutional amendment to do it, but IESA of Indiana is creating a new position on its board of directors for Frank J. Teskey, editor of its official monthly, "The Hoosier Test Probe." The move acknowledges the significant role the publication—and its editor—have played in advancing IESA activities. It also facilitates the close coordination needed to enhance this role in the future. Teskey, whose conviction that national unity is essential figured prominently in bringing his Indianapolis group into the NATESA fold, was also named chairman of the IESA License Steering Committee. Good luck, Frank. We hope your stepped-up activities leave you some time to run your shop!

Also from Indiana comes news that the central part of the state is being swept by the "free" tube-testing gimmick. As has been the case elsewhere, this "wave" will pass after a while, when enough set owners have been taken in to alert the remainder. However, it will leave in its wake not only fleeced customers, but legitimate servicers who have lost income, and a blackened eye for TV service in general.

IESA proposes to resist the racket with facts for its members and their customers. Men making calls for the "free" testers, it states, work on commission only and therefore must build up a bill to make a profit on each job. Customers are "loaded" with as many new tubes, after testing, as possible, needed or not. Then come extras, often over-priced, like cleaning the tuner (no chassis removal), adjusting controls ($3.50), and rejuvenating the CRT ($9.95, plus $4.50 for a brightener). Sets are pulled wherever possible. The lowest shop bill noted in this case was $44. Often there is no evidence that work has been done. Proof, once more, of the high cost of getting something for nothing.

Stop the CRT Racket

While a rebuilt picture tube, properly made and using a new gun, is *bona fide* merchandise, some shady "rebuilders" are peddling substandard goods. "NATESA Scope" claims that at least 60 per-cent of this shoddy merchandise has never been opened up, using the original gun, possibly rejuvenated. On this premise, it suggests how the racket can be stopped cold. Every legitimate technician should apply line voltage to the heater pins of every dud through a cheater cord to burn up the filament. This will not impair the dud's value either to him or to an honest rebuilder, but it will thwart the "junkmen" completely. ▲

Marine Radios To Double In 5 Years

Number of licensed radiotelephones may hit 180,000.

THE total number of licensed marine radiotelephones will double to 180,000 over the course of the next five years, according to a prediction by J. Leonard Lovett, marketing manager for *Raytheon* marine products. Lovett also predicted that motor manufacturers will yield to consumer pressure and offer motors that adequately suppress ignition and generator noise radiation.

The addition of alternators on outboard motors and improved noise suppression, coupled with more efficient and less expensive radiotelephones to be introduced by electronic manufacturers, will further tax the available communications channels. Lovett suggested increased use of the Citizens Band to relieve some of this traffic. Citing the inability to call the Coast Guard on 27-mc. equipment, he proposed designation of a single channel in each boating area as a safety and distress channel and urged the Coast Guard to monitor this channel locally. He also proposed the development of an inexpensive radiotelephone alarm system.

Discussing other alternatives to the marine band for all communications, the *Raytheon* executive praised v.h.f. equipment but observed that the general safety and calling frequency of 156.8 mc. is not well guarded because of the limited number of v.h.f. sets in use. A marine v.h.f. 3- or 4-channel radio telephone represents an investment of $750-$800 whereas a 4- or 5-channel marine-band unit costs only $250-$300. He predicted that the marine band would continue to enjoy at least a two-to-one price advantage over v.h.f. despite new components and manufacturing techniques.

Although many years away from widespread use on small craft, single-sideband equipment will eventually help relieve the congestion. This type of equipment will be particularly attractive to long-range pleasure craft and commercial vessels.

Lovett urged that communications education programs be tied more closely to over-all safe boating programs. "If you analyze the various electronic products sold in quantity to small craft owners, you will find that they offer added attractions besides safety. The depth sounder helps with fishing, the radiotelephone adds the convenience of being able to talk to home or office and adds prestige, and the RDF also plays broadcast frequencies. The gasoline fume detector, however, is not sold in large quantities. It is reliable and not too expensive but it doesn't do anything except protect life and property. If it would play music or something, it would probably sell in quantity and reduce the needless explosions and fires we encounter every season." ▲

REDUCING FM MULTIPATH DISTORTION

New information on a type of distortion that may affect your FM reception—based on some recent BBC studies.

By **PATRICK HALLIDAY**

HIGH-FIDELITY reception of FM sound broadcasts suffers more often than is generally realized from multipath distortion. This distortion, due to simultaneous pickup of direct and reflected v.h.f. signals, is the counterpart of the much better known "TV ghosting." It is similarly brought about by signal reflections from hills, towers, buildings, and the like, and occasionally by freak auroral propagation. But, whereas ghost images unmistakably pinpoint this condition on TV, the resulting audio distortion on sound program material is often attributed to equipment shortcomings.

Because multipath distortion, when severe, can sound like an off-center voice coil, complaints are often wrongly directed to loudspeaker manufacturers. Less severe distortion may pass unnoticed for a time but eventually shows up on certain types of program material. Fresh information on this type of distortion has come to light recently as a result of investigations by the *British Broadcasting Corporation*, using delay lines to simulate reflections.

European broadcasting came late to FM, but once the decision to introduce v.h.f. broadcasts had been made, there were no half measures. West Germany, with AM programs severely handicapped by lack of frequency allocations after World War II, established a nationwide FM service in the early fifties. A few years later, despairing of the chaotic and overcrowded conditions on the AM broadcast bands, the *BBC* and other European broadcasting organizations followed suit. In Britain there is now a full three-program FM network in the 87.5-100 mc. band available to 97 per-cent of the population: one home in five has an FM or AM/FM, or combined TV/FM receiver. The primary intention is to provide an interference-free, rather than a high-fidelity, service but the performance specifications for the FM transmitters call for an a.f. response from 60 to 10,000 cps with less than 1 per-cent distortion at the full 75-kc. deviation; and but little worse up to 15,000-20,000 cps and down to 30 cps. In practice, the audio performance is often restricted by the losses in the program lines between studios and transmitters. But for many of the more important musical transmissions special lines are used and the transmitted a.f. range is well calculated to meet the needs of the most discriminating high-fidelity enthusiasts.

But within a short time of the opening of the FM service, reports of poor quality began to trickle in to the *BBC*, and engineers were put on to investigating these unexpected complaints. It was soon discovered that the trouble was caused by multipath reception which, until then, had received comparatively little attention and was almost ignored in many standard texts. Set makers were advised to improve AM suppression characteristics and recent receiver designs have proved less susceptible.

Effects & How Produced

Whereas this form of distortion often passes unnoticed on standard broadcast receivers of restricted audio range, it can show up on hi-fi installations in varying degrees from just perceptible to a severe breaking up of the higher audio notes. Difficult to detect on orchestral music, it can be observed on sustained notes and solo instruments, particularly piano pieces. Although most common in fringe areas or in pockets of poor signal strength, distortion may be experienced almost anywhere throughout the service area of an FM transmitter.

Basically, multipath distortion is produced by the mixing of the reflected signal with the direct signal, the combination possessing unwanted amplitude and phase modulation which may prove too much for the degree of limiting provided by a ratio detector even when assisted by the partial limiting found in most FM receivers and tuners. In the *BBC* investigations it has been found that high-fidelity tuners are often only marginally better than standard tuners in combating multipath effects; possibly because of the phase- or frequency-modulated component. A good capture ratio thus helps but, as we shall see later, is not the whole story.

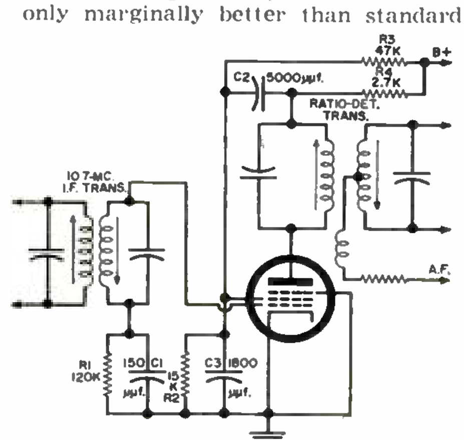

Fig. 1. Final i.f. stage of typical FM receiver showing one method of reducing distortion of the i.f. response curve.

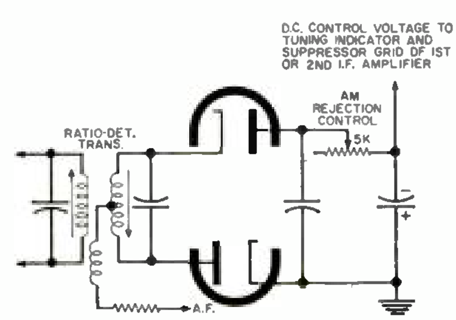

Fig. 2. A method of improving the AM suppression characteristics of ratio detector.

Improving AM Suppression

A well-designed ratio detector provides considerable AM suppression on good signals, but is vulnerable to downward amplitude modulation of the carrier, a condition which often occurs in multipath conditions. Additional limiting is thus highly desirable, provided the receiver has sufficient reserve of gain to permit this.

Fig. 1 shows the final i.f. stage of a typical FM receiver: the effect of R_1 and C_1 in the grid return converts what would otherwise be a straight amplifier into a saturated limiter provided that the carrier input is sufficient to cause grid current to flow. The time constant, $C_1 \times R_1$, is chosen to be long enough to allow the AM signal variations to develop bias to reduce stage gain but not so long as to make the receiver susceptible to ignition and other impulse forms of interference: typical values would be between 2.5 and 10 μsec. Low plate and screen voltages improve the limiting effect at the expense of some reduction in stage gain. This type of limiting can be much improved by applying it to two stages with a short time constant in the first stage and a longer one in the second stage; this is usually possible only in the more elegant tuners having a good reserve of gain.

Fig. 1 also shows a popular method of reducing distortion of the i.f. response curve due to positive feedback in the tube. The plate decoupler, C_3, is connected to screen instead of direct to chassis. The common plate and screen decoupler, C_3, then forms part of a bridge neutralizing circuit in conjunction with the tube capacitances.

Another method of improving the AM suppression characteristics of an unbalanced ratio detector, incorporated in a number of current European FM and AM/FM receivers, is shown in Fig. 2. A 5000-ohm pre-set AM rejection control can be adjusted at the factory or by a service technician to provide a position of maximum AM suppression. Accurate setting of this control requires the injection into the receiver of an AM signal from a generator entirely free from any appreciable FM component and adjustment of the pre-set control for minimum audio output. Connection of the d.c. potential developed in the ratio detector to the suppressor grid of the first or second i.f. stage provides a.g.c. action to further reduce the effect of signal variations.

However, standard limiter circuits of this type will not eliminate entirely

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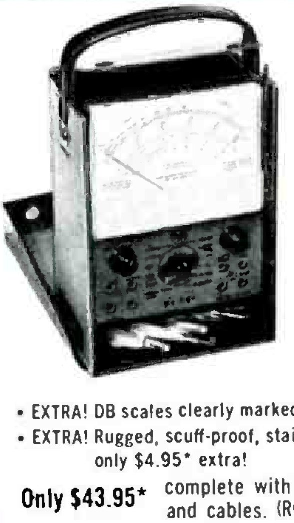

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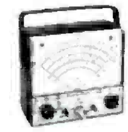

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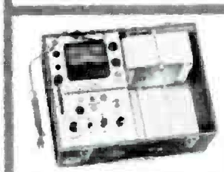

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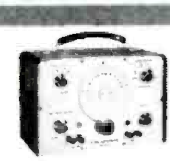

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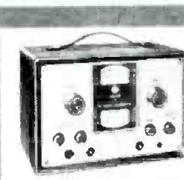

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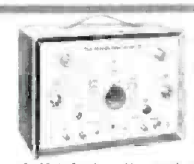

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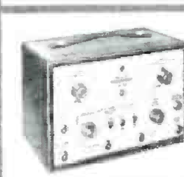

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the effects of multipath conditions. A most important criterion is the difference in the path lengths of the direct and the reflected signals. A tuner which may function perfectly in one location despite the presence of reflected signals can show distortion in another, even though the relative amplitudes of the direct and reflected signals may be the same. The *BBC* tests show that distortion becomes more serious as the difference in path lengths increases. For instance, the amplitude of reflected signal compared to direct signal needed to produce "slightly disturbing" distortion on solo piano is about 35 percent for a path difference of 5 miles; similar distortion can be produced with a path difference of 18 miles by reflected signal content of only 6 per-cent.

These results point up the very real importance, in locations where natural or man-made obstructions favor the production of long path reflections, of minimizing pickup of the reflected signals. This can best be done by careful orientation of directional antennas. Even the simple dipole can be adjusted to provide relatively low pickup of the reflected signal by change in position and/or slope. The benefits of a well-designed antenna system also include the more efficient functioning of the limiting circuits in weak signal areas. Often any FM antenna which provides quiet background noise levels is considered satisfactory, whereas an improved antenna system would also clear up multipath effects if adjusted for minimum indirect wave pickup.

Accurate orientation of an FM antenna without test equipment can be difficult in areas where the signal is strong enough to provide good limiting even when well off beam. In such conditions an attenuator pad between feeder and receiver antenna socket can be used to bring down the input signal level below the level of limiting action to make it easier to line up the antenna; afterwards the pad should, of course, be removed.

A final tip to help positive identification of multipath distortion as opposed to equipment faults is to check whether reception of all stations is equally affected. Multipath distortion usually shows up in varying degrees on stations operating on different frequencies, even when these are located quite close together. ▲

CLEVELAND HAMFEST

THE 1961 ARRL Great Lakes Division Convention, sponsored by The Cleveland Amateurradio Convention, Inc., will be held October 13 and 14 at The Sheraton-Cleveland Hotel. A SSB dinner will start off the convention at 1900 EDST on October 13, followed by open house and hospitality gatherings at 2000. A "Royal Order of Wouff Hong" initiation will take place at 2359.

Saturday's session will include displays, technical talks, a DX session, Army MARS session, XL forum, etc. The convention will conclude with a banquet in the Grand Ballroom of the hotel.

Requests for tickets should be mailed to Cleveland Amateurradio Convention, P.O. Box 5167, Cleveland 1, Ohio. ▲

VARIABLE TIME-DELAY RELAY

By C. J. FAUST, Jr.

Simple circuit uses heater warm-up to produce delay.

AT ONE time or another, most of us find the need for a time-delay relay to retard the application of voltage to a circuit, such as plate voltage to rectifier tubes, and for various timing operations.

When such a need arose recently, the unit to be described was built and found to perform the required functions quite satisfactorily. Since other readers might find themselves in a similar situation, the author is passing along the circuit details. The unit is simple and low in cost.

Operation of the unit depends on the fact that the warm-up period of an indirectly heated cathode type tube can be controlled by varying the heater voltage applied to it. Usable delay periods of from 20 seconds to approximately 2 minutes can be obtained from the time heater voltage is applied until the tube begins to conduct sufficient current to close the relay.

The original circuit, shown in Fig. 1, was designed to operate from a supply voltage of 20 volts a.c. as part of an automatic furnace-control system. With a value of 100 ohms for R_1 and 150 ohms for R_2, the delay time was adjustable from 30 seconds to a little over 2 minutes with good reliability. These values are suitable with supply voltages between 20 and 30 volts.

The type of relay used will determine the value of R_2, which is not critical. Pick a value which will pass enough current to allow the relay to pull in at maximum delay settings. The relay used by the author was a 6-volt, 105-ohm surplus unit from a radiosonde trans-

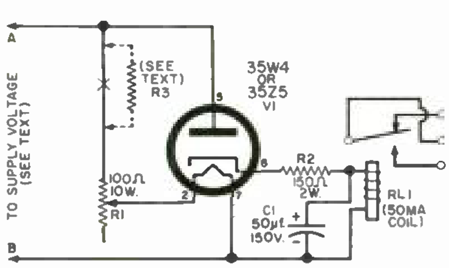


Fig. 1. Circuit for 20 to 30 volts a.c. Pin connections shown are for 35Z5 tube.

mitter. Any relay that will pull in at 50 ma. or less will be satisfactory.

Most likely you will want to operate the unit from the 117-volt power line. In this case, the value of R_1 should be 3000 ohms and R_3 (500 ohms) would be added in series as a current-limiting resistor. For a 50 ma. relay, R_2 should be approximately 2000 ohms. If the relay draws less current or you use different supply voltages, simple Ohm's Law calculations will derive the proper values for R_1 and R_2. ▲

ACOUSTICS ANAGRAM

By **JOHN COMSTOCK**

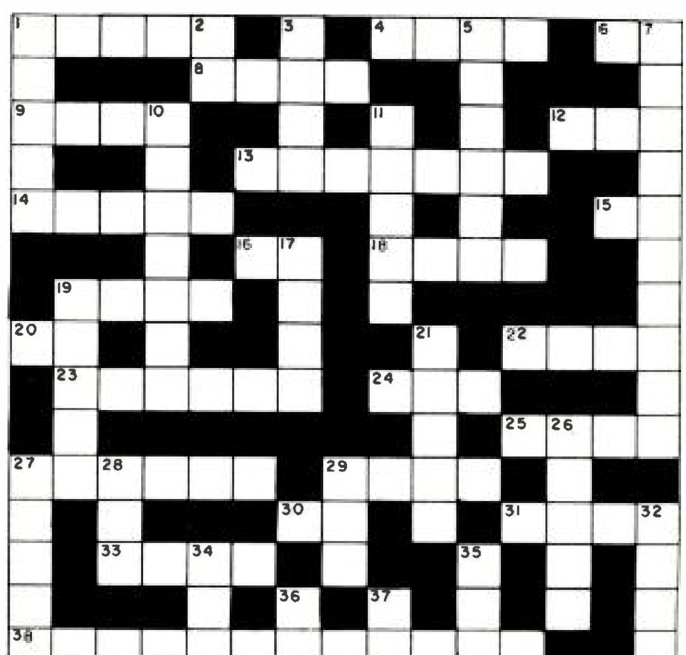
(*Answers on page* 126)

ACROSS

1. Audio.
4. Sound energy dissipated without accomplishing any work.
6. Part of familiar term for full-range reproduction.
8. A regularly occurring pulsation of amplitude resulting from the combining of two sounds or tones.
9. Opposite of treble sound frequencies.
12. Device used in a sound system to attenuate a signal or couple two impedances.
13. Term often applied to a coaxially constructed speaker.
14. Electro-acoustic unit of power ratio based on the Napierian base of logarithms.
15. Coil found in speakers (abbr.).
16. Class of audio amplification.
18. Satisfactory in quality.
19. Transducer that picks up sound and converts it into electrical currents (fam.).
20. River in Italy.
22. Unit of loudness.
23. Material removed from surface of phonograph recording disc by the cutting stylus.
24. Undesirable noise in an audio system.
25. Opposite of a "dead" or highly damped room.
27. High frequencies.
29. Unit of stylus pressure.
30. Equipment used to address large gatherings (abbr.).
31. Essential component in a hi-fi system (abbr.).
33. Recording companies' trade association (abbr.).
38. Frequencies above 20,000 cps.

DOWN

1. Unit of sound absorption.
2. Electro-acoustic unit of relative power, voltage, or current (abbr.).
3. The amount that an audio amplifier can increase the amplitude of a signal.
5. Sound in its "third dimension."
7. In acoustics, inertance is the equivalent of _ _ ___ _.
10. Transducer used in every audio system.
11. One circuit of audio amplification.
17. The _ _____ of audio frequencies extends from 15-20,000 cps.
19. The part of a speaker that receives power from the electrical circuit and converts it into mechanical energy.
21. Pertaining to the ear or sense of hearing.
26. The "receiving" circuit of an audio amplifier.
27. Ordinarily, sound is composed of a number of ______.
28. Organ used for the perception of sound.
29. That portion of a magnetic circuit in which there is no ferromagnetic material.
32. Loud, undesirable sound.
34. Medium through which sound waves travel.
35. Sound ratio.
36. Meter watched by recording engineer (abbr.).
37. "Twin" of "hi."



Marine Electronics

(Continued from page 62)

not touch the chart. Do not disconnect the motor or motors so as not to disturb the power-consumption balance. Make sure that the full input voltage is applied to the sounder.

After a thorough warm-up. adjust the tuning slugs or trimmers for maximum output. using the minimum possible input from the audio generator.

When the pulse generator is a vacuum-tube oscillator, a slightly different technique is employed. With the transducer to be used with the sounder connected, and with the sounder operating at the correct input voltage. adjust the oscillator transformer's tuning slug to produce the maximum kick on the lowest a.c. scale of a v.o.m. connected across the transducer terminals. Now disable the keying and connect a scope (sweep off) and an audio generator as shown in Fig. 13. Warm up the sounder, scope, and generator.

Using a clip lead or other convenient means. key the sounder slowly, attenuate the scope input signals as required. and adjust the audio-generator frequency until a circular pattern is obtained. The audio generator is now set for the frequency at which the energy transfer between the pulse generator and the transducer is maximum. This setting will be quite close to the rated frequency of the sounder. When adjusting the audio generator. do not allow the pulse generator to run for more than a few seconds at a time.

Remove the scope and. without disturbing the setting of the audio generator, connect the latter across the transducer terminals. Connect the scope or a v.t.v.m. to the amplifier output as before. using the 10,000-ohm load with recorders. and adjust the tuning slugs or trimmers for maximum output with the minimum input.

Small sounders having a single adjustment may be aligned or tuned quite well without instruments if they are in operating order but seem insensitive. Set the gain at a maximum and, if a second echo appears. proceed to water deep enough to cause it to disappear. Then attempt to bring it back by adjusting the tuning control. If this is not possible, the tuning was correct. Return to shallower water and make sure the tuning has been re-set properly. If it is not possible to obtain a second echo in more than about 10 feet of water, the sounder probably requires further work.

Accuracy: The accuracy of flashers and recorders is dependent entirely upon the scanning or stylus-drive motor running at the correct speed. Too high a speed will give depth indications higher than the correct value and *vice versa*.

Check d.c. motors for correct governor setting and, if they cannot be brought up to speed, check for tight bearings. a partially shorted commutator, or faulty windings. Input voltage must, of course, be correct.

The speed of a.c. motors is controlled

by the supply frequency which, in turn, is dependent upon the power-supply vibrator frequency. Most "off-the-shelf" replacement vibrators are close enough to the rated frequency to hold the accuracy of the sounder within the manufacturer's specifications. However, an occasionally fussy customer will insist on one that is exactly 60 cps. When such selection is necessary, a vibrating-reed frequency meter is a great convenience. Friction and defective motor capacitors will also affect the speed of motors used in sounders.

Inaccuracies in scopes are caused by incorrect sweep speed. Check the *RC* circuit and, if the capacitor is good, adjust the series resistor as required.

The best way to check for the source of inaccuracy in a meter-type indicator that is electronically timed is to work backwards from the meter movement through the gating and pulse circuits.

Strays: Random flashes around the dial of a flasher or on the screen of a scope, or short, black marks scattered over the chart of a depth recorder, are known as strays. They can be caused by turbulence due to barnacle growth on the transducer or other underwater factors, by vibration, or by electrical pick-up through the transducer or power cables. Remedies include grounding the sounder, connecting a capacitor of several hundred microfarads across the power leads, and separating transducer and power cables, if they run close together. If not already installed, conventional radio noise-suppression capacitors should be connected to the engine generator, the voltage regulator, and also the coil on spark-ignition engines.

If the strays assume a regular pattern, the trouble is probably due to defective filtering or spurious oscillation in the sounder itself. Check plate and bias-supply filtering and bypass and decoupling capacitors.

A completely black chart on recorders can be caused by lack of bias on vacuum-tube pulse generators or on the output tube, or by a defective fix marker switch.

Conclusion

As the technician gains experience with depth sounders, he will soon be able to spot transducer, stylus, and keying troubles quickly. Once these elements are out of the picture, the remainder resolves itself into straightforward electronic troubleshooting. Aside from the electro-mechanical items and transducers, the author has, during the past ten years, found the following to be the most common trouble points: shorted buffers, defective 2D21's, open gain controls (when used to control plate voltage), shorted motor capacitors, leaky coupling capacitors, open windings in iron-core transformers, and open screen resistors.

Nothing has been said about checking for lack of plate voltages, vibrator troubles, or lack of high voltage or sweep on scopes; for it is believed that this would be "old stuff" to the radio, TV, and audio man. ▲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New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 130.

ISOLATION TRANSFORMERS

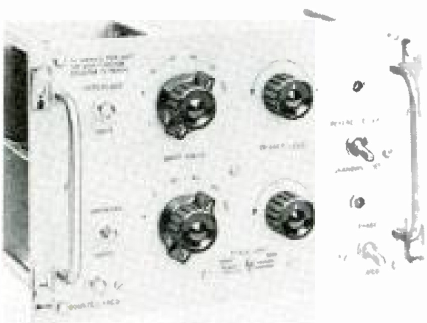
1 **United Transformer Corp.** has added a series of ultra-shielded isolation transformers to its HIT series as the HIT-15.

Designed to simulate battery operation, these units can be used for extremely critical circuits requiring the ultimate in isolation for power-line equipment, according to the company. The HIT-15 has a power rating of 150 watts industrial and 120 watts to MIL-T-27A. Effective capacity between primary and secondary windings is less than .1 μμf. Input and output terminals are brought out on opposite sides of the special housing for maximum isolation.

PLUG-IN PHASE UNIT

2 **Hewlett Packard Company** is now in production on a new unit for phase-angle measurement, with accuracy approaching ± .1 degree.

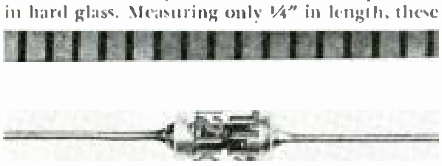
Designed as a plug-in unit for the company's Models 524B/C/D electronic counters, the Model 526D phase unit equips the counter to measure



any lead or lag phase angle between two signals in the 1 to 20,000 cps range. For frequencies from 396 to 404 cps, a X3600 frequency multiplier provides readings direct in tenths of a degree. At other frequencies readings are presented in time units, with resolution of 1 μsec. for full frequency range.

ENCAPSULATED RESISTORS

3 **Texas Instruments Incorporated** has announced the commercial availability of an ⅛-watt hermetic precision resistor encapsulated in hard glass. Measuring only ¼" in length, these



new ⅛-watt carbon film units are the same size as conventional 1/10-watt film resistors.

The Type CG-⅛ resistors are now available in values from 10 ohms to 100,000 ohms at a tolerance of ± 1%.

SWEEP GENERATOR/MARKER

4 **Paco Electronics Company, Inc.** is now offering the Model G-32 sweep generator and marker adder, designed for versatility and ease of operation.

As the r.f. output is swept in frequency, an electronic voltage regulator keeps the amplitude

constant. Dual attenuators permit close control of output voltage to match circuit conditions. Sweep width is also continuously variable.

Frequency coverage is 3 to 220 mc. in five fundamental sweep-frequency ranges. Sweep width is 0 to over 20 mc. on high-frequency ranges, continuously variable; the marker oscillator is crystal-controlled.

PRINTED-CIRCUIT ADHESIVES

5 **Minnesota Mining and Manufacturing Co.** has announced the development of four new liquid synthetic resin-base thermosetting adhesives for bonding copper foil to phenolic or epoxy-impregnated base stock, phenolic paper, epoxy paper, and epoxy glass materials in printed circuit manufacture.

The four adhesives, designated as EC-1855, EC-1857, EC-2080, and EC-2130, have been developed to meet each individual manufacturer's requirements.

V.H.F.-U.H.F. POWER OSCILLATORS

6 **Microdot Inc.** is now offering a new line of v.h.f.-u.h.f. power oscillators featuring compactly designed r.f. cavities with frequency ranges from 200 to 1050 mc. and power output from 50 mw. to 50 watts.

The new units can be used for antenna evaluation, calibration of power measuring devices, driving amplifiers and solid-state varactors, and other applications requiring more power than milliwatt signal generators can provide.

The oscillators are continuously tunable over 2:1 frequency bands and have a high ratio dial featuring negligible backlash and a logging scale permitting a resettability of .002%.

Model 408 offers a range of 220 to 550 mc. while the Model 410 covers from 500 to 1050 mc. Both operate from 115 volts a.c., measure 8" x 11½" x 19", and weigh 45 pounds.

WAFER CAPACITOR

7 **AMP Incorporated** is now marketing a new wafer capacitor, molded in silicone rubber, which is ideally suited for encapsulation in epoxy resins, for applications involving heavy shock, vibration, and temperature and altitude extremes.

The new unit is available in a range of capacitance from 100 μμf. to .1 μf. ± 10%, working voltages of 2 to 12 kv. pulse, 4 to 15 kv. d.c. It is extremely light in weight with minimum size as small as 1⅛" x 1⅛" x ¼".

BUTTON CAPACITOR

8 **Sangamo Electric Company** has announced a new welded-seal button capacitor which is said to embody the high-frequency characteristics and reliability associated with hermetically sealed units.

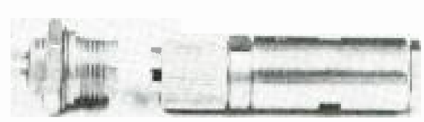
The solder-free design completely eliminates the restrictions imposed by relatively low-melting point soft-solder seals and thus permits operation at high ambient temperatures. This also allows high-temperature soldering techniques for easy circuit installation without risk of damage to capacitor seals.

Capacitance values up to 1500 μμf. at 500 volts are available, in a wide variety of mounting configurations.

MINIATURE PLUG LINE

9 **Cannon Electric Company** has added a new series of connectors to its line.

The TM (Twinax Miniature) plugs are de-



signed for subminiature applications involving a common shield over a twisted pair of wires or for requirements involving two power leads, thereby replacing two subminiature plugs. Identical inserts with either male or female contacts are used for both plug and receptacle.

The inserts can be removed for bench soldering and are assembled into the plug shells before the appropriate clamping parts are assembled.

TUBE TESTER

10 **Sencore, Inc.** has announced the availability of an improved version of its tube tester which is being marketed as the "Mighty Mite II."

The improved tester, Model TC114, is designed to check all the tubes that the earlier model could handle plus the new G-E compactrons, the new Sylvania 10-pin tubes, and RCA nuvistors and novars.

The cover of the case is mirrored so that it can be set at any angle and used for TV adjustments.

SILICON PLANER TRANSISTOR

11 **Fairchild Semiconductor** has developed a new silicon planar transistor which has broken all speed records for fast switching in saturating logic circuits.

The new device, designated the 2N709, is capable of switching speeds "two to three times faster than any existing germanium or silicon transistor," according to the company.

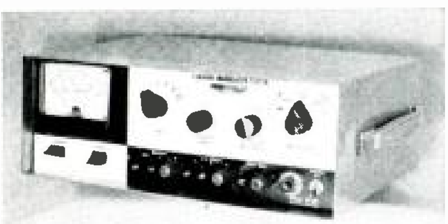
The transistor is rated at 300 mw. of power. Its high-speed features include: typical charge storage time-constant of 3 nanoseconds; average propagation delay time of only 2.5 nsec. in direct-coupled transistor logic circuits; average propagation delay time of 7.5 nsec. with a rise time of 3.5 nsec. in TDL logic circuits.

H.F. TRANSFER VOLTMETER

12 **Ballantine Laboratories, Inc.** is now marketing its Model 393 high-frequency transfer voltmeter by means of which an unknown a.c. voltage may be measured in terms of a d.c. voltage. The design is such that the transfer impedance of the probe is uniform from 25 cps to 30 mc. Primary uses of the new instrument will be in standards laboratories for calibration of r.f. signal sources, r.f. voltmeters, and the frequency response of amplifiers or other devices. Accuracy of transfer is .1% from 25 cps to 10 mc., and .5% from 10 mc. to 30 mc.

CURRENT-MODULATED TESTERS

13 **Modutronics, Inc.** is now offering a new line of current-modulated testers designed to eliminate time-consuming breadboarding. The new units are capable of quickly determining the d.c. and/or a.c. characteristics of such d.c.-excited components as zener diodes, matching diodes, rectifiers, chokes, filters, transformers, relay coils, and solenoids, as well as meter movements, power supplies, etc.



The instruments make use of a 60-cps internal current-modulated circuit, while providing for external modulation of frequencies from 20 to 100,000 cps. Three models (0-80 volts, 0-40 volts, 0-250 volts) are included in the series.

MICROMINIATURE RESISTORS

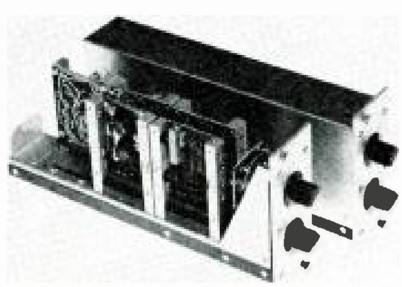
14 **Dale Electronics, Inc.** has announced a line of microminiature resistors, utilizing the standard RCA wafer, which can be made to customer specifications. Dimensions of the wafer are .31" x .31" x .010". The wafers have 12 interconnecting notches, three to each side.

Electrical specifications are: resistance range from 100 to 100,000 ohms, ± 1%; temperature coefficient of 100 ppm-per-degree C; and maximum dissipation of ½ watt per wafer.

MODULE TEST INSTRUMENTS

15 **Burr-Brown Research Corporation** has added the Model 1800 Series to its line of transistorized laboratory test equipment.

The new series employs standard submodules including differential and chopper stabilized operational amplifiers to provide a variety of gain ranges, gain steps, frequency response, and outputs. The typical instrument provides variable gain of 0 to 1000 over 0 to 20,000 cps with an input impedance greater than 1 megohm and an output impedance suitable for driving a 100-ma. galvanometer.



The 1800 Series features a plug-in modular package with up to 8 units accommodated in a 5¼" x 19" standard rack.

ELECTRO-OPTICAL CONTROLS

16 **Raytheon Company's** Industrial Components Division is now in production on a relay and potentiometer, both designed for noise-free control of a.c. or d.c. signals over a wide range.

These two electro-optical components incorporate a light bulb and photocell, assembled in a light-proof casing. A variation in the input to the four-terminal devices causes a change in the output resistance. There are no moving parts or electrical connection between the control and signal circuits, eliminating noise and resulting in inherently long operating life.

The Model CK-1111 incorporates a special gas-discharge light source while the CK-1112 uses an incandescent light source.

NEW PC LAMINATE

17 Cincinnati Division of The Cincinnati Milling Machine Co. has introduced a new copper-clad laminate for printed-circuit applications.

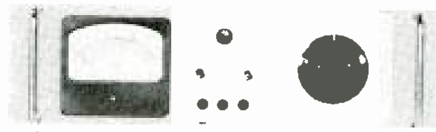
Known as "Cimclad," the new product provides the high tensile, flexural, and impact strength of glass-fibre re-inforced plastic at a price competitive with paper-base phenolic circuit boards.

The new boards are easy to process and cold punch well at room temperatures. From the flamability standpoint, it is self-extinguishing.

RACK-MOUNTED V.O.M.

18 The Triplett Electrical Instrument Co. has announced the availability of a rack-mounted v.o.m., the Model 630-NA-RM.

Among the features of this new 68-range, mirror-scaled instrument are: meter protection



against overloads, high accuracy on the same scale for a.c. and d.c., frequency compensation from 35 to 20,000 cps, temperature compensation, accuracy within a wide range of ambient temperatures, and d.c. reversing switch.

The etched aluminum panel, 19" x 5¼", has two chrome plate handles for easy removal of the tester from the rack.

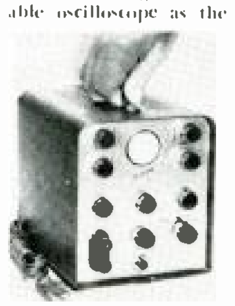
THIN-CELL SELENIUMS

19 General Electric Company has introduced a new line of thin-cell selenium rectifiers in a new paper base, phenolic cartridge.

Known as "Vac-U-Sels," the cells are of .010-inch thin aluminum stock. They are fitted into the new phenolic housing in stacks with up to 300 cells available per stack. The cells operate at 130 degrees C ambient temperature. A single stack used in a half-wave circuit will accommodate 15,000 volts and will block a peak reverse voltage of 31,500 volts.

COMPACT OSCILLOSCOPE

20 National Union Electric Corp. is currently introducing a self-contained, compact, portable oscilloscope as the "NUscope." According to the company, it provides performance equivalent to many larger and bulkier instruments. The new NU125 cathode-ray tube provides a brilliant, sharp-focused display of ample size to observe electrical phenomena.



The unit measures only 5¼"x6"x7" and weighs just 5½ pounds. It operates from a 117 volt power source. The instrument is housed in a black case with gold finish front panel. The carrying handle permits the unit to be moved about easily.

The vertical amplifier provides nearly flat response from 10 to 225,000 cps and is useful from 10 to over 500,000 cps. Sweep frequencies are controlled between 20 to 30,000 cps.

VOLTAGE CALIBRATOR

21 Electro Scientific Industries has released its Model SC-194 voltage calibrator, a two-dial test instrument for checking the calibration adjustments of accurate d.c. voltmeters.

Output voltages of .05, .1, .5, 1, 5, 10, 50, 100, 500, and 1000 are provided. A calibration certificate supplied with the unit specifies corrections for the left-hand dial to obtain highest accuracy.

(Continued on page 122)

Because today's fringe area reception problems cannot be solved by yesterday's antennas...

CHANNEL MASTER

Channel Master's world-famous Antenna Development Laboratory has done it again! By using a brand new concept in antenna design... **PROPORTIONAL ENERGY ABSORPTION**...***Channel Master meets the fringe area challenge with the most powerful TV antenna ever produced...the Crossfire!***

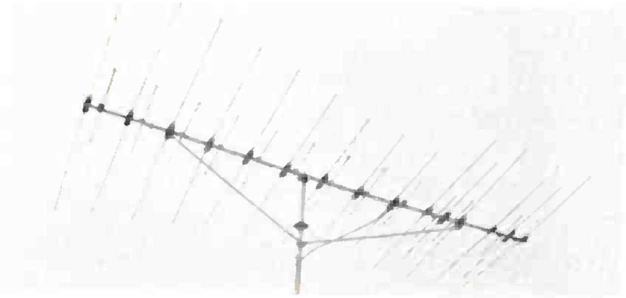
Proportional Energy Absorption works like this!

Each Crossfire element has a predetermined impedance, at each frequency, which determines its degree of energy absorption. This impedance, governed by the taper and spacing of the dipoles, decreases with the distance from the feed point. Each successive element therefore absorbs a larger percentage of the available energy.

Since the amount of available energy decreases as it progresses along the length of the antenna, each element, by absorbing a *larger* percentage, absorbs approximately the *same amount* of energy as the other elements in the array.

This means that the Crossfire...unlike other antennas...has a large group of driven dipoles actively working to increase gain *on every channel*...on both low and high bands.

More working elements provide more picture power! This is the key to the remarkable performance of the Crossfire.



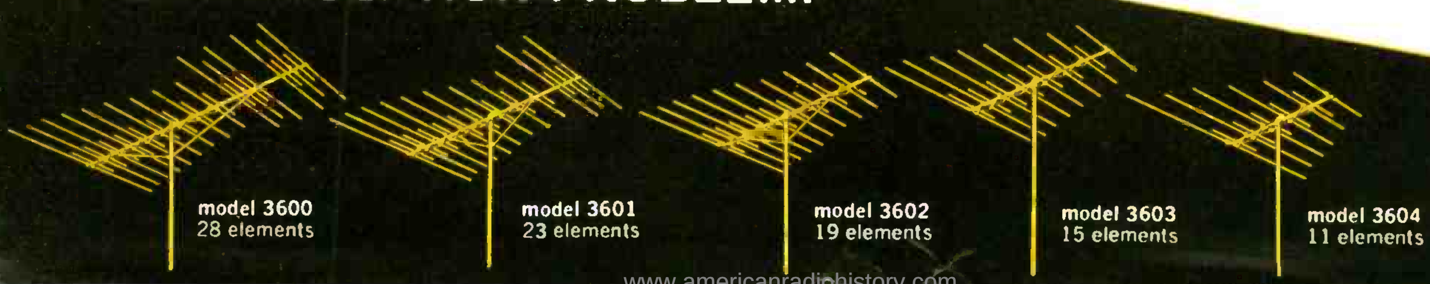
...And the Crossfire is Gold!

The Crossfire's performance is matched only by its beauty. Channel Master's exclusive E*P*C Process gives the antenna a lustrous golden coating that enriches its appearance and protects it for years against corrosion.

Channel Master's E*P*C Process is *not* anodizing! The disadvantage of anodizing is that the anodized film is an electrical insulator, and must be removed by *abrasion* wherever metal-to-metal contact is required. Therefore, anodized antennas have no surface protection on the very parts that need it most!

Channel Master's E*P*C Process protects the *entire* antenna. It is the same protective treatment now required on all commercial jet aircraft and on rockets like the Redstone.

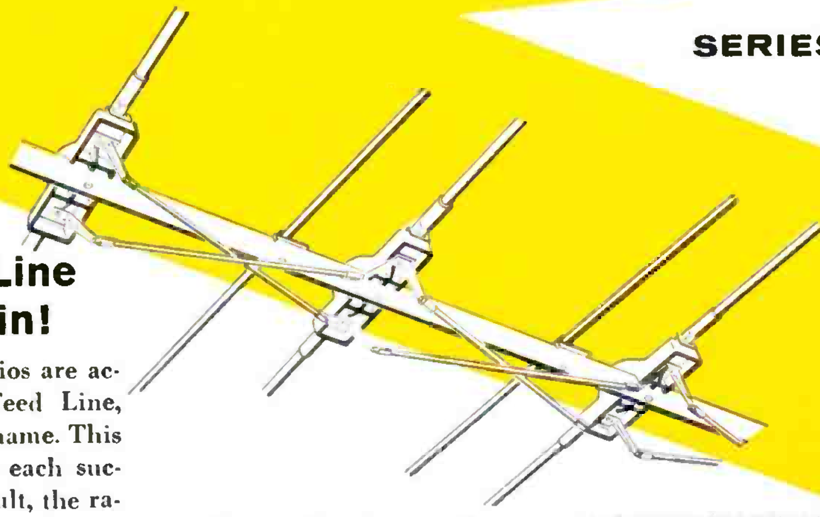
THERE'S A CROSSFIRE TO MEET EVERY RECEPTION PROBLEM!



INTRODUCES THE NEW, GOLDEN

Crossfire*

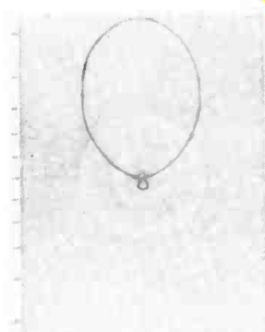
SERIES 3600

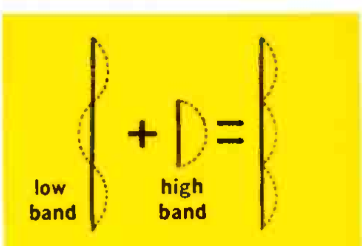


Transposed Feed Line Means Cleaner Gain!

Extremely high front-to-back ratios are accomplished by a Transposed Feed Line, from which the Crossfire gets its name. This feed line is transposed between each successive pair of elements. As a result, the radiations from each pair of adjacent elements are self-cancelling because they are 180° out of phase. This carefully engineered system is so efficient that the Crossfire needs no parasitic reflector element.

Because of these high front-to-back ratios, the Crossfire provides *cleaner* gain than any other all-channel antenna. It pulls in the signal you want while rejecting unwanted interference of every type (auto ignition systems, electrical noise, other TV signals, etc.) from both side and rear. See unretouched photo of actual horizontal polar pattern.





Revolutionary New Dual Dipole System

Each parasite reverses phase of high band current on the adjacent low band dipole, so that it operates as three driven half-wave high band elements.

The Crossfire is the only antenna you can sell with full confidence that it will outperform anything your customer is now using!

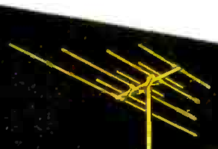
For still more power...add the new

CHANNEL MASTER JETRON

Antenna-mounted transistorized signal amplifier and set coupler
Most effective...most dependable...lowest noise figure!

model 0020

Power supply (with built-in 4-set coupler) is conveniently located in the home. Compact, only 5" x 3¾" x 1¾".



model 3605
7 elements

* Patent Pending

Calibration data is accurate to better than ± .005% at a temperature of 25 degrees C at the time of measurement.

CAPACITOR STANDARDS

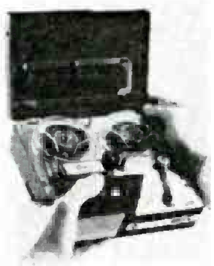
22 **Central Scientific Co.** is now offering two new precision capacitor standards for use as laboratory standards or as circuit elements in tuned circuits, measurement circuits, and filter networks.

The Model 83516-1 has a capacitance of .5 μf. while the Model 83516-2 is rated at 1 μf. Capacitance tolerance is ± .25%, capacitance stability is ± .1%, d.c. working voltage is 400, and power factor at 1 kc. is ± .02%. Universal binding posts accept all common connectors.

HI-FI—AUDIO PRODUCTS

TRANSISTORIZED RECORDER

23 **Craig Panorama, Inc.** has available a miniaturized transistor tape recorder which is being offered as the Model TR-403.



Featuring two-speed operation, the unit can record up to 68 minutes on one tape. A vu meter provides for checking recording level and battery condition. The recorder is powered by standard penlite batteries.

The unit comes equipped with microphone and case, reel case, and earphones. Available accessories include footswitch, telephone pickup, as well as an a.c. adapter for 117-volt operation.

FULL-FIDELITY SPEAKER SYSTEM

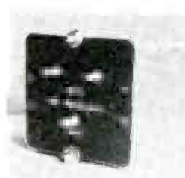
24 **Advanced Acoustics Corporation** has added the "Modulaire" to its line of "Bi-Phonic Coupler" unique full-fidelity loudspeaker systems.

Smaller in both size and depth than previous types, the new unit covers the range from 35 cps to well beyond audibility. It is 13½" wide and 3⅛" thick, permitting the unit to be hung on a wall like a picture, used as a room divider, or incorporated into any furniture piece or bookshelf. It will also mount between 16" studs of a standard wall for built-in applications.

The unit incorporates an electro-dynamic driving system and can be coupled to the 8-ohm output of any hi-fi amplifier, requiring only 15 watts of clean audio power to produce its full range of output.

LOW-PASS FILTER

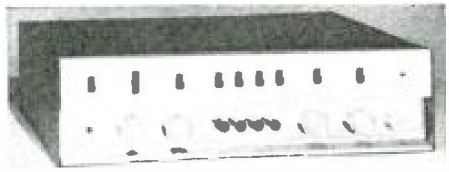
25 **Phi Research** is currently introducing a new low-pass filter which has been developed specifically for the recently adopted stereo multiplex system.



Known as the LP-15, the filter is designed to be used either at the inputs of stereo exciters and generators or to simplify output measurements of adapters. Attenuation at 19 kc. is at least 60 db yet the pass-band is flat to less than .5 db from 20 to 15,000 cps.

TRANSISTORIZED STEREO AMP

26 **Allied Radio Corporation** has added an all-transistor, 75-watt stereo amplifier to its "Knight" line of audio equipment.



The new KN-450 features 37½ watts per channel (IHFM music power output); response 20-30,000 cps ±.5 db at rated power; harmonic distortion of .5% at rated power, and hum and noise 95 (tuner) and 65 db (magnetic phono). The amplifier has five pairs of inputs and two convenience a.c. outlets.

SINGLE-SPEED TURNTABLE

27 **Acoustic Research** is currently marketing its first product outside the loudspeaker field—a single-speed (33⅓ rpm) turntable which comes complete with arm, oiled-walnut base, transparent dust cover, cables, and an overhang adjustment device and needle force gauge.

The unit features belt drive, synchronous motors, 3.5-pound machined, individually balanced aluminum platter, plus a manufacturer's guarantee that the turntable meets NAB specifications for broadcast equipment on wow, flutter, rumble, and speed accuracy.

INTEGRATED AMPLIFIER

28 **Monarch Electronics International, Inc.** is now in production on a 32-watt stereo amplifier, AM-FM-SW tuners, and control facilities built on a single chassis and being offered as the Model 200-A.

The 15-tube circuit incorporates Foster-Seely discriminator, a.f.c., FM sensitivity of 2 µv. for 20-db quieting, scratch and rumble filters, plus inputs for magnetic, crystal, and ceramic cartridges, microphone, and multiplex adapter. The preamp, which is transistorized, offers complete control of function, mode, bass, treble, presence, balance, phasing, loudness, and volume.

PORTABLE TAPE RECORDER

29 **International Products Co.** is now marketing a miniature tape recorder which features printed circuits and transistor operation. Response is 150-6000 cps and the unit will record over an hour at 1⅞ ips and over 30 minutes at 3¾ ips. Features of the recorder include a combination level meter and battery drain indicator, footswitch, remote control microphone, stereo headset, patchcord for direct recordings, telephone pickup, and a.c. adapter.

Powered by six penlite cells, the unit measures 7⅜" x 5¾" x 2½" and weighs 3.7 pounds including batteries. A leather carrying case with adjustable strap is included with the instrument.

NEW SPEAKER SYSTEM

30 **Bogen and Rich, Inc.** is bringing out a new type of high-fidelity speaker which features a unique transducer utilizing a completely active plane radiation surface. According to the company, extremely low harmonic distortion, even at bass frequencies, and transient response equivalent to that obtainable only from electrostatic loudspeakers are characteristics of the new unit.

The three-way system is flat from 20 to 20,000 cps.

COLOR-CODED CABLES

31 **Zoron, Inc.** has announced the availability of a new series of color-coded connector cables for tape, magnetic phono, ceramic phono, tuner, amplifier, microphone, and speaker.

The new cables are coded in five colors for quick and easy lead identification. The cords are supplied in white, green, yellow, red, and blue. One basic color is recommended for each connection from jack to cord to jack while channel or multiple connections may be marked for rapid identification by means of available colored marking strips applied to handles or color dots applied to chassis.

INTEGRATED MULTIPLEX TUNER

32 **Harman-Kardon, Inc.** has recently introduced an integrated multiplex tuner, the Model T300X. The new unit is an AM-FM tuner with built-in multiplex section. The T300X features a wide-band detector and three high-gain i.f. stages. Sensitivity is .95 μv. for 20 db of quieting and 3.2 μv. usable sensitivity (IHFM standards). Distortion is less than .1% at 100% modulation while response is 10-35,000 cps ±1 db.

The company is also marketing a plug-in multiplex adapter designed to be used with the firm's F500 professional FM tuner.

CB-HAM-COMMUNICATIONS

CB ACCESSORY

33 **Martin Development Co.** is now in production on an accessory for CB use, the "CB-Beeper." Essentially a tone generator for signalling use with any CB transceiver, the "Beeper" is a compact, transistorized, and self-powered unit. It measures 2" x 3" x 4" and is housed in a black and hammertone gray case.

The instrument generates a 1000-cps tone for signalling. Its installation requires only one simple connection. A less expensive unit, the "Econo-Beeper," is slightly smaller in size but is not self-powered. Its installation requires three connections to the CB transceiver.

MARINE RADIOTELEPHONE

34 **Pearce-Simpson, Inc.** is now offering a 30-watt marine radiotelephone which has been specifically designed with the small boat owner in mind.

The "Marathon-30" features 5 marine channels plus the broadcast band, hybrid circuitry for premium performance, unbreakable cabinet,

low current drain, simple operation, small size, and light weight.

The units operate from 12 volts d.c., measure 9½"x 13"x 5¾", and come complete with a nylon-cased microphone with coiled cord.

POCKET TRANSCEIVER

35 **Osborne Electronic Sales Corp.** has added a transistorized, portable transceiver to its line of communications equipment.

Known as the "Duo-Com 120," the new unit weighs 28 ounces, is hand-held, and delivers a full watt of output. In addition to noise quieting features, it has a rechargeable battery pack with up to 18 hours of usable life before recharging. The company also produces the battery charger unit for use with this transceiver.

NEW CB UNIT

36 **E.C.I. Electronics Communications, Inc.** is now marketing the "Courier I," a CB transceiver featuring triple-conversion and two i. f. stages.

The unit features 12-channel transmitting, fixed and tunable drift-free reception, built-in

"S" and "RF" meter, electronic switching, built-in noise limiter and squelch circuits, and a front-panel-adjustable r.f. gain control.

The circuit is built in five individual hand-wired segments facilitating service and replacement. All metal parts are cadmium plated for marine applications. AM radio is available as an optional feature at extra cost.

CB TRANSCEIVER

37 **The Hallicrafters Co.** has introduced a new CB transceiver which features eight-channel potential.

The "Littletone" Model CB-3 has a self-contained dual power supply, permitting operation on standard 117-volt a.c. or on 12-volt battery.

Switching from a.c. to d.c. is accomplished by changing power plugs, which are included with the unit. A completely electronic squelch device quiets static.

Included with the CB-3 are a mounting accessory kit, a push-to-talk hand microphone, crystals for one channel, and CB license application forms.

NEW TWO-WAY RADIO

38 **General Electric Company** has developed and is currently marketing a new, extensively transistorized personal portable two-way radio for the 132-174 mc. service.

Known as the "Voice Commander," this FM unit is small, light, and compact. It features a 1-watt transmitter r.f. power output. The transmitter-receiver is housed in a single 9.5" x 5.3" x 1.7" case which contains a built-in microphone and speaker.

NEW CB EQUIPMENT

39 **Eico** has announced a new series of deluxe CB transceivers which feature multi-channel operation, a choice of crystal or continuous reception, press-to-talk microphone, superhet receiver

with an r.f. stage and a 1750-kc. i.f. strip, and adjustable squelch control and automatic series-gate noise limiter.

Three models are available in the new series. All have transformer-operated silicon-diode doubler power supplies for 117 volt, 60-cps operation. In addition, the Models 771 and 772 are equipped with vibrator power supplies for 6 volts d.c. and 12 volts d.c. battery operation, respectively.

All three units, Models 770, 771, and 772, are being offered in both kit and wired versions.

MANUFACTURERS' LITERATURE

ULTRAMINIATURE WIREWOUNDS

40 Reon Resistor Corp. has issued a technical bulletin (PS 5/61) which describes its line of ultraminiature encapsulated wirewound resistors for microminiature circuitry applications in industry and the military.

Complete physical and electrical specifications are given on a wide range of both axial and lug types.

SILICON DIODE DATA

41 Computer Diode Corporation has released a four-page brochure listing the characteristics of 86 conventional glass silicon diodes currently available from the firm.

Catalogue D-100 lists 35 general-purpose types and 51 computer-diode types.

SILICON RECTIFIERS

42 Bradley Semiconductor Corp. has issued a six-page short-form data folder covering its line of JEDEC-type silicon rectifiers.

The material is presented in tabular form for ready reference.

TERMINALS & SPLICES

43 AMP Incorporated has issued an 8-page catalogue which enables users to compute precisely what terminal or splice barrel size must be used to accept any given size of solid, stranded, rectangular, or square wire (singly or in combination) from #26 to 1,000,000 circular mils.

Separate charts define the computations necessary to determine the circular mil area of square or rectangular wire, round solid wire AWG, and stranded wire AWG. Another chart shows how to choose oval-shaped terminal barrels for some combinations of wire or in cases of unusually wide and thin rectangular wire. When circular mil area has been computed, reference is then made to a series of charts which equate circular mil area with terminal or splice size.

MODULAR POWER SUPPLIES

44 Quan-Tech Laboratories, Inc. is now offering a technical flyer which describes three versions of its new Series 170 modular, regulated power supplies.

Complete technical data is given, including dimensional drawings, electrical specifications, weight, and price.

CB-HAM-SW EQUIPMENT

45 Lafayette Radio has issued a two-color brochure listing a complete line of equipment for the Citizens Bander, radio amateur, and SWL. Details on the firm's line for these services are given, with complete specifications and application data. In addition, this publication carries useful information on the CB service, lists CB channels and frequencies, provides a CB call area map, explains CB licensing procedures, how to choose the right antenna, and how to mount fixed antennas for maximum range. A line of CB accessories is briefly described and illustrated.

HEAVY-DUTY CAPACITORS

46 Corson Electric Mfg. Corp. has issued a four-page catalogue which describes a line of heavy-duty capacitors for use in power supplies, voltage-doubling circuits communication receivers and transmitters, x-ray equipment energy storage, and other electronic applications.

The literature describes how these capacitors may be used for high-voltage filtering for 10,000 hours between −55 and +115 degrees C. Ten different ranges are covered from 10 to 60 kv. d.c.

DYNAMIC HEADPHONES

47 **Permoflux Products Company** has available a four-page brochure containing complete descriptions and prices of its entire line of binaural and monaural headphones. The models offered range in impedance from 8 ohms to very-high. In addition, the catalogue sheet gives a complete list of adapters which will enable headphones to be used with any type of equipment, together with a list of replacement parts.

FLASHTUBES FOR LASERS

48 **General Electric Company's** Photo Lamp Department has issued a booklet which describes the Laser effect, how it is produced, and lists the company's flashtubes available for its application. By using standard currently available photographic-type flashtubes certain economic advantages can be achieved.

The text describes the various units suitable to this application and discusses their merits as drivers.

HIGH-VOLTAGE CAPACITORS

49 **Corson Electric Mfg. Corp.** is offering a new 4-page catalogue which describes a line of high-voltage d.c. Mylar capacitors which far surpass the requirements of MIL-C-25A, characteristic E.

The units are suitable for high voltage power filters, audio coupling, voltage-doubler circuits, receivers and transmitters, energy storage, etc. Complete specifications and operating characteristics are provided on fifteen ranges of capacitors.

PANEL INSTRUMENTS

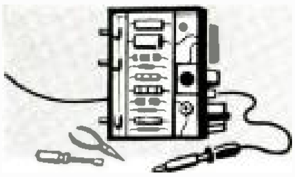
50 **Weston Instruments Division** has issued a 6-page bulletin which discusses features, selection, and uses of a line of 2½" and 3½" matched panel instruments which are available in round or square Bakelite cases. The meters include d.c., r.f., and a.c. rectifier types as well as moving-iron a.c. types.

Complete electrical and physical specifications, as well as application data, are included in this publication.

PILOT LIGHT DIGEST

51 **Dialight Corp.** is offering a digest of condensed technical information on a wide range of pilot lights and the various lamps for which they were designed. The categories described include subminiature indicator lights, pilot lights with built-in resistors for neon lamps, enclosed assemblies for neon and incandescent lamps, oil-tight indicator lights, dimmers, light shields, press-to-test indicator lights, indicator lights for T-2 telephone slide-base lamps, open type assemblies, lens holders for panel mounting, connectors and sockets for small lamps. ▲

Answer to Puzzle Appearing on page 108



ELECTRONICS MARKET PLACE

RATE: 60¢ per word. Minimum 10 words. December issue closes October 1st. Send order and remittance to: ELECTRONICS WORLD, One Park Ave., N. Y. C. 16, N. Y.

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ELECTRONICS! Associate degree—29 months. Technicians, field engineers, specialists in communications, missiles, computers, radar, automation. Start September, February. Valparaiso Technical Institute, Dept. N, Valparaiso, Indiana.

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MINIATURE Transistor 20 Watt HiFi Amplifier; Wireless FM Mike (Circuit size of your thumb); Transistor Guitar Amplifier: Schematic with Construction info. $2.00 ea. Brunswick Industries, P.O. Box 639, Hawthorne, Calif.

EARN $150 Week Mechanical, Electronics Drafting. Send $2 first Lesson, $25 Complete Home Study Course. Prior. Inc., Dept. 123. 23-09 169 Street, Whitestone 57. New York.

FOR SALE

TV Tuners—Rebuilt or Exchanged $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: L. A. Tuner Exchange, 4611 West Jefferson Blvd., Los Angeles 16, California.

TUBES—TV, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed. 1st Quality, Top Name Brands Only. Write For Free Catalog or Call WAlker 5-7000. Barry Electronics Corp., 512 Broadway, New York 12N, N. Y.

DIAGRAMS for repairing radios $1.00. Television $2.00. Give make, model. Diagram Service. Box 672-E, Hartford 1, Conn.

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Parabolic Reflectors. Picture Catalog 10¢. Meshna, Malden 48, Mass.

GOVERNMENT Sells Surplus: — Electronics: Oscilloscopes; Transceivers; Test Equipment; Radar; Sonar; Walkie-Talkie; Boats; Jeeps; Aircrafts; Misc.—Send for "U.S. Depot Directory & Procedures"—$1.00—Brody, Box 425(RT), Nanuet, New York.

PROFESSIONAL Electronic Projects -Organs, Timers, Computers, Industrial, etc.—$1 up. List Free. Parks, Box 1665 Lake City, Seattle 55, Wash.

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FIX LOOSE CRT BASES

By HERB BROWN

A PICTURE TUBE often "fails" or becomes intermittent although it is in perfectly good condition, internally speaking. This happens when there is nothing more than poor contact at one or more base pin. The actual failure is of the base-to-glass cement. Repair is a tricky business, but better than scrapping an expensive, otherwise useful component. Try this technique to make the job relatively painless.

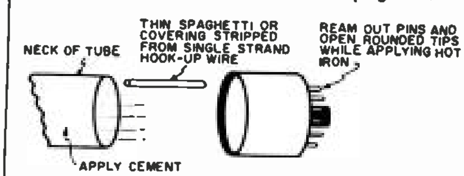
First remove the base without breaking the fine leads that protrude from the glass into the base pins, as follows: heat each pin with a soldering iron and work the base to free the wire. After this is done for each pin, the base is drawn off entirely.

Scrape, clean, straighten, and tin each lead on the neck. Then prepare the base as follows: Ream out each pin while heating it with the iron. Make sure each is unobstructed all the way through and use the reamer to open out the rounded pin tips.

Now for the master stroke. Take spaghetti, thin enough to pass through the pins, and cut it into as many lengths, each five or six inches, as you have wires. Thread a spaghetti sleeve on each lead right up to the glass. With the base correctly aligned (see illustration), thread each sleeve through the corresponding base pin and out the other side. Coat the butt of the tube and the inside of the base with a good cement; then draw the base tightly up against the glass.

Now withdraw each length of spaghetti carefully. Each bare wire will be entirely inside its own pin, and perhaps even protrude slightly past the open end. With solder and an iron, you can now make a good bond between each wire and its pin. Clean up each pin and you are done. ▲

Threading leads through base pins, normally tricky, is easier with spaghetti.



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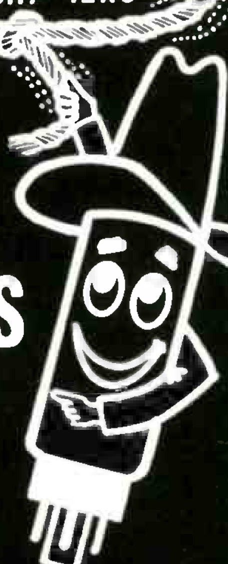

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	DC3	.80		2AF4	.96		3Q5	.80		5AV8	1.01		5Y4	.59
	0Z4	.79		2D21	1.20		3S4	.61		5BC8	.79		6A8G	1.20
	1AX2	.62		2EN5	.45		3V4	.58		5BE8	.83		6AB4	.46
	1B3	.79		3A3	.76		4AU6	.54		5BK7	.82		6AC5	1.05
	1DN5	.55		3A4	.60		4BA6	.51		5BQ7	.97		6AC7	.96
	1G3	.79		3AF4	1.02		4BC5	.58		5BR8	.79		6AF3	.73
	1H5	.54		3AL5	.42		4BC8	.96		5BT8	.83		6AF4	.97
	1J3	.79		3AU6	.51		4BN6	.75		5CG8	.76		6AG5	.68
	1K3	.79		3AV6	.41		4BQ7	1.01		5CL8	.76		6AH4	.81
	1L4	.68		3BA6	.51		4BS8	.98		5CM8	.90		6AH6	.99
	1LC5	.59		3BC5	.54		4BU8	.71		5CQ8	.84		6AK5	.95
	1LD5	.69		3BE6	.52		4BZ6	.58		5CZ5	.72		6AL5	.47
	1LG5	.69		3BN6	.76		4BZ7	.96		5EA8	.80		6AL7	1.43
	1LN5	.59		3BU8	.78		4CS6	.61		5EU8	.80		6AM4	1.50
	1R5	.62		3BY6	.55		4DE6	.62		5J6	.68		6AM8	.78
	1S2A	.76		3BZ6	.55		4DK6	.60		5T4	.79		6AQ5	.53
	1S4	.59		3CB6	.54		4DT6	.55		5T8	.81		6AR5	.55
	1S5	.51		3CF6	.60		4EW6	.58		5U4	.60		6AS5	.60
	1T4	.58		3CS6	.52		5AM8	.79		5U8	.81		6AS6	.8D
	1U4	.57		3DG4	.85		5AN8	.86		5V3	.90		6AT6	.43
	1U5	.50		3DK6	.60		5AQ5	.52		5V6	.56		6AT8	.79
	1V2	.50		3DT6	.50		5AS8	.86		5X8	.78		6AU4	.82
	1X2B	.82		3Q4	.63		5AT8	.80		5Y3	.46		6AU6	.52

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	6AU7	.61		6J6	.67		12D4	.69
	6AU8	.87		6J7	.62		12DB5	.69
	6AV6	.41		6K6	.63		12DE8	.75
	6AW8	.90		6L6	1.06		12DL8	.85
	6AX4	.66		6N7	.98		120M7	.67
	6AX5	.74		6S4	.51		12DQ6	1.04
	6AX7	.64		6S8	.76		12DS7	.79
	6AX8	.92		6SA7GT	.76		12DT5	.76
	6BA6	.50		6SG7GT	.41		12DT7	.79
	6BA7	.84		6SH7GT	.49		12DT8	.79
	6BA8	.88		6SJ7	.88		12DW8	.89
	6BC5	.61		6SK7GT	.74		12DZ6	.56
	6BC7	.94		6SL7GT	.80		12EG6	.54
	6BC8	.97		6SN7GT	.65		12EK6	.56
	6BD5	1.25		6SQ7	.73		12EL6	.50
	6BD6	.57		6T4	.99		12EM6	.79
	6BE6	.55		6T8	.85		12EN6	.78
	6BF5	.90		6U8	.83		12EZ6	.53
	6BF6	.44		6V6GT	.54		12F8	.66
	6BG6	1.66		6V8	.86		12FA6	.79
	6BH6	.65		6W4	.60		12FM6	.43
	6BH8	.87		6W6	.71		12FR8	.91
	6BJ6	.62		6X4	.39		12FX8	.85
	6BJ7	.79		6X5GT	.53		12GC6	1.06
	6BK7	.85		6X8	.80		12J8	.84
	6BL7	1.00		6Y6G	.65		12K5	.65
	6BN4	.57		7A8	.68		12L6	.58
	6BN6	.74		7AU7	.61		12S8	.62
	6BQ5	.65		7B6	.69		12SA7	.92
	6BQ6	1.05		7EY6	.73		12SF5	.50
	6BQ7	1.00		7F8	.90		12SF7	.69
	6BR8	.78		7Y4	.69		12SH7	.49
	6BS8	.90		8AU8	.83		12SJ7	.67
	6BU8	.70		8AW8	.93		12SK7	.74
	6BX7	1.02		8BH8	.90		12SL7	.80
	6BY5	1.15		8BN8	.75		12SN7	.67
	6BY6	.54		8BQ5	.60		12SQ7	.78
	6BY8	.66		8CG7	.62		12U7	.62
	6BZ6	.55		8CM7	.68		12V6	.53
	6BZ7	1.01		8CN7	.97		12W6	.69
	6BZ8	1.09		8CS7	.74		12X4	.38
	6C4	.43		8CX8	.93		17AX4	.67
	6C8	.90		8EB8	.94		17BQ6	1.09
	6CB6	.55		8SN7	.66		1704	.69
	6CD6	1.42		9CL8	.79		17DQ6	1.06
	6CE5	.57		11CY7	.75		17L6	.58
	6CF6	.64		12A4	.60		17W6	.70
	6CG7	.61		12AB5	.55		18FW6	.49
	6CG8	.77		12AC6	.49		18FX6	.53
	6CK4	.70		12AD6	.57		18FY6	.50
	6CL8	.79		12AE6	.43		19AU4	.83
	6CM6	.64		12AE7	.94		19BG6	1.39
	6CM7	.66		12AF3	.73		19T8	.80
	6CM8	.90		12AF6	.49		19V8	.79
	6CN7	.65		12AJ6	.46		21EX6	1.49
	6CQ8	.84		12AL5	.45		25AV5	.83
	6CR6	.51		12AL8	.95		25AX4	.70
	6CS6	.57		12AQ5	.60		25BK5	.91
	6CS7	.69		12AT6	.43		25BQ6	1.11
	6CU5	.58		12AT7	.76		25C5	.53
	6CU6	1.08		12AU6	.51		25CA5	.59
	6CY5	.70		12AU7	.60		25CD6	1.44
	6CY7	.71		12AV6	.41		25CU6	1.11
	6DA4	.68		12AV7	.75		25DN6	1.42
	6DB5	.69		12AX4	.67		25EH5	.55
	6DB6	.51		12AX7	.63		25L6	.57
	6DE6	.58		12AY7	1.44		25W4	.68
	6DG6	.59		12AZ7	.86		25Z6	.66
	6DK6	.59		12B4	.63		32ET5	.55
	6DN6	1.55		12BA6	.50		32L7	.90
	6DQ6	1.10		12BA7	.84		35B5	.60
	6DT6	.53		12BD6	.50		35C5	.51
	6DT8	.79		12BE6	.53		35L6	.57
	6EA8	.79		12BF6	.44		35W4	.42
	6EB5	.72		12BH7	.77		35Z5	.60
	6EB8	.94		12BK5	1.00		36AM3	.36
	6EM5	.76		12BL6	.56		50B5	.60
	6EM7	.82		12BQ6	1.06		50C5	.53
	6EU8	.79		12BY7	.77		50EH5	.55
	6EW6	.57		12BZ7	.75		50L6	.61
	6EY6	.75		12C5	.56		5763	1.00
	6F5GT	.39		12CN5	.56		7DL7	.97
	6F6	.69		12CR6	.54		7025	.69
	6GK6	.79		12CU5	.58		84 6Z4	.46
	6GN8	.94		12CU6	1.06		807	.70
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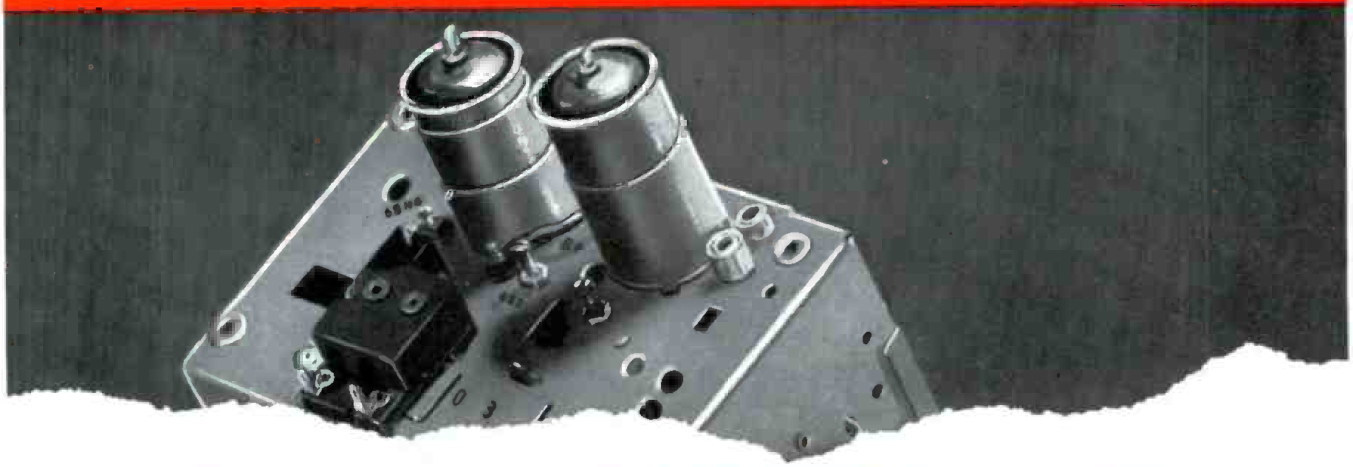

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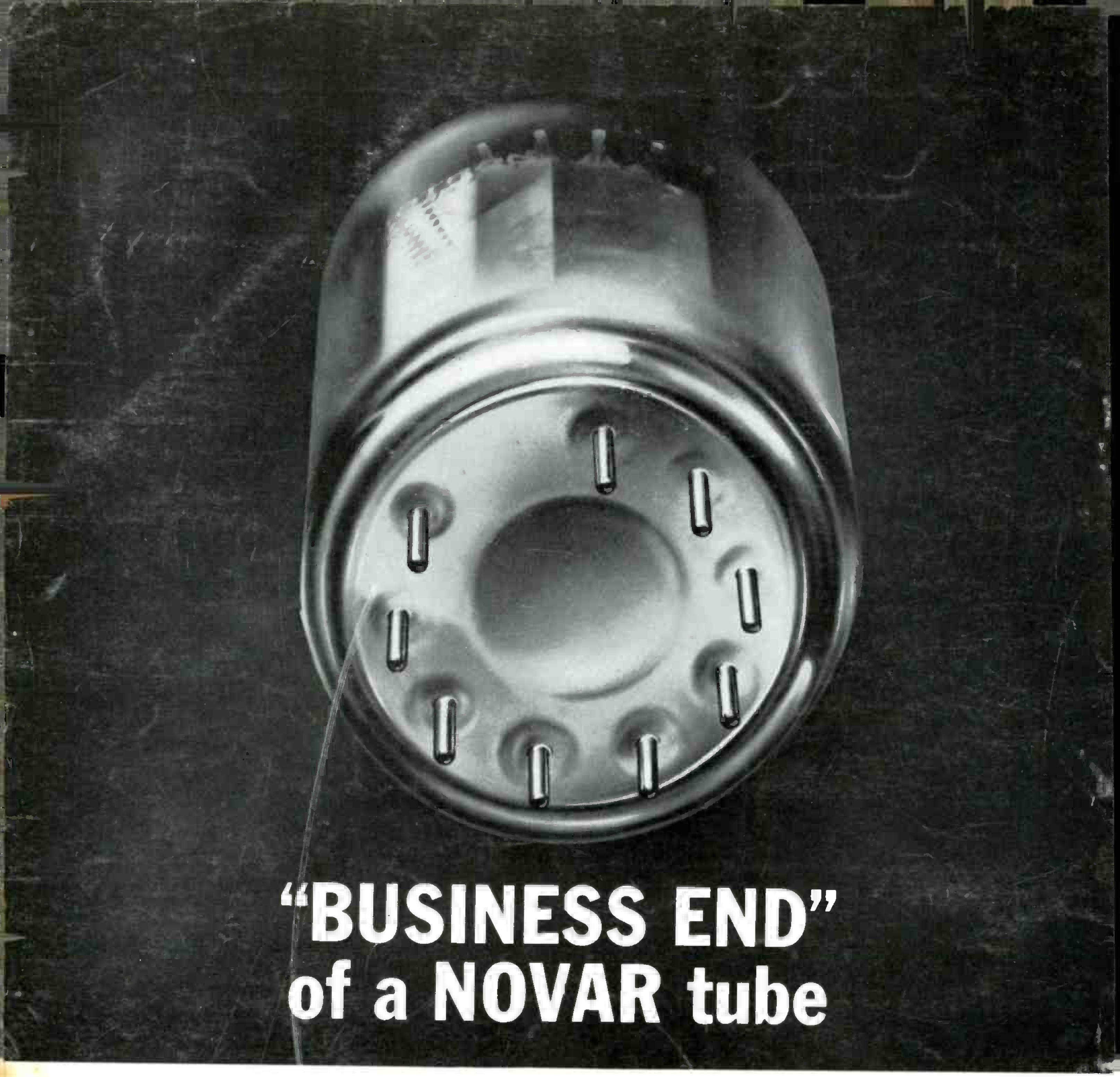

You're looking at the base of one of RCA's remarkable new novar tubes... the first in a new family of tubes that will mean better business for you through reduced call backs.

This new base—with 9 widely-spaced, heavy-gauge pins—characterizes novar, RCA's line of large all-glass integral base tubes designed to do the work of conventional tubes with molded bases. Because novars *outperform* these conventional types, they are being selected for use in more and more radio and TV receivers as well as hi-fi equipment. From present indications, novar should become the standard of the industry.

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