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6-19			Cleveland			
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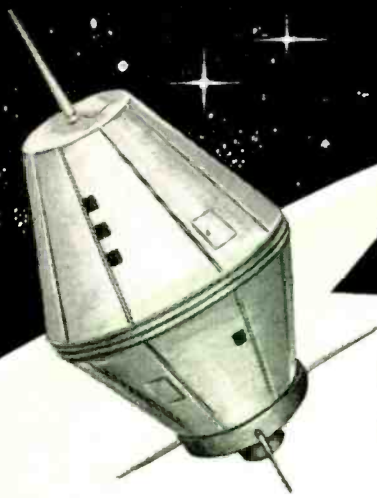

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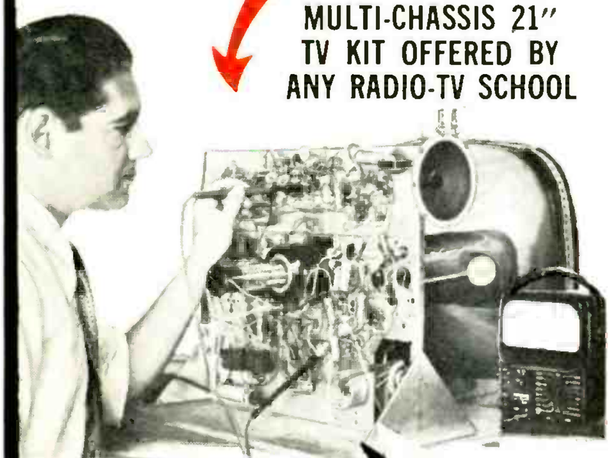

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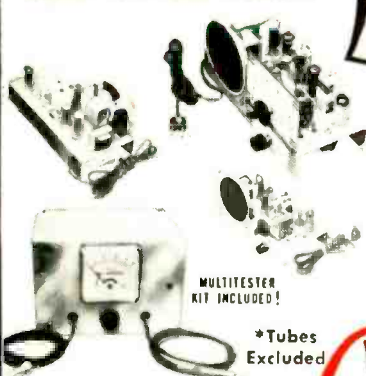

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. . . for the Record

By W. A. STOCKLIN
Editor

WHEN Christmases roll around in a matter of months instead of annually—it is a pretty safe bet you are well out of your teens. This year has moved fast—in the electronics industry in particular and the country as a whole. We have seen space probes and satellites hurled into outer space with unbelievable nonchalance and almost incredible success, redeeming the prestige we lost when the first Sputnik was orbited.

However, this first year in the new decade has proven less hopeful than our crystal-ball gazing last year indicated. There were a number of factors which contributed to this "softening of the economy" or "sliding recession" . . . or whatever phrase you select to characterize the present business climate.

Paradoxically, the Gross National Product remains at a record high, bank deposits are up, and more people are gainfully employed than ever before . . . but still the annual reports rolling in show earnings, sales, and profits all down over a like period in 1959.

Is the market oversold or are potential customers "running scared"? Practically every consumer survey shows that the public *has* cut back on planned purchases. Those who earlier in the year planned to buy a second TV set or invest in a color receiver, now report a change of heart. True, the cost of living has edged up, taking an even higher percentage of a man's take-home pay and leaving fewer "discretionary dollars" available for luxury purchase . . . but perhaps the industry itself has been falling down on the job by failing to provide that incentive-to-purchase that many consumers seem to require.

In an economy of plenty, such as we enjoy, would-be customers are inclined to be lethargic in the matter of pursuing merchandise since they know it is available and can be obtained any time the spirit moves them.

The true test of salesmanship is to create a desire, supply the need, and insure customer satisfaction. It is not necessary to make wild claims for quality products . . . and plugging non-existent features of poor merchandise has a way of boomeranging unpleasantly.

Many people claim that our industry has been oversold. In some cases this may be all too true. Basically, however, the electronics industry has much to offer in comfort, convenience, and entertainment. Electronics in itself is enough of a "miracle" to create the desire for such products. But if, as some analysts claim, our market is "oversold," it is up to the sales departments of our manufacturers to develop a program that will create the incentive necessary to increase the sales of their products.

As we wind up this year and head toward 1961, it is our hope that the New Year has many good things in store for all of our readers. So, from the entire staff of ELECTRONICS WORLD, may we wish you all . . . .

Merry Christmas

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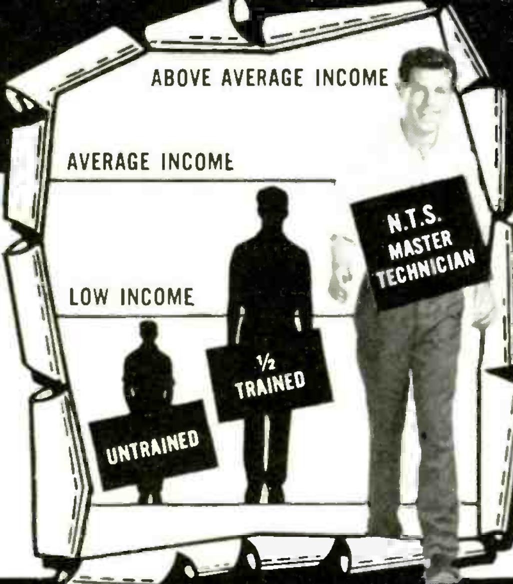

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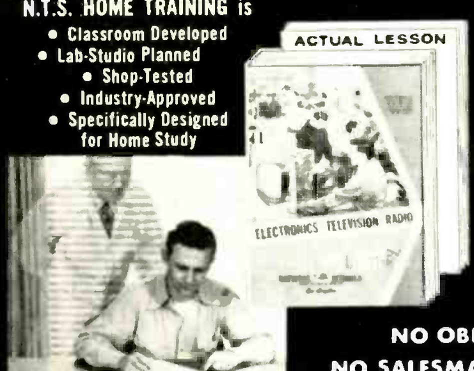

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Letters from our Readers

TRANSISTORIZED RAILROAD RADIOS

To the Editors:

Your article on "Railroad Radio" in the August issue was very interesting and comprehensive. We would like to bring up to date the last paragraph in which you say that partially transistorized equipment now in use has semiconductors in the audio output stages and in the power supplies. The latest *Motorola* railroad radio goes quite a bit further.

Our 64/12-volt universal "MOTRAC" railroad radio has a completely transistorized receiver, completely transistorized power supply, and a partially transistorized transmitter. The unit can be operated from either 64- or 12-volt power sources, thus making possible installation in either diesels or cabooses.

Lee Weddig
Press Relations
Motorola Communications & Electronics Inc.
Chicago, Illinois

We are certain that our readers will be interested in being brought up to date on the use of completely transistorized railroad radios.—Editors.

* * *

HAM RADIO CONSTRUCTION

To the Editors:

I have just finished reading Howard Pyle's article "Has Ham Radio Construction Improved?" which appeared in your August issue, and I enjoyed it very much.

But quite frankly, I do not agree with you that amateur radio construction has improved. The technical end has advanced unbelievably fast, particularly so since World War II, and the technical know-how of the amateur today has progressed accordingly. However, therein lies the basis of comparison for, considering the state of the art now and 30 or 40 years ago, actual construction has gone backwards, if anything. You see, I do not include "kit building" as *construction* for it is not, and there are relatively few hams today who build from the ground up. In the "old days" the ham usually built everything except meters, headphones, and tubes, and I have known some who were not stumped by these.

Leslie E. Wright
New Woodstock, New York

Here is a portion of Author Pyle's reply to the above letter.—Editors.

Dear Les:

In connection with kits, I can agree with you only partially. True, the hard work is done by factories; holes are drilled and punched, panels lettered, etc., all of which greatly enhance the *appearance* of the finished product. Actual on-the-air performance is due, in my opinion, *not* to the fact that kits provide more workmanlike appearance, but to the fact that the *technical* developments, to which the ham has contributed in a major way, have progressed, as you say, to an almost unbelievable extent.

Nevertheless, there still remain a number of us of the "old school" who like at times to "build from scratch;" I know that I do. Naturally, we don't have the facilities which a modern kit factory must provide from the production standpoint. Sure, we can buy socket hole punches and many other tools unheard of in the pioneer days when we laboriously drilled a circle of small holes in a chassis, chiseled out the inner circle and patiently filed the edges.

I don't often go to that extreme anymore. In fact, I consider kits a boon to the experimenter who is willing to adopt conventional circuits and practice. For the man with a new idea (are there any?), the laborious process of developing your brain child the "hard way," is still pretty much of a "must." I often get a design idea for which no kit exists. I have a yen then to bring my "brainchild" into being, bend sheet metal (without a brake), drill and punch holes, letter panels with the small decals (not available to early pioneers), but I try to come up with a workmanlike job, based on background and experience.

For the newcomer to the ham ranks, there *is* no electronic background; probably not much mechanical experience. For him the kit is ideal. While assembling and wiring it, craftsmanship gradually rubs off on him and, when he has progressed to the stage where the urge to actually "build from scratch" and from his own design becomes overpowering, he cannot help but do a better job of construction than were he to be forced to grope in the semi-dark to produce a "breadboard" job such as appeared photographically on the first page of my article.

Howard S. Pyle
Mercer Island, Washington

* * *

TAPE RECORDER SPEED AT 50 CPS

To the Editors:

Recently I had to record a week's convention in Rio de Janeiro, Brazil, where the power is 50 cps.

Since I have many excellent portable recorders for 60-cycle operation, I wanted to be able to use them and still get good recordings. The solution was easy, and I want to pass it on to the readers of Electronics World.

I recorded as usual, but when I got back to 60-cycle power, I dubbed (copied) the material to another machine. On it I had built up the diam-

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HERE'S PROOF...that Grantham students prepare for F. C. C. examinations in a minimum of time. Here is a list of a *few* of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Edgar T. Phelps, 931 Hickory Street, Poplar Bluff, Mo.	1st	12
Wayne Hogg, 4830 San Fernando Rd., Glendale, Calif.	1st	20
Robert Watson, Star Route, Box 24, Renovo, Pa.	1st	12
William H. Patchin, 3865 Westview Ave., NW, Canton, Ohio	1st	12
V. Dean DeVore, 309 Bess Street, Washington, Ill.	1st	16
Edward T. Wall, Box 184, Kenly, N. C.	1st	12
James W. Wranich, 4236 Michigan Street, Kansas City, Mo.	1st	20
Robert E. Sullivan, 2475 E. Douglas, Des Moines, Iowa	1st	12
Nelson S. Kibler, 1413 Patrick Henry Dr., Falls Church, Va.	1st	18
Barry L. Ulrich, 1110 Chestnut Ave., Barnesboro, Pa.	1st	14
Jerry E. Milligan, 707 Ragsdale Dr., Milan, Tenn.	1st	12
Robert S. Davis, 2100 - 10 Ave., So., Apt. 12, Birmingham, Ala.	1st	13

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Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

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I am interested in: ☐ Home Study ☐ Kansas City classes
☐ Hollywood classes ☐ Seattle classes ☐ Washington classes

16-A

eter of the capstan drive shaft with Scotch splicing tape #41 where it pulls the tape until twelve seconds of leader and timing tape went through in ten seconds. My capstan shaft is approximately one-quarter inch in diameter and I needed exactly twelve inches of splicing tape for the job.

After the original tape is copied on the recorder with the built-up capstan, that copy will play at proper speed on any other recorder. It is only necessary to use the tape on the capstan once. Always play the copy with a bare capstan. The splicing tape is very thin and does not leave enough ridge at the beginning and end to make any apparent wow in the reproduced tape.

Wes Miller, Chief Engineer
Southern Baptists' Radio
and Television Commission
Fort Worth, Texas

We are pleased to pass along this very helpful hint to any of our readers who may desire to correct the speed of material taped at 50 cps. We also wish to thank Reader Miller for his thoughtfulness in advising us of his experiences in this regard.—Editors.

* * *

CITIZENS BAND USE

To the Editors:

I have recently been on a ten-day trip through New England and have traveled on turnpikes, thruways, toll roads, and in isolated places, driving approximately 2000 miles. We felt at all times that if we needed help due to breakdown of our car, or finding a place to stay or eat, there was always someone available to help us through the use of our Citizens Band equipment.

In Buffalo for example, we heard several CB operators giving assistance to other CB operators in Niagara Falls and arranging for accommodations.

As a real-estate broker, I have six units, and they have been a great help in my business and well worth their cost.

James D. Quillen
Dover, Delaware

Many of our readers have pointed out the usefulness of CB gear on the road. Our write-up of "A National Travel Service Frequency for Citizens Banders" for just the above purposes in our September 1960 issue received a large number of favorable comments.
—Editors.

* * *

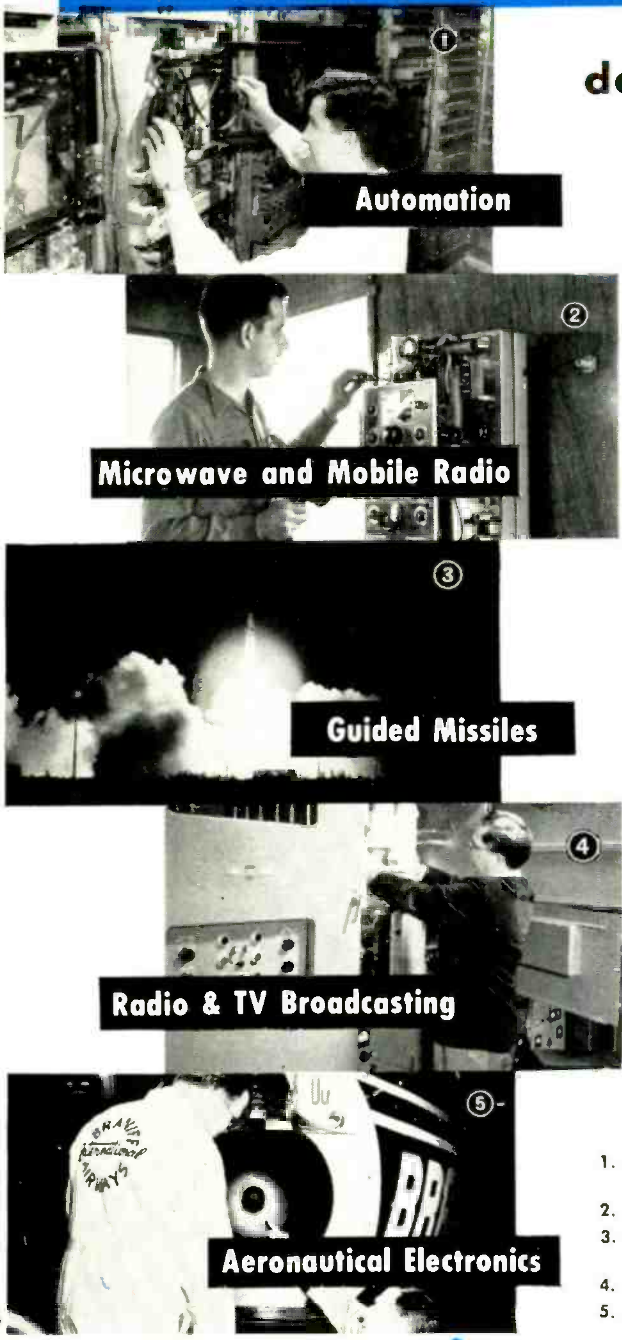
THE CASCODE CIRCUIT

To the Editors:

As a co-inventor of the original low-noise cascode with A. B. Macnee and H. Wallman (U.S. Patent 2,644,860), I object to its being called the "Wallman" circuit, as was done in your September, 1960 issue. The triple invention of this circuit is based on the fact that I suggested it, Macnee and Wallman predicted its possible low-noise advantages theoretically, and I built and tested the first model.

Incidentally, Fig. 2 of Mr. Kyle's article should show the suppressor of the

How to Get a Commercial FCC License



do you know what an FCC license really can do for you in Electronics?

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Chances are if you are reading this magazine, you can qualify for the really good jobs in electronics, like those shown at left . . . and it won't take long to do it. Your past training and experience in radio & TV repair, armed forces electronics, ham operator, etc. can be your foundation for a profitable career as an electronics technician. Send for the Career Information Material shown below today.

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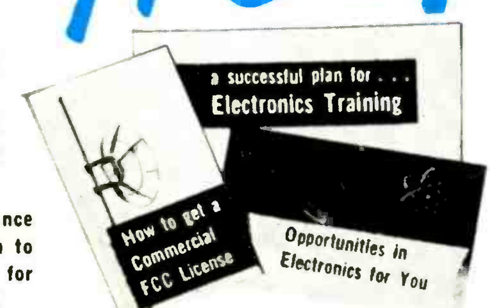
3. Training is Job Insurance when employment is tough to find . . . and more money for you when times are good



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☐ Radio-TV Servicing ☐ Home Experimenting
☐ Manufacturing ☐ Telephone Company
☐ Amateur Radio ☐ Other

In what kind of work are you now engaged? ____________
In what branch of Electronics are you interested? ____________

Name ____________ Age ____
Address ____________
City ____________ Zone ____ State ____

RN49

6AK5 connected internally to the cathode. It may be noted that the word "cascode" was coined by F. V. Hunt, who originated this type of circuit in connection with a voltage stabilizer (unpatented). The series modification of the high-frequency circuit was made by E. K. Nelson in adapting it to TV tuners (U.S. Patent 2,775,659).

CHRISTOPHER P. GADSDEN
Assistant Professor of
Electrical Engineering
Tulane University
New Orleans, Louisiana

Some authors have attached Wallman's name to the cascode circuit for brevity and because the paper which formally described the development to the industry was written by him, and he placed his name on it first. However, Wallman has disavowed the practice of singling him alone for credit in a letter to the "Proceedings of the IRE," which Professor Gadsden was good enough to forward to us.—Editors.

* * *

PHOTOELECTRONIC BURGLAR ALARM

To the Editors

I recently bought a photoelectronic relay and light source kit from *Allied Radio* as a protective device against housebreaking, which is very bad here on Taiwan, especially for Americans.

I received the kit one morning, assembled it during the same afternoon, and had it installed and operating that night with a buzzer that I had to convert from a bicycle horn, as all doorbells and buzzers here are for 110 volts a.c. About 2 a.m. that same night, the buzzer sounded, and I had a sneak thief cornered with a baseball bat that just happened to be handy. The culprit is now weaving grass rugs in the local monkey house and will be there for a few months to come.

GORDON B. SCOTT
Martin Company Tech. Rep.
Tainan, Taiwan (Formosa)

These kits work in the United States, too.—Editors.

* * *

LINE-VOLTAGE ADJUSTER

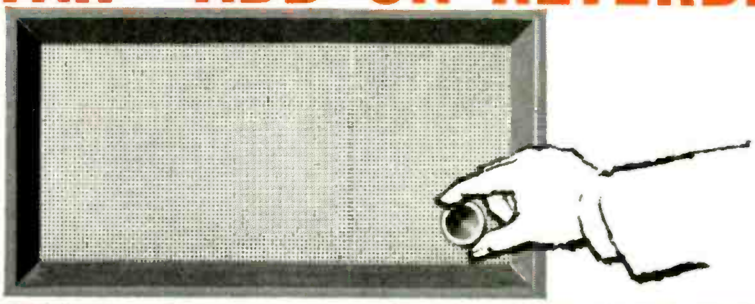
To the Editors:

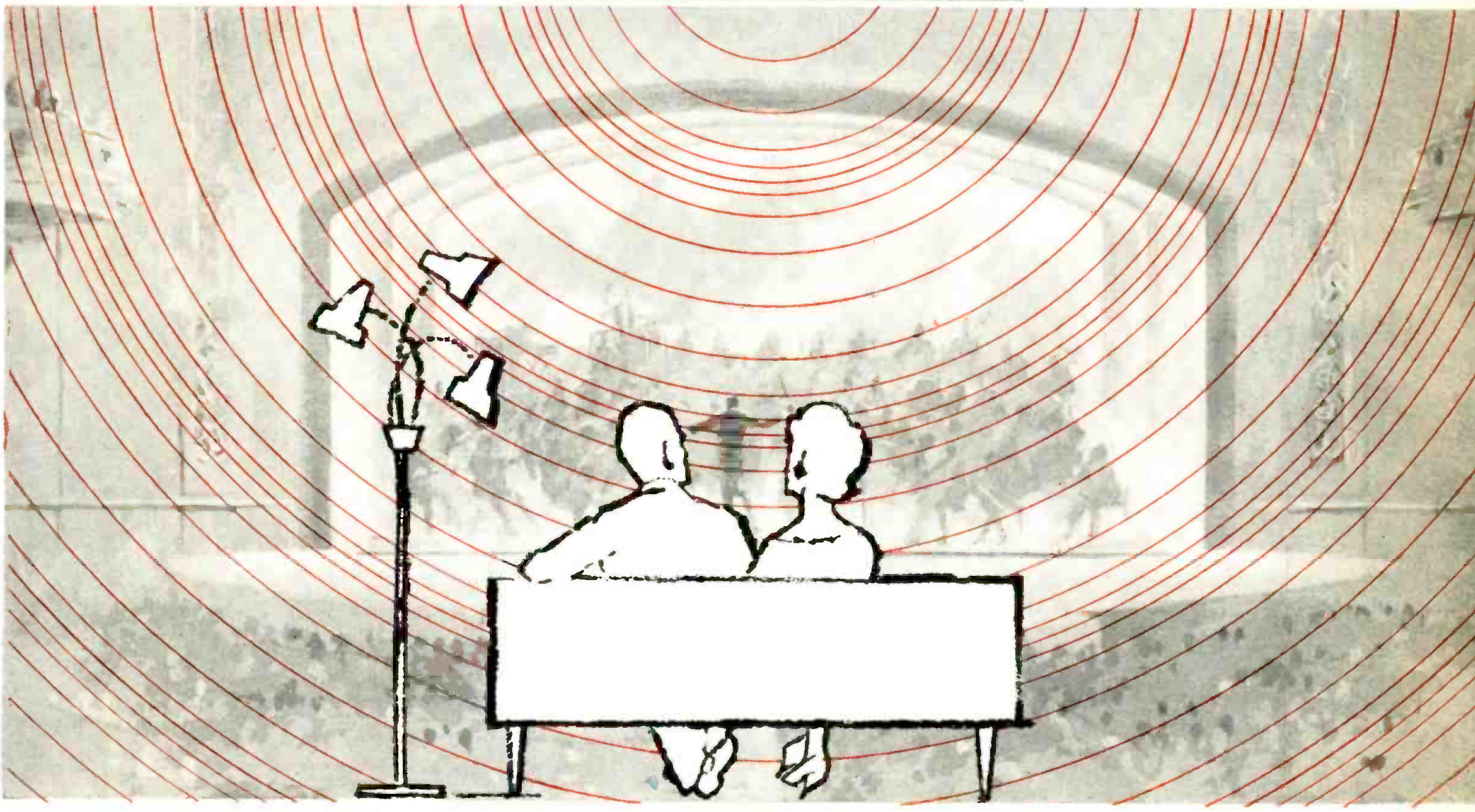
Before the smoke from burning transformers completely obscures Fig. 4 on page 67 of ELECTRONICS WORLD for November 1960, I urge you to change that wire leading downward from the lower left-hand terminal of S_6 from its present position on the terminal "E" lead to a more logical spot, the "F" lead.

JOHN D. MCCURRACH
Commonwealth Edison Company
Chicago, Illinois

We certainly appreciate the alertness of reader McCurrach in pointing out the improper connection that occurred in Fig. 4 of the article "A Line-Voltage Adjuster" by Ronald L. Ives. We are sorry that neither we nor Author Ives caught this when tracing the circuit operation through the various switches that are utilized in the line-voltage adjuster.—Editors. —30—

NEW FROM UTAH—ADD-ON REVERBERATION





MAKES YOUR LIVING ROOM SOUND AS LARGE AS A CONCERT HALL!

Change acoustic dimensions of a room to fit the music . . . switch from club lounge intimacy to concert hall grandeur at the touch of a dial. Controlled reverberation is the secret! Some of this year's consoles feature "built-in" reverberation. But Utah alone offers "Acousti-Control"—a self-contained reverberation speaker-and-amplifier that hooks into any radio, phonograph (mono or stereo), or component sound system.

Here's how it works: *Hook Utah's "Acousti-Control" unit into any speaker system. Part of the original signal feeds through a carefully tuned device which delays the sound for 1/30th of a second. This delayed sound blends with the original sound to add acoustic dimension to the room. (The further you turn the knob, the larger the room sounds.) Makes monaural FM sound like stereo—adds startling dimension to stereo itself. Ask for a demonstration at your dealer's—or write for free literature and prices.*

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Replace improper equipment with the only microphone designed specifically for citizen's band

THE TURNER 350C

This reasonably priced, mobile-type ceramic microphone is the perfect replacement for the many improper, tape recorder-type microphones now being used on CB equipment Has DPST switch wired for relay operation with easily reversible terminals to allow modifications (if necessary); wiring diagram enclosed with each microphone; hanger button and standard dash bracket for mobile rig mounting; and an 11" retracted (five foot extended), plastic-jacketed, coiled cord. Response: 80-7,000 cps. Output: −54 db. List price: $16.80 complete. See your Turner Distributor, listed below, he has the 350C in stock.

THE TURNER MICROPHONE COMPANY
934 17th St. N.E.
Cedar Rapids, Iowa

ARKANSAS
Little Rock: Southern Radio Supply
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DISTRICT OF COLUMBIA
Washington: Electronic Wholesalers
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La Salle Electronics
Peoria: Klaus Radio & Electric
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Bloomington: Stansifer Radio Co.
Evansville: Hutch and Son, Inc.
Ohio Valley Sound
Fort Wayne: Pembleton Laboratories
Indianapolis: Brown Distributing Co.
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Van Sickle Radio Supply
Kokomo: George's Electronic Sup.
Michigan City: Tri-State Electrical Sup.
Portland: Buck's Hi-Fi
Richmond: Fox Electronics Company
Terre Haute: Midwest Supply Company
IOWA
Cedar Rapids: Iowa Radio Supply
Des Moines: Bob & Jacks, Incorporated
Radio Trade Supply Co.
KANSAS
Topeka: Acme Radio Supply
KENTUCKY
Lexington: Radio Equipment Co.
Louisville: Arcby Electronics
P. I. Burks Company
Peerless Electronic Equipment Co.
LOUISIANA
Baton Rouge: Davis Electronics Sup.
New Iberia: Brooks Electronics
MASSACHUSETTS
Boston: A. W. Mayer Company
O'Donnell Electronic Supply
Radio Shack Corp.
Lawrence: Alco Electronics
MICHIGAN
Ann Arbor: Purchase Radio Supply
Detroit: High Fidelity Workshop
Lansing: Offenhauer Company
MINNESOTA
Minneapolis: Lew Bonn
National Electronics Co.
Harry Starks, Inc.
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Farmingdale, L.I.: Gem Electronics
Forest Hills: Beam Electronics
Hicksville: Gem Electronics
Kingston: Greylock Electronics
Long Island City: Spera Electronics
Mt. Vernon: Davis Electronics
New York: Harvey Radio Company
Acme Electronics
Poughkeepsie: Greylock Electronics
Rochester: Rochester Radio Supply
NORTH CAROLINA
Greensboro: Johannesen Electric Company
Raleigh: Southeastern Radio Supply Co.
Winston-Salem: Womack Company
OHIO
Cleveland: Pioneer Electronic Sup.
Columbus: Whitehead Radio Company
Mansfield: Wholesaling, Inc.
Toledo: Lifetime Electronics
OKLAHOMA
Oklahoma City: Johnson Wholesale
OREGON
Portland: United Radio Supply
PENNSYLVANIA
Homestead: M. Leff Radio Parts
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Philadelphia: Radio Electric Service Co.
Pottstown: George D. Barbey Co.
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Send this coupon to the nearest Turner distributor listed above or write The Turner Microphone Company for the name of a distributor in your area.

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Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

ELECTRONIC SPEED MAIL MAKES DEBUT—An innovation in mailing featuring a microwave network and electronic facsimile was unveiled recently in Washington. Hailing the development as a..."major landmark in the evolution of postal service"...spokesmen said that the system should prove to be a practical and economical means of sending a "preferred type of mail." In operation, the sender types, writes, draws or otherwise imprints a message on a special form (similar to the V-mail form of World War II) and then folds, seals, and mails the form. At a local post office, it is sent to a Speed Mail unit. One machine places a code mark on the letter which guides it through a "brain" of the system—a complex electronic switching equipment—which directs it to the correct destination printing machine. Moving on to other machines, the sealed edges are then trimmed off; the latter is "read" and transmitted over a microwave network to the destination post office. There it is reprinted in its original form, automatically folded, sealed, and sent out to the addressee. Each sending and receiving unit can handle one letter every four seconds. At present, the basic transmission and reception system is between Washington and Chicago, with four sending and four receiving units in the capital and four divided between Chicago and Battle Creek.

OVER 40 TRANSMITTERS BEAMED ELECTION RETURNS OVER VOA CIRCUITS TO WORLD—The U.S. Information Agency global radio network, the Voice of America, involving 46 domestic and overseas transmitters with a total power of 3,000,000 watts, was used to send election returns worldwide. Besides making its studio facilities available to foreign correspondents, more than 30 feeder broadcasts were scheduled for overseas stations or networks located in Italy, West Germany, Austria, France, Spain, Luxembourg, Holland, Iceland, Norway, Turkey, Tanganyika, and Kenya.

RUSSIA TO HAVE 15-MILLION TV SETS BY 1965, REPORT DISCLOSES—By 1965, the number of TV sets in Russia is expected to increase from the now more than 3-million to over 15-million, according to a report appearing in a Russian magazine. The article, translated by a government agency, also notes that there will be, five years from now, 160 TV stations, compared to the 70 now operating. In addition, the report continues, new studios will be added to the three now in Moscow and a new tall tower for broadcasting will be erected in Ostankin. It was also revealed that both black and white and color will be transmitted at that time.

FORWARD-SCATTER TRANSMISSION OVER NORTH ATLANTIC SOUGHT BY FAA—The forward-scatter principle, successfully used by military and communications networks, may soon be used for airways communications, the Federal Aviation Agency announced recently. Based on the effectiveness of the Pan American Airline system in Ireland with a range of 400 miles, the FAA said that it believed forward scatter should be practical for both domestic and overseas operations. As a first step in determining the extent to which forward scatter might be used, the FAA will establish two terminals here and subsequently locate others in Europe.

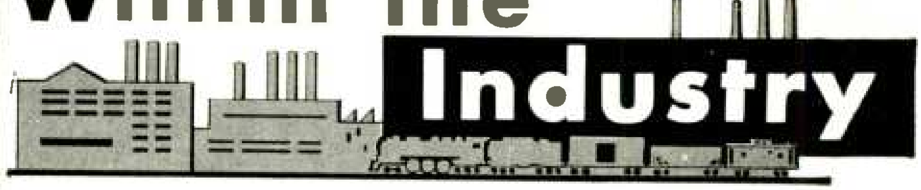
ELECTRONIC SUPERMARKET DEVELOPED—A novel approach to electronic marketing—where a customer never handles the goods—has been demonstrated. The system features an automatic method of warehousing coupled with electronic order-taking which enables one to make a choice by inserting a card into slots over goods on display. The cards are then fed into a processing machine, which sets automatic dispensing from the warehouse into action.

MICROWAVES FOR BUSINESS RADIO SERVICE—Frequencies above 10,000 mc. will soon be available for the Business Radio Service, according to an amendment issued by the FCC.

PROPOSED RULES TO AFFECT OPERATION IN 450-470 MC. BAND—The rules governing the Public Safety, Industrial, Land Transportation and Citizens Radio Services, may be amended to require a reduction in the modulation-frequency deviation of all FM transmitters operating in the 450-470 mc. band from plus or minus 15 kc. to plus or minus 5 kc.

-30-

Within the Industry



ORLAND O. SCHAUS has joined *Audio Devices, Inc.*, of New York, manufacturer of magnetic tapes, as manager of research and engineering.

Dr. Schaus has been technical director of *Cyanamid of Canada* for the last six years. Before this, he was Lecturer in Chemical Engineering at McGill University in Montreal where he received his Ph.D. in physical chemistry and his B.S. in chemical engineering. Dr. Schaus is a director of the Chemical Institute of Canada.

* * *

DR. HARRY F. OLSON, *RCA Laboratories*, has been elected president of the Audio Engineering Society for 1960-61.

Serving with Dr. Olson are Herman H. Scott, *H. H. Scott, Inc.*, executive vice-president; L. R. Burroughs, *Electro-Voice, Inc.*, central vice-president; Pell Kruttschnitt, *Capitol Records, Inc.*, western vice-president; C. J. LeBel, *Audio Instrument Co.*, re-elected secretary; and R. A. Schlegel, *RKO Teleradio Pictures, WOR Division*, re-elected treasurer.

New governors include Murray G. Crosby, *Crosby Laboratories, Inc.*; John M. Hollywood, *CBS Laboratories*; and Dr. M. R. Schroeder, *Bell Telephone Laboratories*.

* * *

ALFRED STROGOFF has been named vice-president and general manager of *Adler Electronics, Inc.*, New Rochelle, N.Y.

Since joining the firm in 1949 as a design engineer, Mr. Strogoff has held key positions in every phase of the firm's operations, including manufacturing, sales, and administration.

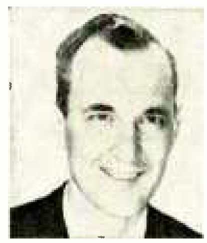
He is a member of the executive committee of the EIA, Institute of Radio Engineers, Armed Forces Communications and Electronics Association, and the American Society of Mechanical Engineers. He is a graduate of Worcester Polytech.

* * *

LAFAYETTE RADIO ELECTRONICS CORP., Jamaica, N.Y. has created a nation-wide chain of associated, franchised stores to distribute electronic parts, high-fidelity components, and allied products. Stores are presently in operation in Trenton, N.J. and Waterbury, Conn. with a new store scheduled to open in Denver around the first of the year . . . **HICKOK ELECTRICAL INSTRUMENT CO.** has opened a new 14,000-square-foot electronics research center at 1348 East 133rd St., East Cleveland, Ohio . . . Ground has been broken in Paris, Illinois by **ZENITH RADIO CORPORATION** for the construction of a new radio receiver and electronic component manufacturing plant. The first unit will provide 100,000 square feet of floor space for the company's wholly owned subsidiary, **CENTRAL ELECTRONICS, INC.** . . . **TELECHROME MANUFACTURING CORP.** is building a 40,000-square-foot addition to its plant in Amityville, L.I. The new section will house executive offices as well as expanded engineering, manufacturing, and laboratory facilities . . . **CLEVITE TRANSISTOR** has moved into its new plant at 200 Smith Street in Waltham, Mass. . . . **SYLVANIA ELECTRIC PRODUCTS INC.** has begun construction of a new electron tube research and development center in Emporium, Pa.

* * *

C. P. OLIPHANT has been named managing editor of the technical book division of *Howard W. Sams & Co., Inc.*, Indianapolis.



In his new post, Mr. Oliphant will be responsible for the operation of the book division, including technical editing and coordination of production and art departments with editing, among other duties.

He has been associated with the company for the past eight years and was a professional service technician. He is the author of several standard servicing texts.

* * *

JULIAN SPRAGUE, president of *Sprague Electric Company*, died recently at the age of 57. He was a well-known figure in the industry and actively associated with the EIA, NEMA, AMA, and AIM. He was president and/or director of a number of firms both in and out of the electronics field . . . **DR. REMO PELLIN** has joined the semiconductor products division of *Motorola Inc.* as product manager, semiconductor materials. He was formerly associated with *DuPont* . . . **NEVILLE W. JAMES** has been named reliability-quality control engineer of *International Resistance Co.* . . . *RCA Electron Tube Division* has announced the appointments of **JOSEPH T. CIMORELLI** as manager, engineering, receiving tube operations and **KENNETH G. BUCKLIN** to the newly created post of manager, new products engineering. Both

men will make their headquarters in Harrison, N.J. . . . **JAY S. SALZ** is the new general manager of *Trio Laboratories, Inc.* . . . *Lafayette Radio Electronics Corp.* has elected **ROBERT LAUB** vice-president for sales and **JACK BREAKIRON** vice-president of mail order operations . . . **W. W. SMITH** has been appointed chief of engineering development for *Babcock Electronics Corporation* . . . **RICHARD B. VOSK** has joined *Transdyne Corp.* as assistant director of engineering . . . **EDWIN S. DAVIS** has been appointed device design engineer by *Industro Transistor Corporation* . . . The distributor division of *Amphenol* has appointed **R. F. MEINICKE** vice-president for sales . . . The new post of director of marketing at *Allied Radio Corp.* is being filled by **THORNTON S. ADAMS.** He was formerly marketing consultant to the firm . . . **CLARENCE H. HOPPER** is the new president of *CBS Electronics* . . . **JOHN E. CLARKE** has joined *Computer Diode Corp.* as manager of applications engineering.

* * *

JACOB H. RUITER, JR. has been named manager of sales promotion for the *Weston Instruments Division, Daystrom, Inc.*

In his new capacity, Mr. Ruiter will assume over-all responsibility for advertising and sales promotion activities. Before joining the firm, he was associated with the electronics division of *Curtiss-Wright* and *Allen B. DuMont Laboratories.*

He is the author of two books, a senior member of the IRE, and former president of the New Jersey chapter of National Industrial Advertisers Assn.

* * *

TERMINAL ELECTRONICS, INC. and **HUDSON RADIO & TELEVISION CORP.,** major electronic parts and equipment suppliers in the New York metropolitan area, have merged to form **TERMINAL-HUDSON ELECTRONICS, INC.** Corporate headquarters are at 236 West 17th Street, New York. The company will continue to operate its various retail outlets in the area . . . **DALE ELECTRONICS, INC.** of Columbus, Nebraska has acquired **SIOUX RADIO PRODUCTS** of Yankton, S.D., producer of coils and ferrite antennas for radio and TV . . . **GENERAL TELEPHONE & ELECTRONICS INTERNATIONAL INCORPORATED** has acquired a majority interest in the Radio Communications Division of **MAGNETTI MARELLI** of Milan, Italy . . . **INTERNATIONAL COMMUNICATIONS CORPORATION** has been established in Santa Monica, California to design and manufacture airborne and marine navigation and communication equipment. Lawrence Hermes is president of the new corporation . . . **ESPEY MFG. & ELECTRONICS CORP.** has established a new division at Saratoga Springs, New York which will be known as the **SARATOGA SEMICONDUCTOR DIVISION.** The company will produce a line of semiconductor components for military and industrial equipment. —30—

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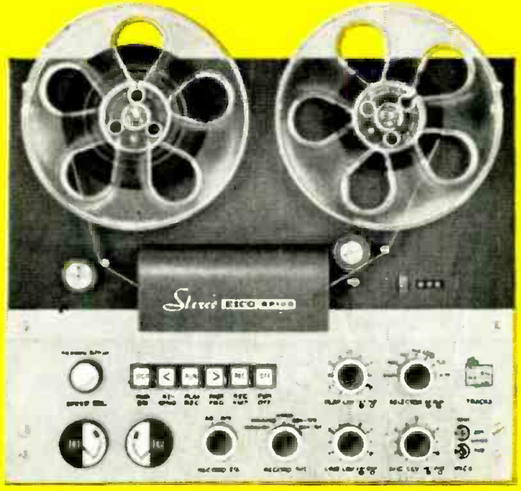

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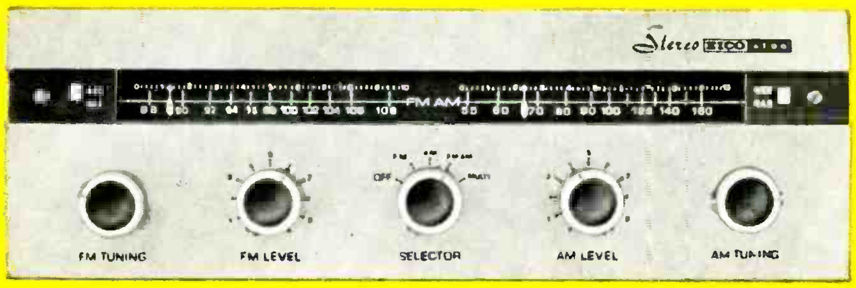

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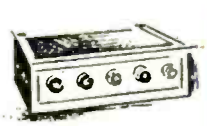

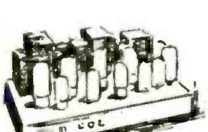

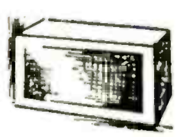

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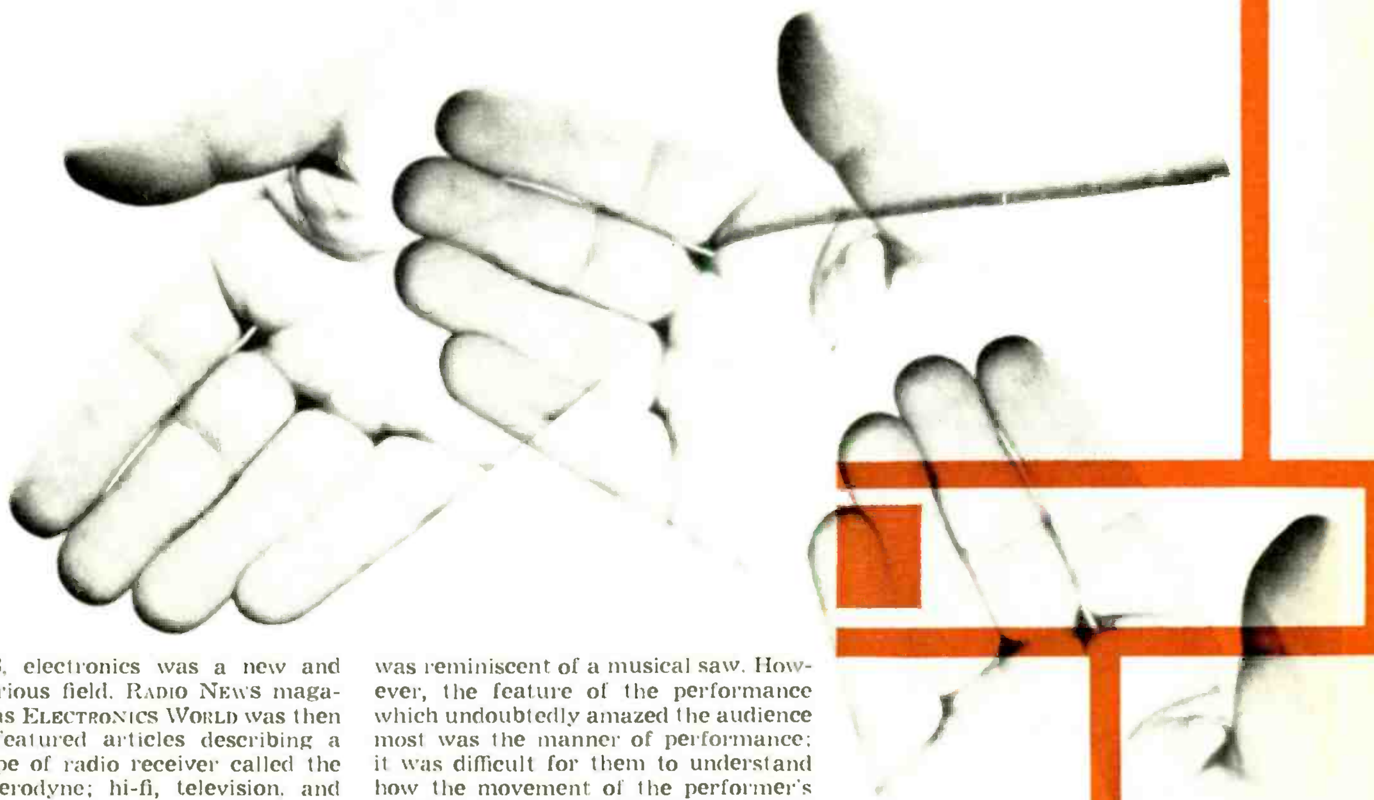
A TRANSISTORIZED THEREMIN

By ROBERT A. MOOG

Build this self-powered, three-octave instrument that will bring "music from the ether." Self-contained unit may be connected to any external amplifier and speaker.



IN 1928, electronics was a new and mysterious field. RADIO NEWS magazine (as ELECTRONICS WORLD was then called) featured articles describing a novel type of radio receiver called the superheterodyne; hi-fi, television, and electronic computers were yet to come. And in 1928, Professor Leon Theremin, a young Russian physicist, introduced to this country a musical instrument which he had invented. The instrument, named for its inventor, had two remarkable features. First, it was entirely electronic and, except for its loudspeaker, had no moving parts. Second, and equally remarkable, the performer played the instrument *without touching it*.

The first public demonstration of the Theremin was given on January 31, 1928 at the Metropolitan Opera House in New York City. The program cover set the mood for the evening: "Music from the Ether," emanating from a pair of slender hands which were reaching out of a raging fire. A fascinated audience heard Rudolf Wurlitzer introduce Professor Theremin and explain that Theremin would play his instrument by varying the position of his hands in the space around it. The audience became even more fascinated when Professor Theremin began to play. The music was unlike anything they had heard before, but was reminiscent of a musical saw. However, the feature of the performance which undoubtedly amazed the audience most was the manner of performance; it was difficult for them to understand how the movement of the performer's hands in space could be used to create music.

Today, "electronics" is a household word. There are millions of color TV sets and stereo sound systems in our homes. We are accustomed to reading newspaper accounts of scientists controlling satellites which are hundreds of thousands of miles distant. Yet the Theremin, invented over thirty years ago, still mystifies and fascinates all who hear it. This may seem surprising at first, since the instrument is basically simple. However, the Theremin's main element of fascination is its completely unique method of playing. It is truly the most modern and original of musical instruments.

The instrument to be described is a transistorized Theremin, powered by a small battery, and designed to be connected to any external amplifier. Although it is quite simple and inexpensive to build, it is a true musical instrument. Its pitch range covers more than three octaves. Its tone quality is pleasing and rich in harmonics. The playing technique can easily be mastered by

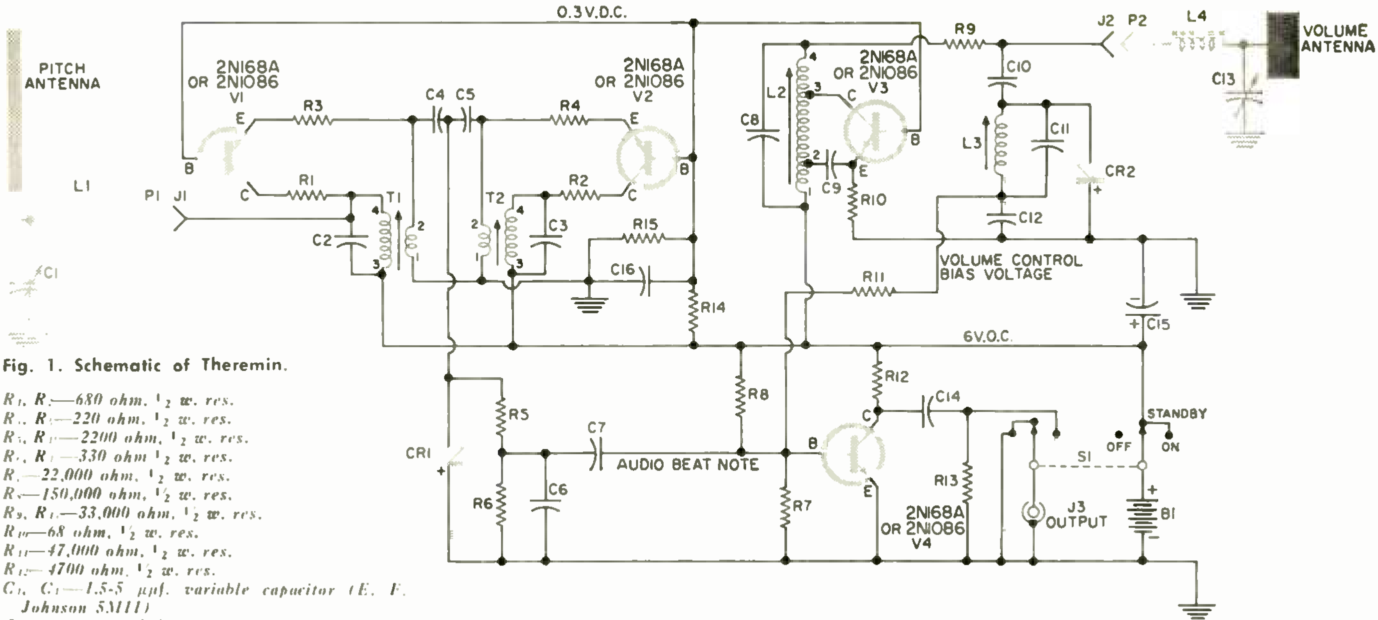


Fig. 1. Schematic of Theremin.

R_1, R_2—680 ohm, ½ w. res.
R_3, R_4—220 ohm, ½ w. res.
R_5, R_6—2200 ohm, ½ w. res.
R_7, R_8—330 ohm ½ w. res.
R—22,000 ohm, ½ w. res.
R—150,000 ohm, ½ w. res.
R_9, R_{13}—33,000 ohm, ½ w. res.
R_{10}—68 ohm, ½ w. res.
R_{11}—47,000 ohm, ½ w. res.
R_{12}—4700 ohm, ½ w. res.
C_1, C_{13}—1.5-5 μμf. variable capacitor (E. F. Johnson 5M11)
C_2, C, C_4, C_5—3900 μμf. mica capacitor ±10%
C_6, C_9, C_{12}—.1 μf., 10 v. ceramic capacitor
C, C_{11}—.47 μf., 10 v. ceramic capacitor
C, C_{10}—560 μμf. mica capacitor ±10%
C_{16}—.005 μf. ceramic capacitor
C_{15}—2 μf., 12 v. elec. capacitor
C_{14}—2.2 μf., 3 v. ceramic capacitor
L_1—75 mhy. pitch antenna coil (Moog 11-311) or three 25 mhy. ferrite-core r.f. chokes in series (J. W. Miller 6308 or Meissner 19-1053). See text.
L—Volume oscillator coil (Moog 11-302, see text)
L—Volume control coil (Moog 11-303, see text)
L_4—10 mhy. volume antenna coil (Moog 11-312) or two 5 mhy. ferrite-core r.f. chokes in series (J. W. Miller 6304 or Meissner 19-1051).
T_1, T—Pitch oscillator transformer (Moog 11-301, see text)
J_1, J—Pin or banana jack
J—Phono jack
P_1, P—Pin or banana plug
S_1—D.p. 3-pos. shorting rotary switch (Mallory 3123J)
B_1—6-volt battery (Eveready 724 or equiv.)
CR, CR—1N34 or equiv.
V_1, V, V, V—"n-p-n" transistor (G-E 2N-168A or 2N1086 or equiv.)
NOTE: Coils for this unit may be purchased direct from R. A. Moog Co., Box 263, Ithaca, N.Y. Price for a complete set of coils (T_1, T_2, and L_1 through L) is $12.50 plus postage. Individual coils are also available. In addition, a complete kit of parts for the construction of the Theremin is available. Orders for coils or requests for information on the kit should be sent direct to the company.

anyone with a musical ear. And, most important from a musician's viewpoint, the instrument is exceptionally stable and reliable.

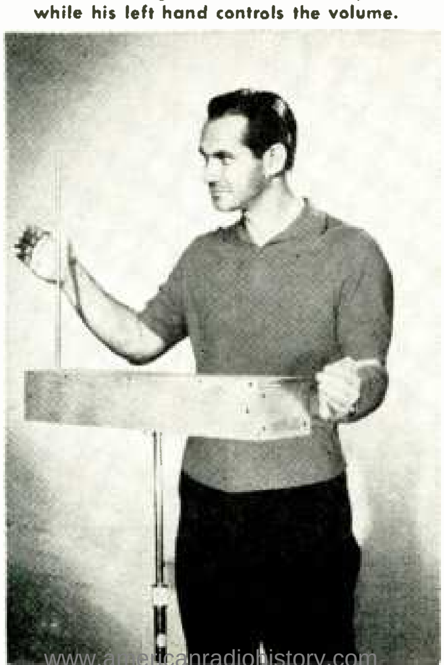
How it Works

The Theremin works by taking advantage of the fact that the hand is a conductor of electricity, and that its connection to the rest of the body effectively grounds it. Thus, the hand can be regarded as a grounded plate of a capacitor. If the hand is moved with relation to another electrical conductor, we have a variable capacitor. In playing the Theremin, the performer varies the capacitance between his right hand and a "pitch-control antenna" to determine the pitch of the tone, and varies the capacitance between his left hand and a "volume-control antenna" to determine the loudness of the tone.

How does the Theremin utilize capacitance to control the pitch (frequency) or loudness of a tone? To answer this question, let us first examine the pitch-generator section of the schematic diagram (Fig. 1). The pitch-generator consists of two stable r.f. oscillators, V_1 and V_2, both of which operate at about 150 kc. The signals from these two oscillators are mixed through C_4 and C_5, and rectified by CR_1. The frequency of the signal appearing at the junction of C_6 and C_7, which is the output of the rectifier circuit, is equal to the difference between the frequencies at which V_1 and V_2 oscillate. If V_1 and V_2 are oscillating at the same frequency, then the difference frequency is zero and no a.c. voltage appears at the junction of C_6 and C_7. If the oscillation frequency of V_1 is one per-cent lower than that of V_2, then the difference frequency appearing at the output of the rectifier circuit is one per-cent of 150 kc., or 1.5 kc. This frequency is in the middle of the audio-frequency spectrum, and is about two and one-half octaves above middle C on the piano. Thus, by lowering the oscillation frequency of V_1 by only one per-cent, the difference frequency can be swept through a wide pitch range, starting at "zero beat" and going continuously up in pitch through all but the highest notes on a piano.

This one per-cent change in the oscillation frequency of V_1 is caused by the change in hand capacitance. Hand capacitance never exceeds a fraction of a micromicrofarad. If this capacitance

Performer's right hand determines pitch while his left hand controls the volume.



were to be applied directly across the tank of oscillator V_1, the oscillation frequency would change by only a few hundredths of a per-cent. Naturally, this change is not enough to produce an adequate pitch range for a musical instrument.

To increase the effect of the hand capacitance on the frequency of oscillation of V_1, a coil with high inductance, low distributed capacitance, and low loss (L_1) is connected between the pitch-antenna and the tank of oscillator V_1. This antenna coil forms a series-resonant circuit with the combined capacitance of C_1 and the pitch-antenna, the resonant frequency of which is slightly below the resonant frequency of the oscillator tank. The total impedance of this series-resonant circuit, as seen by the oscillator tank, is much lower than the impedance of just the pitch-antenna alone. In addition, the *change in impedance* of the series-resonant circuit resulting from variation in capacitance at the pitch-antenna is also much greater than the *change in impedance* of just the pitch-antenna alone. These two factors combine to greatly increase the effectiveness of the pitch-antenna, so that a change of a fraction of a micromicrofarad at the pitch-antenna does, in fact, cause the difference frequency to change by as much as 1.5 kc.

The coupling of oscillators V_1 and V_2 through capacitors C_4 and C_5 produces two effects which are desirable in a Theremin. First, the oscillators tend to synchronize when their frequencies are very close together, making it easy for the performer to adjust for "zero beat." Second, even when the oscillators are not synchronized, they "pull" each other. This pulling is characteristic of any beat oscillator circuit in which the oscillators are coupled. As a result of the pulling, the waveform of the audio difference frequency signal is sawtooth-like, and contains a succession of overtones that impart a pleasing quality to the tone. The degree of coupling has been set to give a moderate amount of pulling, but not enough to cause instability at low difference frequencies.

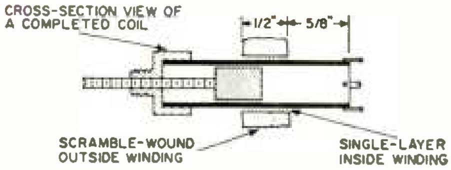
Now let us turn our attention to the volume-control section. In this section, as in the pitch-generator section, the combined capacitance of the control antenna and C_{13} is in series with a high-inductance, low-loss coil L_4, forming a series-resonant circuit. L_4 is connected to a fixed-frequency oscillator V_3 through a large resistance R_9. The impedance of the antenna series-resonant circuit is lowest when its resonant frequency is equal to the oscillator frequency, and increases as its resonant frequency is lowered, for instance by the addition of hand capacitance to the volume-control antenna. When the impedance of the antenna circuit increases, the r.f. voltage at the junction of R_9 and L_4 also increases. This r.f. voltage is applied across the parallel-resonant circuit C_{11} and L_3, and is rectified by CR_2. A negative d.c. voltage, which is proportional to the r.f. voltage, is thus developed at the junction of R_{11} and C_{12}. When the resonant frequency of the antenna circuit is equal to the oscillator frequency, the d.c. voltage at the junction of R_{11} and C_{12} is only a few tenths of a volt. As the resonant frequency of the antenna circuit is lowered, this voltage increases to about five volts.

Although the pitch-antenna circuit and the volume-antenna circuit are similar, they are applied in different ways. The pitch-antenna circuit is connected directly across the tank of oscillator V_1, and is used to change the *frequency* of oscillation. The volume-antenna circuit is connected to the tank of oscillator V_3 through a large resistor, and is used to change the *amplitude* of the r.f. voltage at the junction of R_9 and L_4.

The d.c. voltage developed at the junction of R_{11} and C_{12} is applied through R_{11} as bias to the base of control amplifier V_4. By increasing the d.c. bias voltage, the collector current of V_4 can be decreased until it is completely cut off. The audio signal from the pitch-generator section is also applied to the base of V_4. The a.c. output signal appearing at the collector of V_4 can be varied in amplitude from about 0.5 volt (minimum d.c. control voltage) to zero (maximum d.c. control voltage), and is fed to the output jack through isolating capacitor C_{14}.

The instrument is powered by a small six-volt battery. The current drawn by each of the three oscillators is stabilized by its emitter resistor, the base voltage being fixed by the resistive voltage divider R_{14} and R_{15}. Total battery current is about 8 ma.

A three-position switch is used to turn the instrument on. The first position is "off," and no battery current flows. The second position is "silent" or "standby," in which battery current flows but the output jack is shorted to ground. The third position is "play" or "on," and the short across the output is removed. This arrangement is needed to eliminate the transient accompanying the initial flow of battery current from getting into the amplifier and being heard as a thump at the loudspeaker.



General Instructions:

1. *Use one-half-inch diam., slug-tuned coil forms (CTC LS4/K or J. W. Miller 22A000 RBI)*
2. *Use #36 enamelled and cotton-covered wire.*
3. *Space the windings 5/8" from the lug end of the form and wind the coils 1/2" wide (see diagram above).*
4. *Always wind in the same direction around the coil form, for a given coil.*
5. *Coat the completed coils with a polystyrene-base coil dope.*

Specific Instructions:

1. *T_1 and T_2: First, wind 20 turns in a single layer. Start of this winding is terminal #1 and the end is terminal #2. Next, scramble-wind 145 turns over the 20-turn layer. Start of the 145-turn winding is #3 and the end is #4. Do not wind tape or other insulation between the first and second windings.*
2. *L_2: Start at terminal #1. Wind 5 turns in a single layer and bring a tap out to terminal #2. Next, scramble-wind 30 more turns and bring another tap out to terminal #3. Finally, scramble-wind 95 more turns and connect the end of the winding to terminal #4.*
3. *L_3: Scramble-wind 130 turns.*

Fig. 2. Details on coils employed in unit.

Construction

Building a transistor Theremin is a relatively easy matter. Since the two control antennas have to be separated by at least twenty inches and have to be about three and one-half feet from the ground, we found it convenient to mount everything on a plywood board, and fasten a flange with a standard microphone-stand thread (*Atlas* AD-11) to the bottom of the board. The entire instrument can then be supported by a microphone stand. The photos reveal the layout of components on the board. The board is 1/2" plywood, 24" long by 5 1/2" wide. Two pieces of wood 5 1/2"x 3"x1 1/2" are fastened at either end of the board. These pieces of wood hold the antennas. The pitch antenna, which goes on the right end of the board if you are right-handed, is an aluminum rod 3/8" in diameter and 21" long (3/8" aluminum rod is sold in hardware stores that carry *Reynolds* "do-it-yourself" aluminum). A vertical hole slightly larger in diameter than the 3/8" rod is drilled through the block that goes at the right end of the board. A wood screw is put into the board beneath the block hole, so that with the block in place, the rod can be dropped in the hole, and will rest on the screw head. A wire is fastened to the wood screw before the block is screwed to the board.

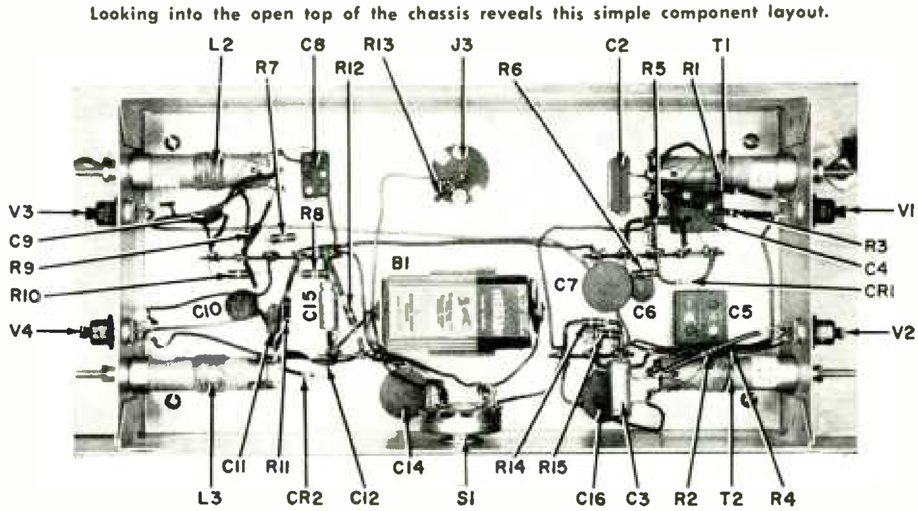
The volume-control antenna is a sheet of aluminum, 5 1/2"x 3 1/2", fastened to the outer face of the block at the left end of the board. Connection to the antenna is made by a wire under one of the mounting screws.

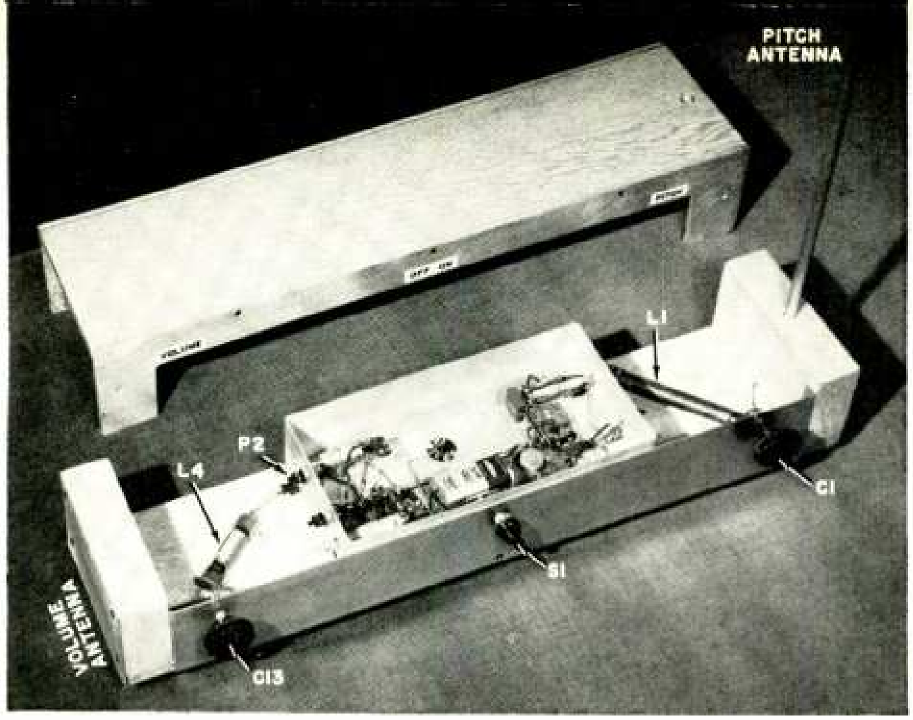
All components, except the antenna circuit components, are mounted on a 5"x 10"x 3" aluminum chassis (*Bud* AC-404) on the middle of the board. The antenna coils L_1 and L_4 are mounted on the board between the chassis and the end blocks, and tuning capacitors C_1 and C_{13} are mounted on a 3"x 22" sheet of aluminum that runs across the entire front of the instrument between the two end blocks. This arrangement minimizes the stray wiring capacitance in the antenna circuits, but provides shielding between the performer's hands and the antennas when he adjusts C_1 or C_{13}.

Other layouts may be employed as long as two requirements are heeded: First, the two antennas must be separated by at least twenty inches, so that the motion of the right hand does not affect the left antenna, and *vice versa*. Second, the antenna capacitances must be kept small. Don't mount the antennas near large pieces of metal. Keep the leads coming from the antennas as short as possible. And, finally, use only wood or other insulating materials for the bottom board and the cover.

The chassis layout is not critical, but it is most convenient to mount the components in the pitch-generator section on the side of the chassis nearest the pitch antenna, and the components in the volume-control section on the side

Looking into the open top of the chassis reveals this simple component layout.





Over-all view of the entire instrument with its wooden cover removed to show layout.

nearest the volume antenna. It is also convenient to mount the output jack on the bottom of the chassis, so that the cord going to the external amplifier can be plugged in through a hole in the plywood board, out of the way of the performer.

Placement of the coils in the chassis is important. The centers of the pitch-oscillator coils should be at least three inches apart, in order not to increase the coupling between the oscillators. Similarly, the volume-oscillator coil should be at least three inches from L. Also, none of the coils should be closer than one-half inch to the sides of the chassis. A suitable layout is shown in one of the photos. Regular lug strips are used to mount most of the components. The use of transisitor sockets, rather than soldering the transistors directly in the circuit, is desirable in the long run.

The layout, as shown in the photographs, is correct for a right-handed person. If you are left-handed, simply reverse the layout so that the pitch-antenna is on the left end of the board. Of course, a left-handed person can play a right-handed instrument, simply by standing behind the instrument instead of in front of it.

Coils

The coils T_1, T_2, and L_1 through L_4 have been specially designed for this instrument and are available direct from the manufacturer. The coils can also be assembled from standard components and materials. The variable coils T_1, T_2, L_2, and L_3 are wound on one-half-inch diameter slug-tuned coil forms. The winding dimensions and material specifications are given in Fig. 2. A partially completed pitch oscillator coil and a completed coil are shown in one of the photos. If the instructions in Fig. 2 are followed carefully, the electrical characteristics of the hand-wound coils will be nearly the same as those of their commercially produced counterparts.

The antenna coils are machine-wound by a special method called "progressive-universal," and cannot be duplicated by hand-winding. However, satisfactory substitutes for the antenna coils may be assembled from standard ferrite-core r.f. chokes. For L_1, connect three 25 mhy. ferrite-core chokes in series, and for L_4, connect two 5 mhy. ferrite-core chokes in series. Because of their low "Q" and high distributed capacitance, air-core or powdered-iron-core chokes cannot be used in place of ferrite-core chokes to make up the antenna coils.

Setting the Coil Slugs

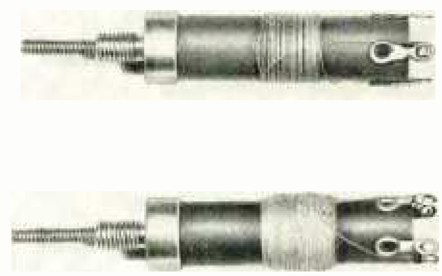
After checking the wiring thoroughly, turn the instrument on and check the voltages at the two points shown in the schematic. If the voltages check, connect an external amplifier to the output jack, and short the junction of R_{11} and C_{12} to ground. If a loud hum is heard when the base terminal of V_1 is touched with the finger, the amplifier stage is working and the pitch adjustments may now be set. Place the Theremin on a microphone stand, and at least two feet from any large objects. Set the slug in T_1 all the way out, and the slug in T_2 half way in. Turn C_1 so that its plates are half meshed. With the junction of R_{11} and C_{12} still shorted to ground, advance the slug in T_1. When the resonant frequency of T_1 approaches that of T_2, a loud, high beat note will be heard, which decreases in pitch as the slug in T_1 is advanced, and disappears entirely when the two pitch oscillators are zero-beating (operating at the same frequency).

If the slug in T_1 is advanced still further, a beat note is again heard. Leave the slug in T_1 at the point where the beat note starts again. Now check the pitch-antenna as follows: Set C_1 so that, when you stand away from the instrument, the oscillators zero-beat, but a beat note is heard as soon as your hand is within eighteen inches of the pitch-antenna.

Now move your hand slowly toward the antenna and listen closely. The pitch of the tone will go up gradually. If at one point it jumps suddenly to a very high note, then the resonant frequencies of T_1 and T_2 are too low. Retract the slug in T_2 a couple of turns and repeat the adjustment procedure. If no jumps in frequency are heard as the hand approaches the pitch antenna, touch the antenna and listen to the pitch of this note. If it is about three octaves above middle C on the piano, then T_1 and T_2 are adjusted correctly.

If the note is much higher than three octaves above middle C, then the resonant frequencies of T_1 and T_2 are too low. Retract the slug in T_2 one turn and repeat the adjustment procedure. Similarly, if the note is much lower than three octaves above middle C, then the resonant frequencies of T_1 and T_2 are too high. Advance the slug in T_2 one turn and repeat the adjustment procedure.

If you don't have a piano, you can whistle a high note and this will be close to three octaves above middle C. By repeating the above procedure a couple of times the correct setting of T_1 and T_2 will be achieved.



If the instructions in Fig. 2 are followed carefully, the coils will look like this. Top view shows just single-layer inside winding of T_1. Completed coil is below.

To set the slugs in L_2 and L_3, remove the short from the junction of R_{11} and C_{12} to ground, and place it from the junction of C_6 and C_7 to ground. Connect a 20,000 ohms-per-volt voltmeter from the junction of R_{11} and C_{12} to ground, retract the slugs in both L_2 and L_3 all the way and set C_{13} so that the plates are about one quarter meshed. The voltmeter should read a couple of volts. Standing away from the volume-antenna, advance the slug in L_2. The meter reading will drop, reach a minimum, then slowly start to climb. Set the slug where the meter reading is at a minimum. At this point, the frequency of oscillation of V is equal to the resonant frequency of the volume-antenna circuit. Next, place your hand on the volume-antenna and advance the slug in L_3. The meter reading will now increase, reach a sharp maximum, then decrease. Set the slug in L_3 where the meter reading is at its highest value (about five volts). This completes the setting of L_2 and L_3.

You are now ready to try your Theremin. Set the instrument on a microphone stand, and at least two feet from walls or large pieces of furniture, and connect it to the amplifier. The Theremin is tuned first by setting the volume

(*Continued on page* 125)

A Versatile Impedance Checker

By **HAROLD REED**

Used with standard test gear, this test box enables quick and accurate measurement of unknown impedances.

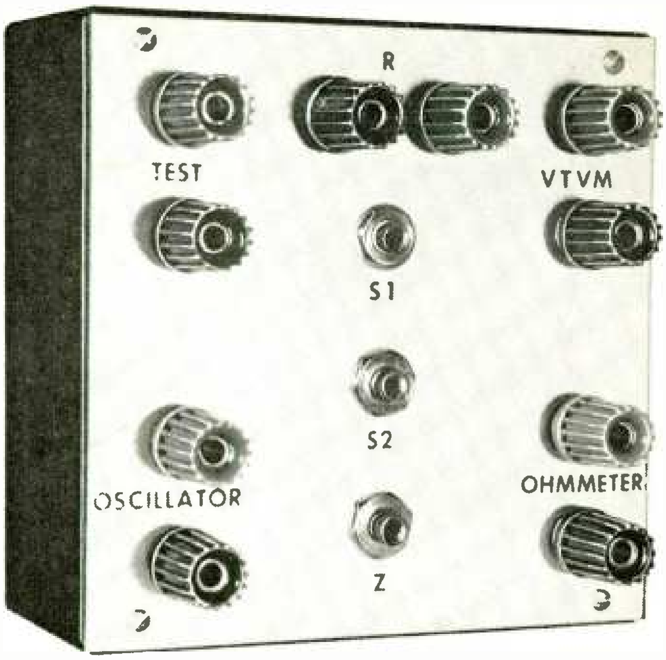


Fig. 1. All connections required for an impedance test set-up are made and switched through this simple device.

EVERY TECHNICIAN, whether he does some kind of servicing or any other kind of work, runs into situations where he should be able to make impedance measurements at various points in electronic equipment. This is particularly true of audio technicians. Cases where knowledge of the impedance is important would include those where modifications or additional equipment or circuits are to be incorporated in a system.

It is true that the specifications for electronic devices generally state input and/or output impedances in ohms. However, these are the impedances for which the devices were designed. That is, the stated input impedance is the source impedance that should be matched to the unit, and the output should work into a load of the stated output impedance. But these figures do not necessarily specify the true input and output impedances of the device itself.

Consider, for example, a line amplifier in an audio network. Filters or equalizers are to be added to this system. For these additions to work properly, the actual impedances at the points where they are to be introduced must be known and the filters must be designed accordingly.

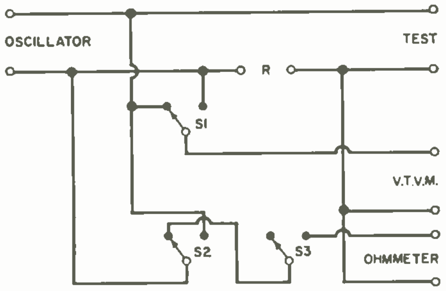
The amplifier is specified as having a 600-ohm output. However, like most quality amplifiers in use today, it has negative feedback around the output stage. This means that the actual impedance looking back into the amplifier can be below 100 ohms. It may also be said that the amplifier has an input of 50 ohms. Yet, to improve gain, the input transformer may be unloaded in such a way, going into the first stage, that the actual impedance seen may be over 1000 ohms.

The test-instrument accessory described here facilitates the measurement of such impedances. Requiring only three push-button switches, ten binding posts, and a small standard cabinet (Figs. 1 and 2), it can be built simply and inexpensively. It is used in conjunction with such conventional equipment as an oscillator, a v.t.v.m., and an ohmmeter.

The cabinet measures 4 x 4 x 2 inches. All binding posts and switches are mounted on the front panel. The binding posts used by the author were of the 5-way type. While these are available from more than one source, the ones used were in the *Lafayette* MS-566 kit, which includes exactly ten posts. They were spaced on ¾-inch mounting centers to accept standard, dual banana test plugs and were insulated from the cabinet by fiber shoulder washers.

The three switches are all single-pole, double-throw units, but momentary, spring-return types are desirable. The ones actually used were push-button switches, *Lafayette* MS-449. They are shown in Fig. 2 in the normal position, when the push-button is not depressed. Since there is nothing critical about parts placement or wiring, the schematic and the front panel, shown in Fig. 1, are sufficient for adequate duplication Designations in both illustrations agree with each other except that S_3 in the schematic has conveniently been identified as Z, for impedance, in Fig. 1.

Fig. 2. Switches and binding posts are chief components in this passive network.

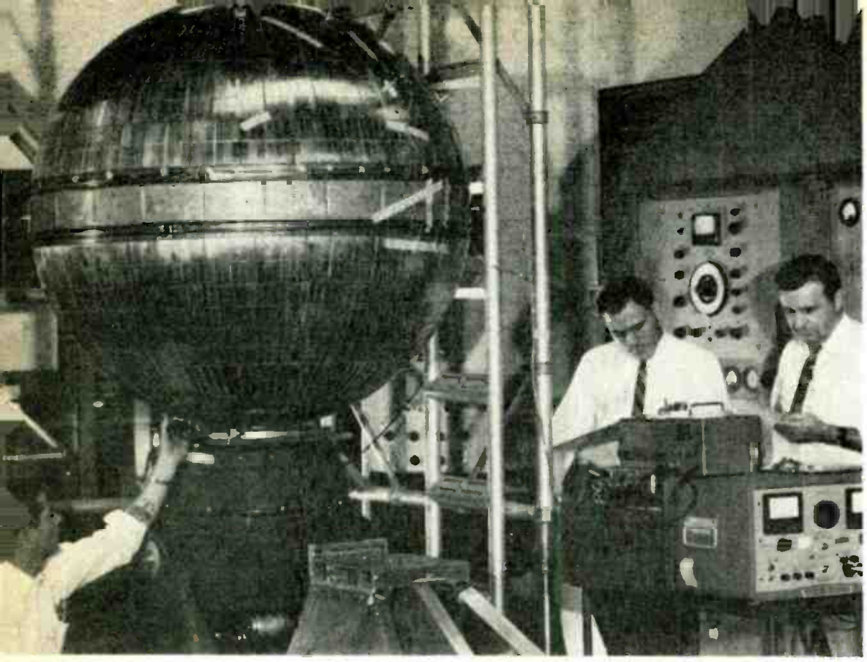


Using the Checker

Although the device may be used in numerous impedance-measuring applications, the constructor will understand its operation sufficiently from an example using an audio amplifier. To measure its output impedance, the output terminals from the amplifier are connected to the "Test" binding posts. An audio v.t.v.m. (or other suitable voltmeter) and an ohmmeter or other resistance-measuring device are connected to the correspondingly labelled binding posts. A variable resistor or potentiometer is connected to the *R* binding posts. Its value will depend on the order of impedance being measured, and should be selected so its value is that of the rated impedance or slightly greater.

Now a generator is connected to the input of the amplifier to provide a signal whose frequency is that at which impedance measurements are ordinarily made on the equipment under test. For an audio amplifier, this can be 1000 cps. Note that no connection is made to the "Oscillator" binding posts of the checker in this test. The generator and/or the amplifier gain control are adjusted to provide a convenient voltage reading on the voltmeter, which is across the amplifier output--say 1 volt. Depress switch S_2, which shunts the resistor across the amplifier output and the meter, and hold it down. Now vary the resistor until the voltage reading drops to half of the initial reading—half a volt here. Release S_2. The resistance across the amplifier output equals actual output impedance. Remove amplifier connections from the test binding posts. Depress S_3 (*Z*) to shunt in the ohmmeter. This will give a direct reading of the desired impedance.

(*Continued on page* 92)

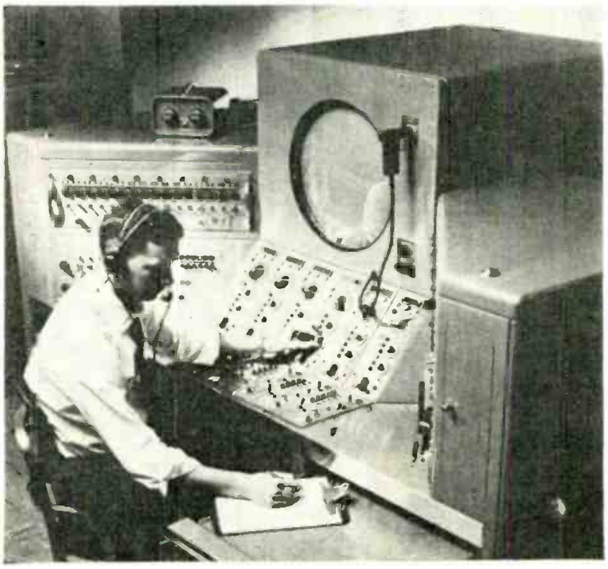


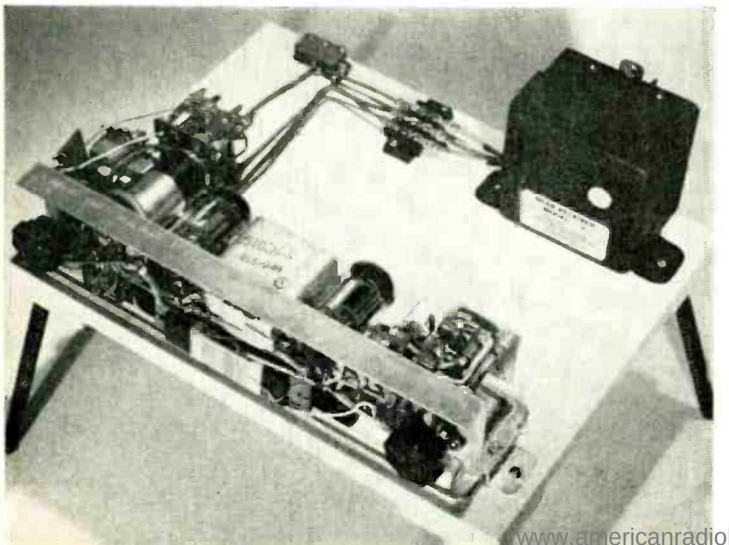
◀ **"Courier" Communications Satellite**
A model of the 500-pound "Courier" satellite, recently orbited by the U.S., is shown here undergoing vibration tests. The purpose of the satellite is to relay messages for communications between ground stations. In operation, it accepts messages from one ground station, stores them, and on command, delivers them to another ground station. The electronics in the *Philco*-built satellite uses but a single vacuum tube along with nearly 1300 transistors and diodes.

Transistorized Police Radio
Newark, N. J. has become the first major city to use a two-way radio system employing transistorized equipment, with inauguration of the police department segment of a hookup that will tie in fire and public works vehicles later. The compact FM communications gear is being installed in city vehicles under a 5-year agreement with *RCA*. ▼

Recent Developments in Electronics

Electronic Air-Traffic Control ▶
A new electronic system, developed for the Air Force by *Avco Corp.*, is undergoing tests for controlling air traffic above busy air terminals. Called "Volscan," the system makes it possible for 120 aircraft to take off and land each hour, or one every 30 seconds. Here an operator at one of the consoles is setting in initial data for an aircraft's approach. Operating under all types of weather conditions, the system employs radar and radio as well as electronic computers—under the supervision of air-traffic controllers—to direct the arrival and departure of aircraft.





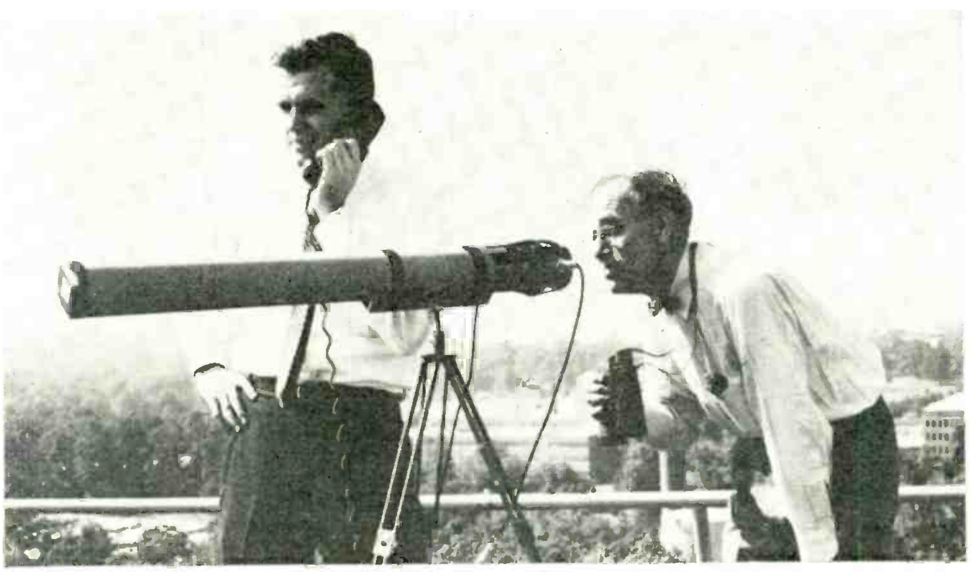
◀ **"Compactron" Defense Radio**
A breadboard hookup of a "Compactron" table radio with a National Emergency Alarm Repeater receiver (right rear corner) is shown here. This setup, recently tested by the Office of Civil and Defense Mobilization, results in the radio being turned on automatically upon receipt of an alarm impulse that signifies a defense or weather alert. Two *G-E* "Compactrons" in the receiver take the place of 5 ordinary tubes.

◀ Microfilm Video Transmission System

A video transmission system that instantly brings drawings on microfilm from a central library to a remote high-resolution TV viewer was demonstrated recently by *Nord Photocopy & Electronics Corp.* The system uses a flying-spot scanner rather than a vidicon camera and lights to generate a video signal that is transmitted *via* cable to the viewer. The operator at the TV viewer is able to scan and enlarge any portion of the film with a magnification of up to 60 times microfilm aperture size.

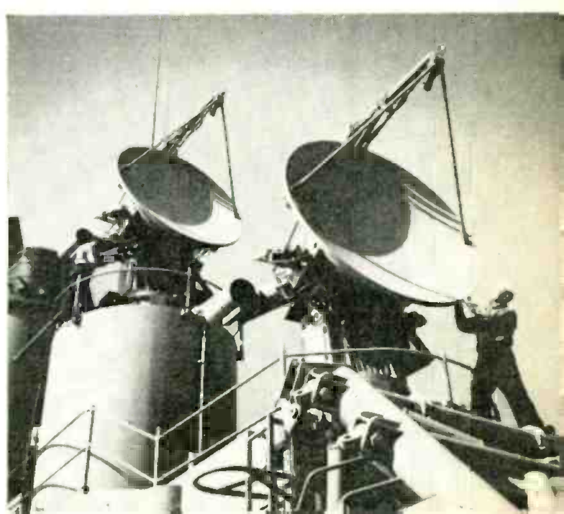
Multi-Polarized Antenna ▶

A new multi-polarized antenna which can do the work of four separate types of antennas in operating with missiles or space vehicles has been developed by the Electronics Division of *Chance Vought.* The highly flexible unit will be used aboard the USNS "Range Tracker," the Pacific Missile Range's first tracking vessel. The single antenna can be used with facilities for tracking, telemetering, or command control of missiles or space vehicles. With its complete polarization coverage, it can perform the functions of four types of antennas—vertically polarized, horizontally polarized, and clockwise and counterclockwise helical antennas. Polarization can be selected either through remote switching or automatically, providing instant response.



◀ Optical Maser

During communication experiment with an optical maser, D. F. Nelson (left) and W. L. Bond, *Bell Telephone Laboratories,* maintain phone contact with experimenters at the *Laboratories'* Holmdel, N. J. location. Light from the maser was flashed from Holmdel to the Murray Hill, N. J. location shown, 25 miles away, where it was received on a phototube. The general principles of optical maser operation were described in our article "The Laser—a Light Amplifier," on page 39 of our September, 1960 issue.



Missile Radars ▶

Fire-control radars for the Navy's new surface-to-air "Tartar" missile are shown on the new guided missile destroyer "Charles F. Adams," commissioned recently in Boston. Developed and produced by *Raytheon* for the Navy, the radars help guide the missile despite enemy evasive tactics or jamming devices. The new radars, called AN/SPG-51, can be used as part of the ship's over-all fire-control system to fire the vessel's conventional guns.

V.H.F. Demonstration Oscillators

By LEWIS G. BLEVINS

Complete details on the construction of some simple v.h.f. oscillators from ordinary beam-power receiving tubes for experiments or for classroom demonstrations.

CASUALLY reading that a 50L6GT beam-power tube makes an excellent oscillator in the very top portion of the v.h.f. band will likely cause you to do a double take, just to see if you've read it correctly the first time. Actually, receiving-type beam-power tubes in the class of the 50L6GT, 50B5, 50C5, etc. will readily develop up to 3 watts output at frequencies as high as 300 mc., while the 6Y6-G, 6V6-G, and 6L6-G will produce considerably larger power outputs up to 200 mc.

In 1938, two independent research teams at the Cruft Laboratory, Harvard University, discovered that beam tubes of all types, 6Y6-G, 6V6-G, 6L6-G, etc. support v.h.f. parasitic oscillations of great intensity when connected in apparently conventional amplifier circuits and operated at rated voltages. In fact, the oscillations persisted under such diverse conditions that it seemed to be a real problem to eliminate them in circuits in which they were not wanted. A study was undertaken by Ronold King (see "Beam Tubes as Ultra-High Frequency Generators," *Journal of Applied Physics*, September, 1939) in order to devise means for preventing the generation of these troublesome very-high-frequency currents and, after a preliminary series of experiments had revealed the rather unusual qualities of beam tubes in sustaining such currents, a more detailed investigation was conducted.

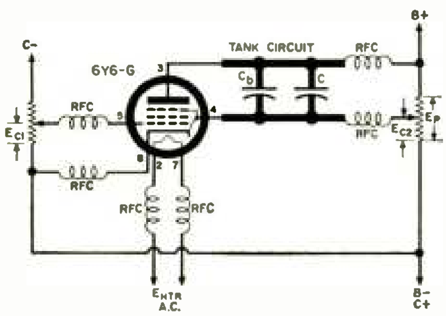


Fig. 1. Basic beam-tube oscillator circuit.

Inspection of the basic beam-tube oscillator circuit of Fig. 1 indicates that it differs from conventional circuitry in that the oscillations occur in the screen-plate circuit, with the control-grid playing no part. Oscillations not only occur with the screen and plate at the same potential, but can be maintained at screen voltages ranging from −40 volts to values well above the plate potential of the 6Y6-G. The tank circuit consists of parallel brass rods connected at one end to the tube's plate and screen terminals, and bridged at the other end by a large blocking capacitor C_b. A second capacitor, C, is used to detune the length of rods extending beyond C_b. All power-supply connections to the control-grid, heater, and tank circuits are isolated by means of adjustable choke coils which are tuned to act as parallel-resonance wavetraps.

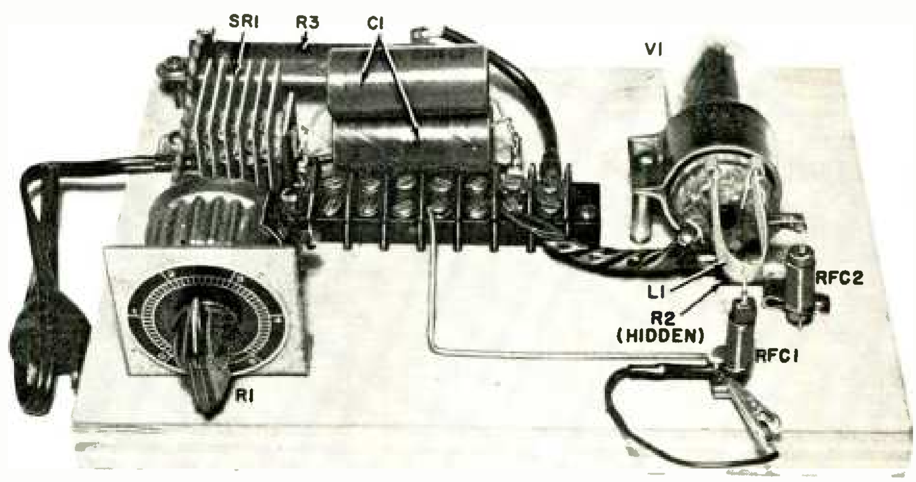
A simplified breadboard version of the beam-tube oscillator is shown in Fig. 2 while the schematic is given in Fig. 3. This unit was developed for use in the classroom to demonstrate standing waves. The very-high-frequency output of the oscillator is inductively coupled to a parallel wire (Lecher) line. Standing waves are set up on the line wires and a simple neon-lamp detector is moved along the line to locate two voltage maximums, which are a half-wavelength apart. If we let d = length of a half-wavelength in inches, the frequency of the beam oscillator's output is found by means of the simple formula: *Frequency* (megacycles) = $5905/d$.

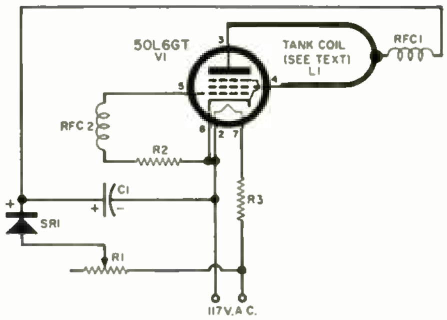
Construction

The components for the beam-tube oscillator and power supply are mounted on a plywood baseboard, as shown in Fig. 2. Since the 450-ohm voltage dropping resistor for the heater of the 50L6GT tube produces considerable heat, it is kept away from the other components by mounting it on the left, rear corner of the baseboard on one-half-inch stand-offs. The rheostat shown in the front, left end of the baseboard is a 500-ohm, 25-watt wirewound unit which is used as a d.c. voltage control. This unit was from the junk box and it has been found that a 250-ohm, 5-watt wirewound fixed resistor can be substituted without any sacrifice in performance.

A barrier terminal strip (also from the junk box) provides a convenient means of supporting the 150-ma. sele-

Fig. 2. Breadboard model of one of the demonstration units built by the author.





R_1—500 ohm, 25 w. wirewound rheostat or 250 ohm, 5 w. wirewound fixed res. (see text)
R_2—33,000 ohm, 1 w. res.
R_3—150 ohm, 25 w. wirewound res.
C_1—80 µf., 150 v. elec. capacitor (two 40 µf. in parallel)
RFC_1, RFC_2—See text
L_1—Tank coil (see text)
SR_1—150 ma., 130 v. selenium rectifier
V_1—50L6GT tube

Fig. 3. Circuit of simplified oscillator.

nium rectifier and the pair of 40-µf., 150-volt electrolytic capacitors which are connected in parallel to give 80 µf. for filtering the output of the half-wave rectifier, as shown in the schematic diagram, Fig. 3.

To secure the highest possible output frequency from any beam tube used in this circuit, connections should be made direct to the tube pins and the tank circuit formed by soldering a heavy jumper wire directly across the tips of the pins connecting the tube's screen and plate. See Fig. 4. (Modifying the tube by removing the base and making connections direct to the leads will, of course, result in a slightly higher frequency.) To permit changing the tank circuit without the necessity for soldering connections each time, the author settled for the next best arrangement in the form of a low-loss octal socket made of polystyrene. The metal mounting strap is removed from the socket and miniature Fahnestock clips soldered to the screen, plate, and control-grid lugs as close to the body of the socket as possible. The metal lugs are removed from holes No. 1 and No. 6 of the socket and all protruding ends of the lugs cut off beyond the soldered connections.

The 50L6GT tube is supported horizontally above the baseboard by a Lucite clamp around its base and a stand-off. A ¾-inch wide, ¹⁄₁₆-inch thick strip of Lucite is heated and bent around the base of the tube to form a clamp, as shown in Fig. 2. The flattened edges of the clamp are drilled for a 6-32 machine screw, which holds it and the tube to the top of a ¼-inch diameter, 1-inch-long aluminum stand-off, tapped in both ends for a 6-32 screw. The stand-off is held to the baseboard with a 6-32 machine screw.

Directly beneath the Fahnestock clip soldered to tube socket terminal No. 5, the control-grid connection, is another Fahnestock clip screwed to the baseboard. One end of the 33,000-ohm grid-bias resistor is connected to this clip by forming a loop in one of the lead wires and clamping it under the head of the wood screw holding the clip to the baseboard. The other end of this resistor is soldered to terminal lugs No. 8 and No. 2 of the octal socket, which are also wired to the d.c. power supply's negative and the common heater load of the 50L6GT tube. These clips provide an easy means of changing r.f. chokes in the control-grid of the tube, which must be changed to match each new tank circuit.

A second Fahnestock clip is screwed to the baseboard near the front edge, directly in line with the tube, and wired to the positive terminal of the d.c. supply. A short length of insulated hook-up wire, terminated in a miniature alligator clip, is connected to this Fahnestock clip for convenience in changing the r.f. choke that connects between the positive terminal of the d.c. supply and the tank circuit. Both of the r.f. chokes used in this oscillator circuit must be matched to the frequency of the particular tank circuit in use.

Operation

A simple tank circuit for use in checking out the beam-tube oscillator is shown in Fig. 5A. No r.f. chokes are required with this simple tank coil, which consists of 6 turns of #14 plastic-insulated solid copper wire (the kind that is used for inside house wiring) wound side-by-side on a 3-inch diameter form. Slide the coil off the form, bunch the turns snugly together, and tape tightly at three points as shown. Bend the lead

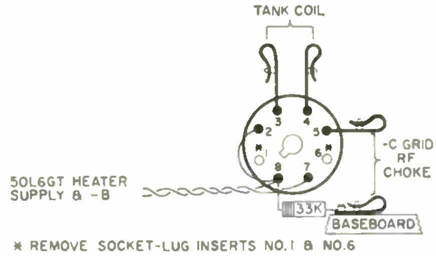


Fig. 4. Bottom view of octal-socket wiring.

wires at right angles to the coil and strip the ends for connection to the Fahnestock clips of the 50L6GT tube's screen and plate. Remove about ⅛-inch of the plastic insulation from the coil winding at the mid-point for a tap. The exact location is not critical, an inch or two in either direction from true center will suffice.

To test the oscillator, the miniature alligator clip from the positive side of the d.c. power supply is connected directly to the tap on the coil, omitting the usual r.f. choke. A short length of bare wire, connected between the Fahnestock clips in the tube's control grid, replaces the r.f. choke normally required at that point.

A simple r.f. output indicator, consisting of a single 3-inch diameter turn of the same type wire used for the tank coil, with the ends connected to the terminals of a miniature 6-volt lamp, is shown in Fig. 5B. With the voltage control rheostat set to its mid-point, a value of 250 ohms, the r.f. output of the beam-tube oscillator is sufficient to light the 6-volt lamp to full brilliance when its single turn loop is brought to within a half inch of the tank coil. The output frequency of the oscillator, using this tank coil, will be approximately 25 mc.

When using this unit for demonstration, be sure to be careful of the exposed a.c. and d.c. voltages that exist.

Tank Coil & R.F. Choke Data

A tank coil suitable for 6-mc. consists of 8 turns of #14 plastic-insulated, solid copper wire, of the same type as used for the test coil, wound on a 6-inch diameter form. The turns are bunched, taped, and center-tapped in the same fashion as the test coil. The r.f. choke may be omitted from the tank circuit and the positive lead from the d.c. supply connected directly to the coil's center-tap. An r.f. choke must be used in the oscillator's control-grid circuit, but its value does not seem at all critical. An extensive collection of video peaking coils in the author's junk box performed properly in the circuit.

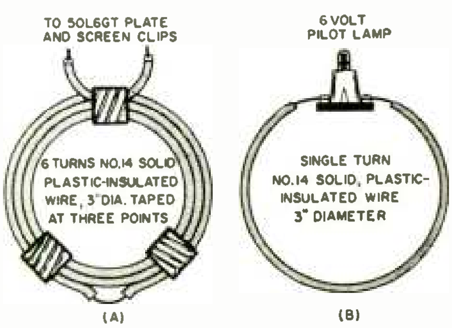
The 75-mc. tank coil consists of 11 turns of #12 solid copper wire close-wound on a ¼-inch diameter form, which is then removed. The r.f. choke coils for use with this tank coil each consists of 57 turns of #36 s.s.c. wire wound in a single layer on a ¹³⁄₃₂-inch diameter form, occupying a length of ¾ inch. A molded composition resistor having a resistance of 1 megohm or more, is used as the choke form. The r.f. choke supplying positive d.c. to the tank may be connected to either the plate or screen end of the coil, or tapped-in at some point on the coil.

The tank for 200 mc. consists of a strip of copper, ¼-inch wide, bent in the form of a "U" that is 1¾ inches long, with the sides spaced ½ inch apart. The matching r.f. chokes are wound on ⁷⁄₃₂-inch diameter, ½-inch long molded composition resistors having a resistance of 1 megohm or over, with 5 turns of #28 enamel wire. (Fig. 2 shows this unit.)

Circuit Refinements

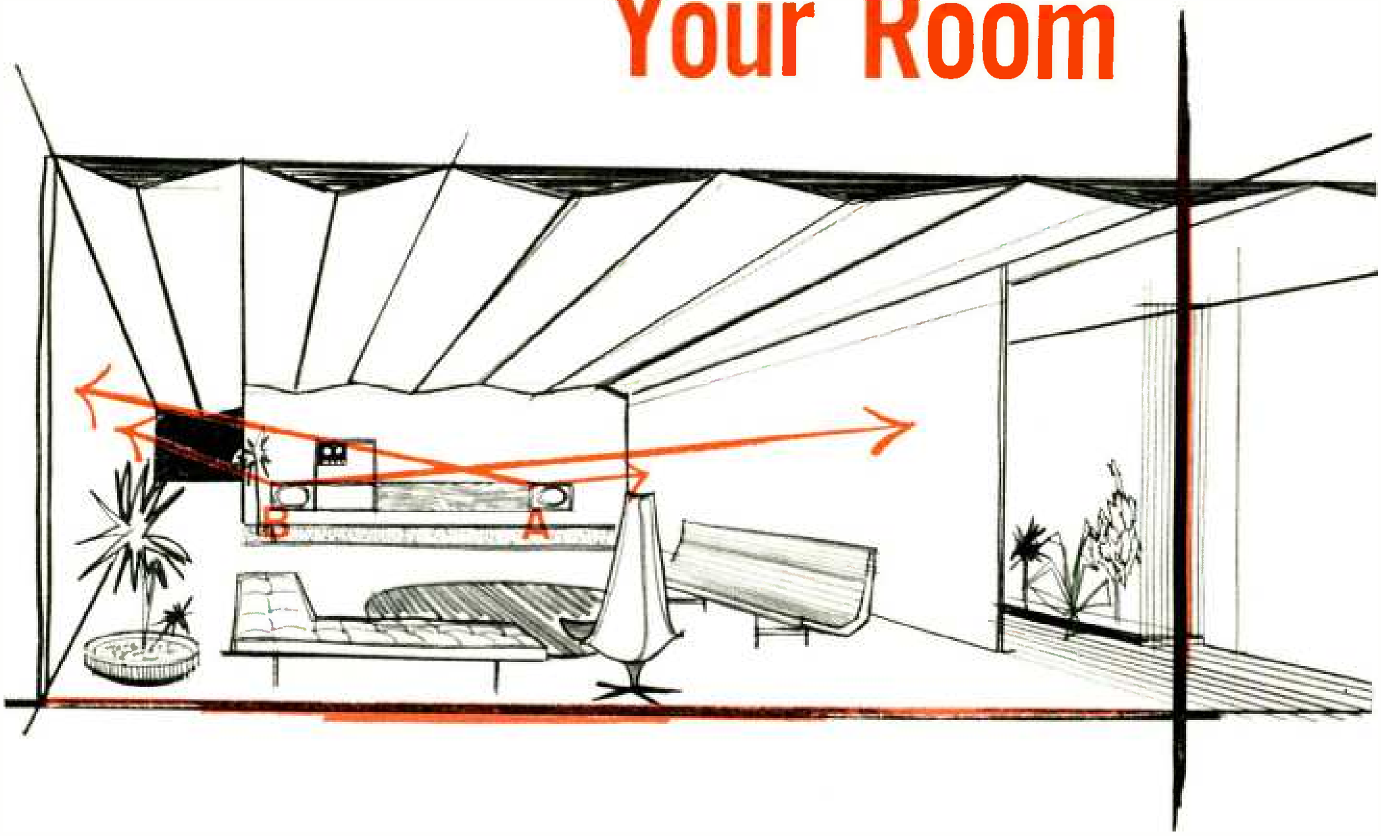
The over-all performance of the beam-tube oscillator operating at the higher frequencies can be greatly improved by incorporating a third r.f. choke in the tube's cathode lead at the socket. Further improvement may be secured by inserting additional r.f. chokes in the heater leads of the tube at the socket, and removing the jumper connection tying the cathode to one side of the heater. Since the performance of the oscillator has proven entirely satisfactory for demonstration purposes, these additional improvements have been omitted for simplicity. —30—

Fig. 5. (A) Twenty-five megacycle tank coil for oscillator check. (B) Output indicator.



Tailor Your Loudspeaker To Your Room

By GEORGE L. AUGSPURGER



How to get the most out of your loudspeaker system in a particular listening room by use of equalizing circuits.

EVERYBODY agrees that a loudspeaker must be considered as part of the room in which it is placed. But as soon as you ask the question, "What should I do to make a loudspeaker system sound best in *my* listening room?", the area of agreement vanishes.

Some experts recommend lots of overstuffed furniture and drapes to make a small room "acoustical." Others advise the use of mirrors and glass-covered pictures hung on the walls. One group has resolved the problem with a single formula: big room—big speaker, little room—little speaker. (Unfortunately, it doesn't always work out this way.) One successful dealer gets rid of the whole difficulty by telling his customers that in a stereo system room acoustics don't matter very much any more.

Obviously, these conflicting theories are more confusing than helpful. But the situation isn't really so complex if we look at it logically.

There are two things to consider: the characteristics of the loudspeaker system and the acoustics of the room. It is the interaction of these *plus* the personal listening preferences of the audiophile which determine how well the system sounds.

Room Acoustics

Contrary to what many people have been told, lots of overstuffed furniture and drapes will not make a small room sound like a concert hall.

Certainly, a reasonable amount of absorption is required. Some of today's modern houses have rooms built entirely of glass and concrete. These make wonderful echo chambers, but you can't carry on an understandable conversation, much less listen to the Pittsburgh Symphony.

Even if the total absorption in a room is within acceptable limits, it must be well distributed. Large parallel hard surfaces (picture windows facing a plaster wall, or uncarpeted floors and hard ceilings, for example) can generate a peculiar flutter as the sound bounces back and forth.

The absorption of sound by carpets, drapes, and furniture affects high frequencies primarily. However, the natural rate at which walls and ceilings flex can absorb substantial acoustic energy in the bass range. But absorption by diaphragm action usually does not affect a wide band of frequencies—it will introduce one or two "holes" at frequencies where the walls tend to become acoustically transparent.

Fortunately, such absorption bands are usually not serious enough to noticeably deteriorate the acoustical qualities of a room. But they may give rise to objectionable interference in the adjoining apartment. Sometimes a different location for the loudspeaker system will let you make more noise (if you like your music loud) without antagonizing the neighbors. If this doesn't work, about the only thing that can be done is to turn down the volume control.

There is still a third acoustic phenomenon which is extremely influential in determining the sound of your hi-fi system.

Suppose we have a room 20 feet long with a loudspeaker system at one end. Over most of the audio range, sound scatters around the room fairly evenly; it is reflected and re-reflected from various surfaces until it is finally absorbed completely. As long as uniform distribution is maintained, the reverberation time of the room is its primary acoustic characteristic. But at about 55 cps the room is a wavelength long, and the wavefront bounces merrily back and forth, from one end of the room to the other, being given a little bump by the loudspeaker cone at exactly the right moment every 1/55th of a second.

Things become even more interesting if we take into account the height and width of the room as well as its length. Standing waves are set up between the various room surfaces, and if one dimension is an even multiple of another, we are in for real trouble. If, for example, our 20-foot room is 10 feet wide and 9 feet high it approaches the shape of two cubes placed together. All three room dimensions combine to set up standing waves at about 55 and 110 cps.

These standing waves naturally introduce discouraging peaks and dips in the response of the system. Not only that, but since stationary patterns of sound pressure are set up, the response of the system changes abruptly, not only with frequency, but depending on the location of the loudspeaker and the listener.

Example: "Why is it that when I play the Popular Psychiatrics Test Record on my Minigon, I don't hear the 40-cycle tone? My old car radio speaker made a nice solid buzz at 40 cycles."

"Well, it doesn't buzz because it doesn't distort. And the reason you don't hear anything is because you are sitting in a pressure node."

"I beg your pardon."

"Let me demonstrate. Move over there into the corner of the room. Now let me put on the 40-cycle tone."

(The eyes light up, the mouth drops open, and the whole face takes on an expression of amazed rapture which simply cannot be appreciated by the outsider.)

Perhaps the factors involved can be made clearer with a more detailed example. Consider the following case.

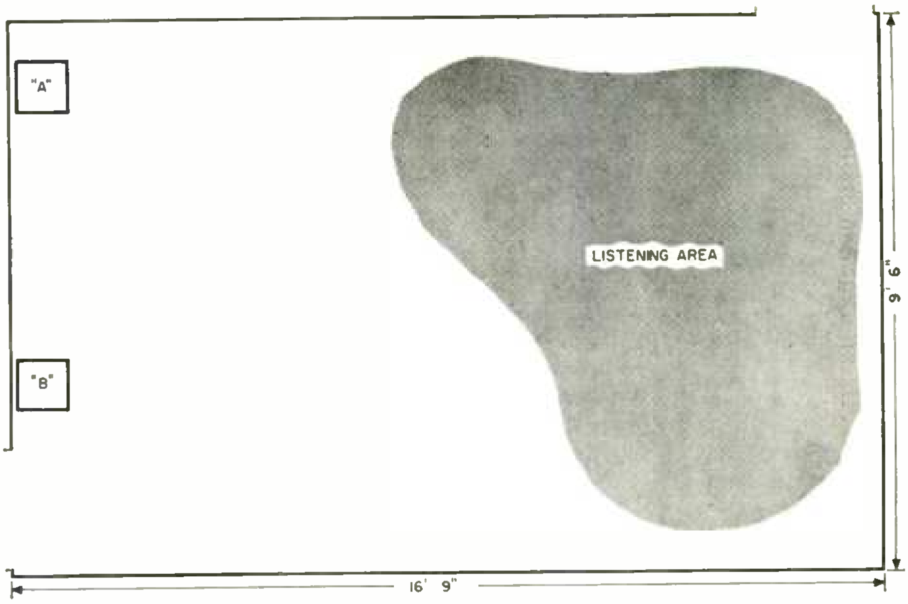


Fig. 1. Author's listening room with two speaker systems located at "A" and "B".

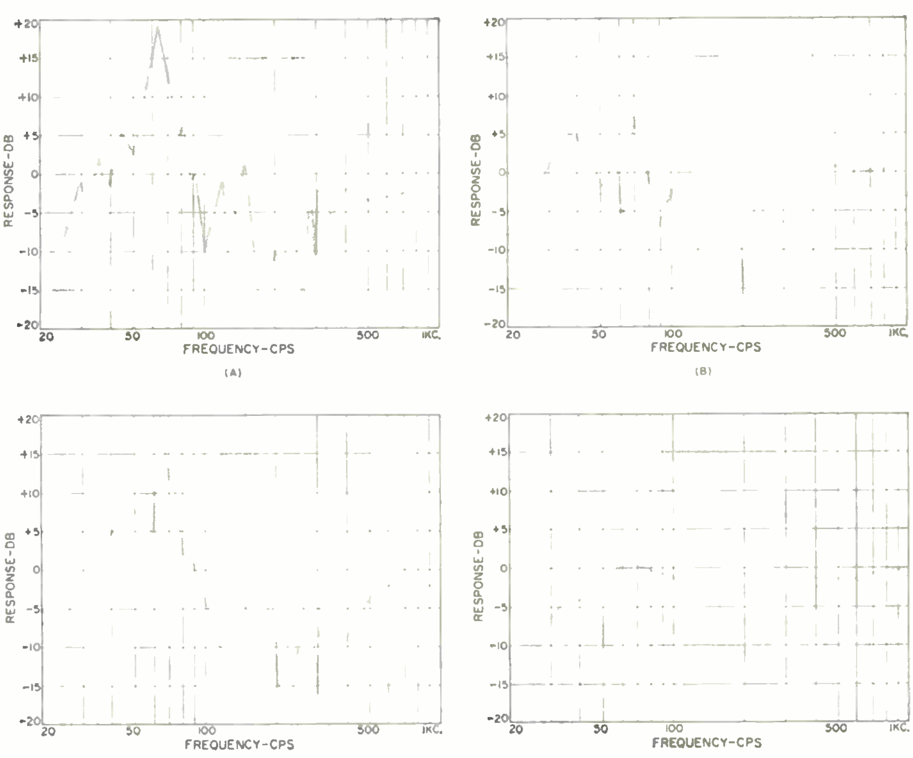
Case History

Fig. 1 shows the living room of the author's apartment. The ceiling is about 8 feet high, so the room approaches the double-cube configuration which was just used as a horrible example. The present loudspeaker installation consists of two small identical systems hung on the wall near floor level at locations "A" and "B." Eventually these will be used in stereo—right now they are paralleled and connected to a single 60-watt amplifier.

Despite the fact that high-quality speakers were used, the system sounded bass-heavy and boomy. A sweep through the low-frequency range with a sine-wave oscillator triggered a strong resonance at about 65 cps. At this frequency the whole room quivered and a heavy crystal ashtray started creeping toward the edge of the table. And there I was, face to face with a standing wave. If I had taken the trouble to measure the living room before moving into the apartment, I could have predicted its unhappy acoustic qualities.

The best thing to do seemed to be to nail down the problem with more detailed information. So, a good microphone and a v.t.v.m. were borrowed, and some curves were plotted. (If you should decide to try this, make sure you get a sensitive meter with an accurate decibel

Fig. 2. Performance of loudspeaker system at location "A" (A), at location "B" (B). Performance of speaker systems at "A" and "B" connected in parallel is shown at (C). The performance of a single loudspeaker system in free space is illustrated at (D).



scale. Also, be sure to use a high-quality condenser or dynamic microphone. If you try to use a ribbon microphone, your curves will be inside-out in the region where standing waves occur.)

It was found that below 300 cps or so, the trick is to measure individual peaks and dips, plotting these points on 4-cycle, semi-logarithmic graph paper. But in the mid- and high-frequency region, the peaks and dips are so close together that it is impossible to chart them all. Instead, you have to take a half-octave at a time, sweeping back and forth in this band, and estimating the average position of the meter pointer.

The procedure is entertaining and it is easy to get carried away. However, readings below 30 and above 5000 cps should be disregarded. Unless fantastically expensive equipment and an individually calibrated microphone are used, such measurements are worthless.

Using this technique, separate curves were drawn for the two loudspeakers. Fig. 2A is a representative curve of speaker "A," and Fig. 2B shows the response of loudspeaker "B." To those who are used to measuring speakers, the picket fence aspect of these curves comes as no surprise. However, there are two things which deserve comment:

(1) In loudspeaker "A," the peak at 65 cps is clearly audible and extremely annoying. We would expect this from a look at the curve even if we had never heard the system. We would also expect the broad depression around 200 cps to be audible too. This is an instance where the microphone doesn't agree with the ear—it isn't audible.

(2) Clearly, if a single monophonic system is used in this room, the corner is *not* the best location. Not only is the

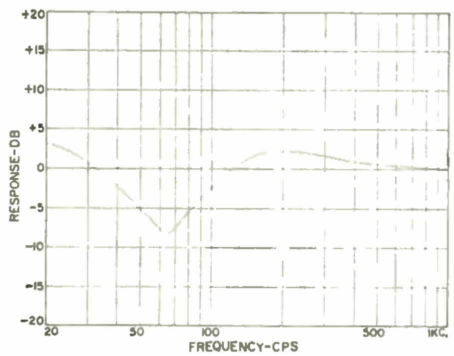


Fig. 3. Response of equalization circuit.

bass response of "B" smoother than that of "A" but its performance in the 30-50 cps range is actually stronger. This is exactly the opposite of what we would expect. It demonstrates the value of experimenting with loudspeaker position . . . a distance of only five feet makes the difference between the results of Figs. 2A and 2B.

After measuring the loudspeakers individually, the next step was to connect them in parallel and check the response of the whole system. The author has explained in previous articles that one of the advantages of separated loudspeaker systems is the tendency to average out peaks and dips caused by room acoustics. Therefore, the performance of "A" and "B" together should be better than either one alone.

Well, nobody is right all the time. Fig. 2C shows the performance of the two speakers in parallel. This is obviously worse than either unit by itself. And because of the law of I.C.I.O. ("The Innate Cussedness of Inanimate Objects"), it sounds as bad as it looks. That is, the 65-cps peak is just as pronounced as you'd expect. However, the spatial quality and improved reflected/direct-sound ratio makes the over-all performance of the two parallel systems much more lifelike than either one alone. The problem was to keep this physical arrangement but get rid of the 65-cycle boom.

Since all three curves show a general rise around 60 cps, and a depression around 200 cps, you might suspect that the problem was a function of the loudspeakers themselves. I did, so I managed to steal a free-field curve of the 10-inch woofer as run by the manufacturer. This is shown in Fig. 2D. "Well," I thought, "there is a *little* bump around 60 cycles. Maybe this is one of these curves that has been forcibly smoothed for publication."

So I went to a lot of trouble to run some free-field curves myself. The results were almost identical with the curve of Fig. 2D. No matter how carefully I tried to find the peaks and dips, the loudspeakers refused to vary their output more than approximately ±3 db from a frequency of 35 to 1000 cps.

Well, since the loudspeakers were good (remarkably good really) and placement was not to be changed, how about changing the listening location? The chair which had been used as the "ideal" listening point was moved two feet and the curve of Fig. 4 was obtained. This was better, but additional equalization was required.

Notice that if the loudspeakers were *not* flat things might be considerably easier. A speaker system having a hole at 60 cycles and a little bump around 120 cycles could be used. It would probably sound very good without any electronic equalization at all. Such a speaker wouldn't be too difficult to find, but since I wanted to use the units I already had, equalization seemed to be the best solution.

The dotted line in Fig. 4 gives a fairly good indication of what the system sounds like in operation. It was drawn by connecting mid-points of the ups and downs of the curve that was measured.

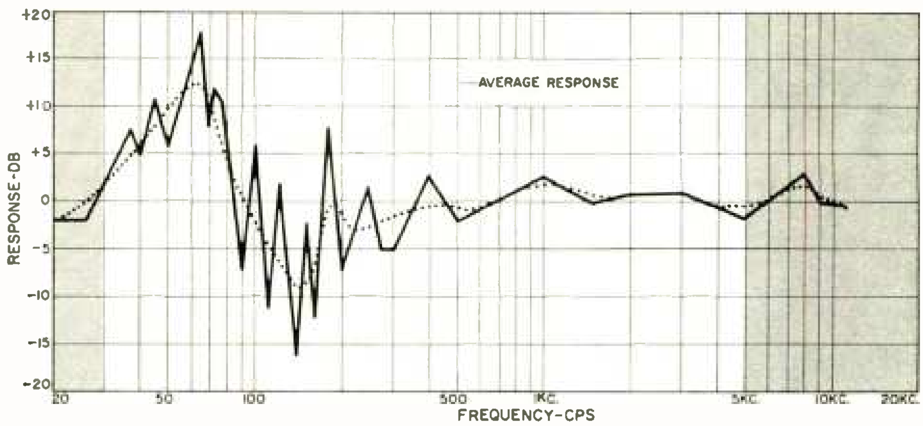


Fig. 4. Performance of two speaker systems in parallel measured at final listening location. Dotted line indicates average response. Shaded areas can be considered reasonably accurate because a laboratory capacitor microphone was used for the tests.

Fig. 3 is the equalization added to the amplifier and Fig. 5 is the averaged response of the equalized system. The bump around 65 cps has been squashed down until it is only about 6 db above mean intensity. I couldn't resist raising the depression around 200 cps to make the curve look nicer even though this refinement doesn't make any audible improvement.

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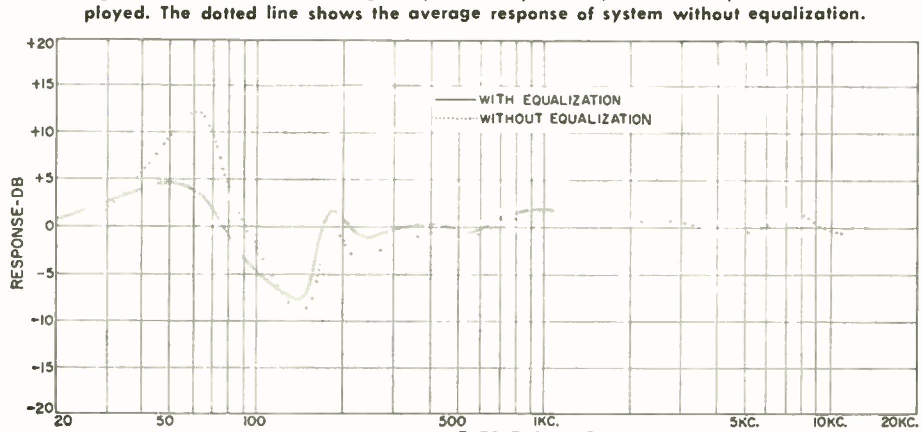
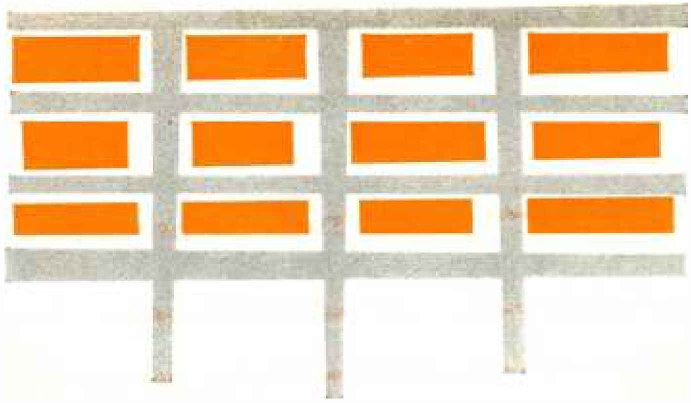
Fig. 5. Solid line shows average response of speaker system with equalization employed. The dotted line shows the average response of system without equalization.





PACKAGED-CIRCUIT SERVICE PROBLEMS

By H. R. HOLTZ

Unitized multi-component networks present some special service problems. How to find and fix faults.

A MANIA for using single physical elements that include the various components of certain networks seems to have our TV and radio designers in its grip, and not without reason. These integrated combinations are sprouting up all over the chassis of newer-model sets today.

These elements are of various types. In the beginning, they were simply called "printed circuits." In these, instead of using conventional components, resistors and capacitors were literally printed on small, ceramic wafers and kiln-fired inside an insulating sheath, with connecting leads protruding. To avoid confusion with other uses of the term today, these plates or packaged units are no longer called printed circuits. The most common early examples were standardized vertical-integrating networks.

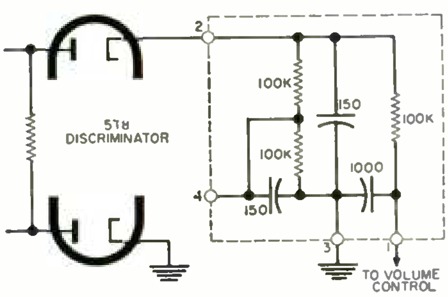


Fig. 1. This FM discriminator output network is used in Philco chassis 7H22.

The newer combinations are a bit different. They will have more depth than the wafers. Standard capacitors, resistors, and possibly other components are mounted on small boards (on the order of 1 x 2 or 2 x 2 inches) and the finished assemblies or modules are dipped in some sealant compound. As is the case with the earlier type, internal connections are sealed in and inaccessible, but external connections are brought out as pigtails. Usually these leads will go through orifices on an etched-circuit chassis board and be soldered to the wiring printed on the latter.

At best, it is quite difficult to "see" the circuit from visual inspection of the physical equipment; it is almost always necessary to examine the schematic drawing of the receiver. Since measurements can be made only at the external connections to the module or package, where individual components are not always accessible, precise understanding of the circuit operation is essential if efficient repair is to be achieved.

Such cut-and-try methods as checking components by substitution have obvious limitations. Even substitution of an entire assembly is not simple, because maintaining a stock of all possible combinations already in use may be wasteful and may also be futile, since new types are constantly being added.

However, this does not mean that you can only take a number of measurements and then go into a trance until you arrive at the correct answer by a series of brilliant deductions. We have heard of fabled geniuses who can do this, but the average service technician has learned that he must get most of his answers the hard way.

The most practical approach to checking a package or module seems to be offered by some form of the signal-tracing technique, with or without signal injection. The value of this approach lies in the fact that it can localize a trouble to a given area, between two specific points in a circuit, although it may not point directly at the defective component. With these multiple-component networks, it is possible to establish at least two such points, which may be considered an input end and an output end. Thus signal tracing can establish whether a defect is indeed inside the compact assembly or not, and we know whether or not a replacement must be ordered.

There are usually other means of checking that can then be used to provide verification of the diagnosis. For example, consider the portion of an FM discriminator circuit used in certain *Philco* receivers, shown in Fig. 1. The voltage-divider and filter network in the discriminator output, appearing within the broken-line box, is sealed in a single unit. In an actual case of weak audio output, an oscilloscope showed ample signal present at the cathode of the 5T8 that connects to terminal 2, which is the input end of the network. Touching terminal 1, the output end, produced a loud hum in the set's speaker. There was no hesitation in branding the assembly as defective.

Nevertheless, as a further check, a 100,000-ohm resistor was bridged across terminals 1 and 2. The audio came in loud and clear. Using various combinations of terminals and checking with an ohmmeter or with injected signals, other components could be checked. Leakage in the upper 150-$\mu\mu$f. capacitor

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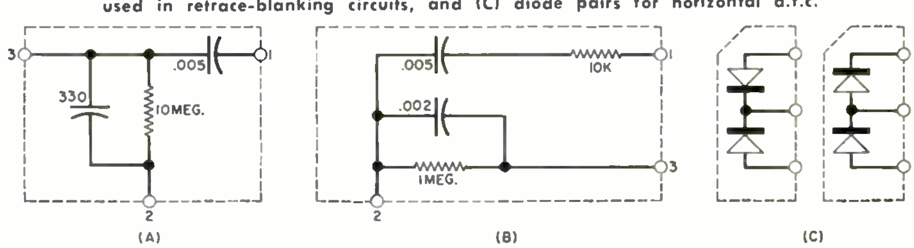
Fig. 2. Other unitized groupings: (A) audio-coupling network, (B) a network used in retrace-blanking circuits, and (C) diode pairs for horizontal a.f.c.



TV performance losses as sets age, gradual and cumulative, are seldom due to single defects. How to restore old life.

Where Did the Gain Go?

By

KENNETH BRAMHAM

REMEMBER the new TV receiver of four or five years ago? At that time, when the set was brand new all the available channels were received, including the "hard-to-get" channel in the neighboring city. Now, after a few years of service, only the stronger stations are seen at all and only those in the low band (channels 2 to 6) are usable.

This loss of gain is often so gradual a process that it may not be noticed by the viewer until repairs are made on some other part of the circuit or until comparison is made with another set. On the other hand, gain may be lost due to a component failure and will be immediately noticed by the viewer. This second case of a sudden catastrophic failure presents a relatively simple problem to the service technician. It is the gradual deterioration and its correction which provides something of a challenge.

The cause of reduced gain may be found almost anywhere in the receiver circuit from the antenna to the viewing screen. Gradual deterioration of the antenna connections and lead-in wire will give a weak and snowy picture; poor amplification in the r.f., i.f., or video-output stages will show on the screen as a weak picture; and most simple of all, yet often not immediately obvious, a dirty screen will result in reduced contrast and brightness. These and other parts of the system where lost gain is likely to be found are shown in Fig. 1.

Tube Faults Not Obvious

Poor amplification in the receiver is most likely to be caused by tube deterioration. Gradual loss of emission by the tubes will result in reduced gain that is not likely to be restored by the replacement of any single tube. A sensitive tube checker will accurately indicate the condition of each tube and permit the service technician to decide intelligently which tubes must be replaced to restore the receiver to its original performance.

While tube testing is a simple procedure, the technician's familiarity with his tube checker can make the difference between a fast, effective service job and a tedious series of tube substitutions. A dual tube, for example, may read "Good" in a particular checker when, in reality, one half of the tube is weak and the other half is very good. In the testing circuit, the two parts of the tube may average out, but this will not be the case under load conditions in the receiver. A dual tube in this condition, for example, if used as a mixer-oscillator in a TV tuner, may give adequate oscillator output on the low channels, none on the high channels, and inadequate amplification in the mixer stage when the oscillator is working.

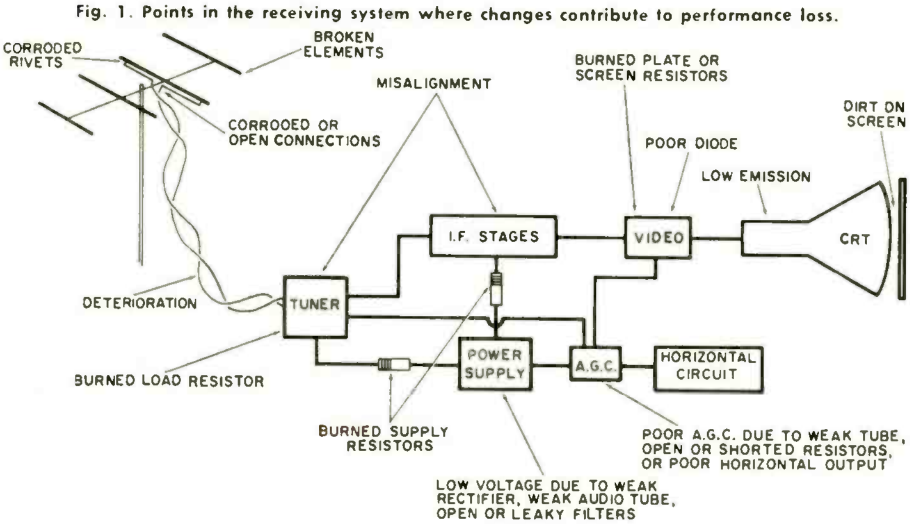
Shorted or gassy tubes must be found if the set is to be restored to full gain. This is far more important than determining if a tube is "weak." The "weak" tube may be quite good for the job it is to do in the set, when it is run under correct bias conditions. A "short test" is provided in all useful tube testers, and serves not only to reject shorted or gassy tubes, but also to protect the instrument itself from damage. To give this protection the short test should be applied before going on to emission or conductance testing.

Cascode r.f. amplifier circuits are perhaps the largest single source of tube failure in sets used under poor signal conditions. If little or no a.g.c. voltage is available, the cascode amplifier tube will draw far more current than it can reasonably be expected to handle, and the resulting failure must be expected. The maximum cathode current rating for a 6BQ7, for instance, is 20 milliamperes. If no bias voltage is applied to the grid, due to a lack of a.g.c. voltage resulting from a weak signal and with the normal 125 volts on the plates, the cathode current will be in the region of 30 ma.—50% over the rated maximum.

Similar conditions prevail in the i.f. stages but to a less serious degree. Cathode biasing of these pentodes by resistors insures some negative grid bias at all times. However, under certain conditions of low a.g.c. voltage, cathode and plate current can become excessive.

Lack of a.g.c. voltage is not always caused directly by poor signal conditions. Reduced gain in the r.f. and i.f. stages results in less signal voltage being applied to the detector and a.g.c.

Fig. 1. Points in the receiving system where changes contribute to performance loss.



circuit which, in turn, develops less than normal a.g.c. voltage for a given signal strength at the antenna. Thus we have a chain reaction where loss of gain creates a low a.g.c. condition which, in turn, produces tube deterioration, due to lack of bias voltage, causing a further reduction in gain.

This low-gain/low-a.g.c.-voltage spiral can be extended to include the antenna as a likely starting point. A new TV set may be equipped with a new antenna, but deterioration of both antenna and set starts immediately upon installation. As antenna connections corrode, elements possibly break off, and lead-in wires become damaged, so the antenna gain is reduced, placing an unnecessary load on the receiver. Because this condition will remain after the receiver gain is restored, it is always a good idea to make a simple ohmmeter check for faulty antenna conditions when servicing for lost gain. If the ohmmeter shows a resistance of more than a few ohms across the lead-in wires to a folded dipole, when they are disconnected from the set, an antenna system overhaul is indicated.

The primary task of the technician when servicing a TV receiver should always be to restore the receiver to its original condition. Replacement of a tube with a new duplicate will only do this if the tube being replaced is of the correct type. Often a substitute may have been installed in the past, for one reason or another, which may cause reduced gain or mis-alignment. It is therefore essential that all replacement tubes should be checked against the original schematic or tube-layout diagram to make sure that the new tubes are identical or otherwise acceptable types (such as improved versions) of the original manufacturer's types.

Developments in tube design have made available improved tube types which are interchangeable with older ones to provide increases in gain or reliability. The 6BS8, for example, may be used to replace the older 6BZ7 r.f. amplifier and should generally provide an increase of about 3 db in gain and a decrease of about 1 db in noise level—a total improvement of 4 db. It is, however, advisable to re-align the r.f. stage when installing this new tube type. This may give a further improvement of as much as 2 db. In the i.f. stages it is also possible to use improved tube types, but their use is often dependent upon correct re-alignment and may even require circuit changes beyond the limits of normal service.

Bad-Tube Chain Reactions

Poor gain caused by defective tubes will not always be corrected by tube replacement alone. Often a defective tube will cause some other component to fail, and the latter must be replaced if full gain is to be restored. The most frequent failure of this kind occurs when a tube develops a shorted or gassy condition and, by drawing excessive current, overloads various resistors in series with the tube. The overloading and resultant overheating varies in effect from a slight change in value of one resistor to the complete burn-out of a whole string of them extending back to the power supply.

The r.f.-circuit dropping resistors in cascode tuners (R_1 and R_2 in Fig. 2A) are possibly the most frequently affected components in this category. In this case the failure will show up, after a shorted tube has been found and replaced, as a loss of sound and picture, or reduced r.f. gain with very weak or snowy pictures. As all the resistors in series with the tube may not be obvious, a voltage check should be made under load after a resistor has been changed.

Similar failures may occur in the i.f. stages, but their effect may be somewhat different. Complete loss of picture will, of course, be the maximum result; but lesser failures will cause a weak rather than a snowy picture. This characteristic of i.f. failures will aid in diagnosis: snow usually denotes tuner trouble but seldom i.f. trouble; a "washed out" picture usually denotes i.f. or video-output trouble.

The i.f. stages, like the ones shown in Fig. 2B, are particularly susceptible to burned-out resistors (especially the ones marked R). In this circuit, a stacked "B+" arrangement is used that resembles the one found in cascode amplifiers, that is, the two tubes are in series across a high "B+" voltage, with the lower "B+" at the cathode of the second tube serving as plate voltage for the first stage, and possibly some other circuits in the receiver. Thus a leaky or shorted tube in one of these stages could set up a chain reaction that would affect components in both stages and possibly have secondary effects on other circuits using the same source of low "B+." This may mask the true symptoms. Similarly, a defect in another circuit supplied from this voltage point might affect the i.f. system. The possibility of such interrelated and cumulative faults should not be overlooked.

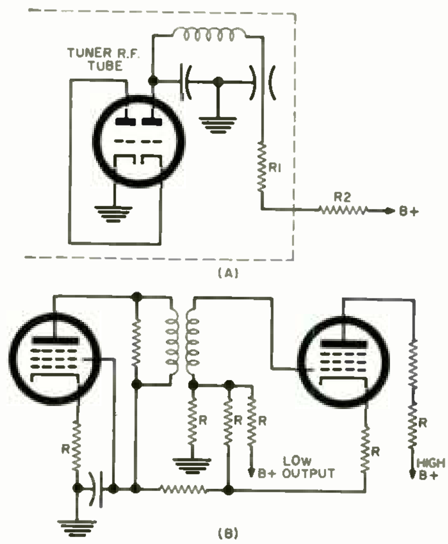
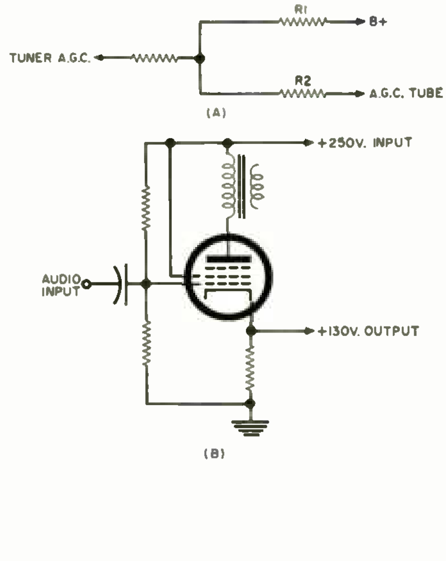


Fig. 2. Shorts in r.f. or i.f. tubes may overload resistors, like (A) R_1 and R_2 in r.f. and (B) resistors R in i.f.

Fig. 3. Resistor changes in voltage divider (A) of a.g.c. line may cut gain or add snow. Changes in (B) stacked "B+" supply may affect sensitivity.



Failures in the a.g.c. circuit will, at times, produce effects similar to tuner or i.f. failures. A snowy picture may result if, for example, an open bias resistor (R_1 in Fig. 3A) allows an excessive negative voltage to be applied to the tuner, thus cutting down the input to the i.f. strip and, in turn, reducing the a.g.c. voltage on the i.f. tubes. If R_1 becomes low in value or R_2 becomes open, the result will be a positive voltage applied to the tuner a.g.c. line, an increase in tuner gain, but increased a.g.c. bias voltage to the i.f. stages from a separate a.g.c. line, and a weak picture. In practice, the r.f. amplifier would probably not survive, which would complicate the service procedure because the direct symptom masked the defect.

Trouble originating in circuits which, at first glance, have little or no relation to tuner or i.f. circuits may be the cause of poor gain. A defective audio-output tube may, in a stacked "B+" supply circuit, cut down the low "B+" voltage and reduce the output of the i.f. strip. In this familiar circuit, shown in Fig. 3A, the audio-output tube is used as a dropping resistor to reduce the 250 volts or so from the power supply to the 100 to 150 volts needed by the i.f. strip. Changed resistor values in this circuit will affect the working conditions of the audio-output tube and produce similar results. Supply voltage reduced by open or leaky capacitors in the power-supply circuit may also show on the screen as reduced gain, as will any other defective component that is "dragging down" the supply voltage.

Sets being serviced on the bench under good signal conditions may not show the same symptoms of lost gain, but such symptoms will recur when the set is returned to the customer's antenna. As all sets are likely to have some loss of over-all gain in time, it is good practice to check all sets undergoing bench repairs with this in mind. A simple test procedure is to check the a.g.c. voltage at both the tuner and the i.f. strip while the set is connected to a "standard" antenna. Once the procedure is adopted, any set showing below-average readings will easily be noticed and can be serviced to restore the gain before it is allowed to leave the bench. —30—

Reverberation in Principle & Practice

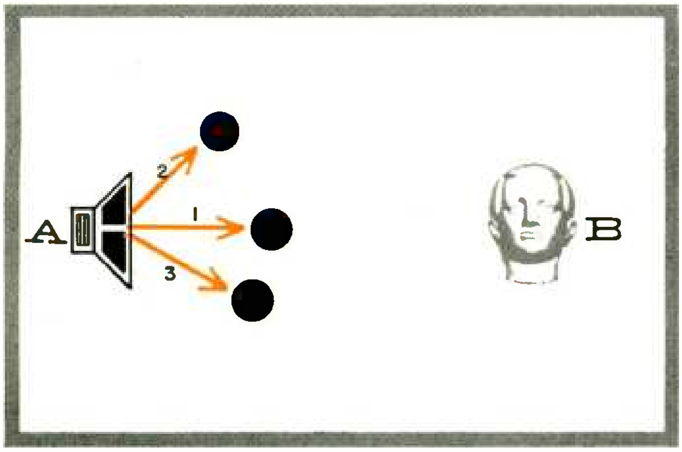


Fig. 1. Sound can be considered as individual bundles of energy, scattering in all directions from the sound source used.

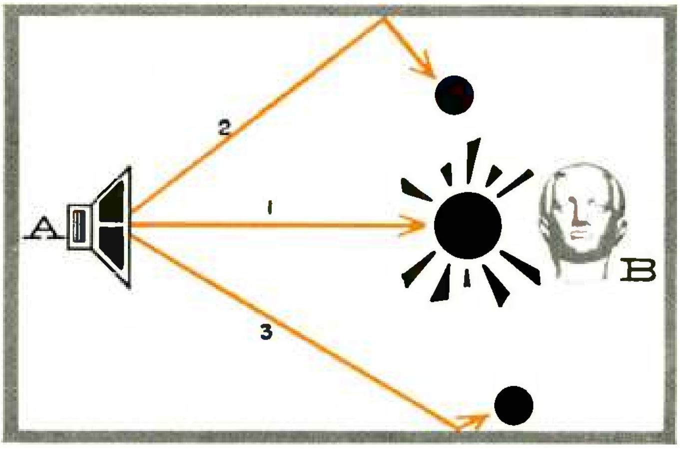


Fig. 2. Parcel 1 is the first to reach the listener. Parcels 2 and 3 arrive later after having been reflected from surfaces.

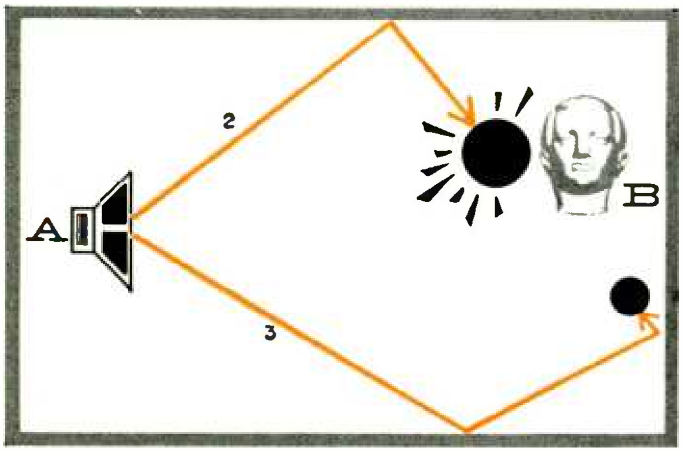


Fig. 3. Parcel 1 has disappeared, while 2 is arriving to cause continuation of sound or echo. Parcel 3 will arrive some time later.

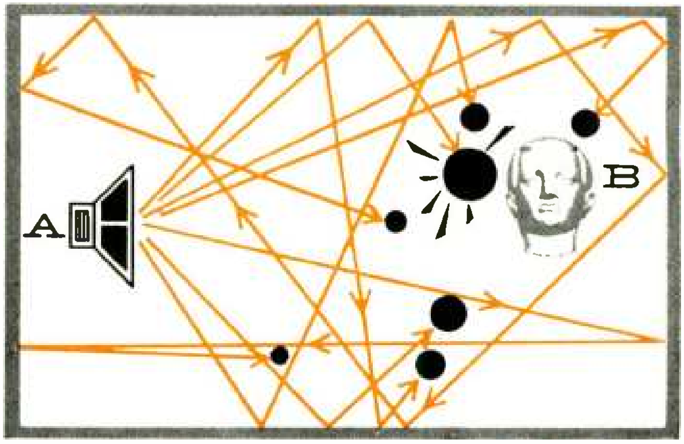


Fig. 4. In a listening room, there are a large number of sound parcels arriving at the listener's location at various times.

By GEORGE OWEN / Project Engineer, Motorola Inc.

Description of the Motorola technique for obtaining the reverberation effect in its packaged stereo units.

THE REPRODUCTION of sound in the living room in much the same way as it is heard in its original state, both as to content and environment, has taxed the energies and imaginations of many who are engaged in the science of sound reproduction.

Advancements in the state of this science have been both psychological and technological for, since we are dealing with the human hearing mechanism, the development of the mechanics of sound reproduction is dependent first on the findings of researchers in the psycho-acoustic field. As an example, the requirements for re-creating an exact sound picture of reproduced music in the home were known for many years before the technical development of stereo recording methods. And now, although the principles and characteristics of reverberation have been covered in dozens of scientific journals for the past 20 years, they have received widespread interest only in the last few months as technical developments have caught up with earlier research.

Before pursuing these technical developments, let's pause for a moment to consider some of the physical factors pertaining to the causes and effects of reverberation so as to clarify their significance as far as our hearing mechanism is concerned.

Effects of Reverberation

Imagine that you are looking down into a room and that you are able to see sound energy in the form of particles. or bundles (Fig. 1). The source of this energy might be a short trumpet blast lasting but an instant.

The source is located at position "A" and the listener at position "B." The total sound energy, divided into three particles as shown, is leaving the source by three different paths. At this point, no sound has yet reached the listener.

In Fig. 2. a short instant of time later, particle 1 has reached the listener who perceives the sensation of hearing a trumpet blast. Particle 2, meanwhile, has struck one of the side walls and has been reflected toward the listener. Particle 3, however has been reflected from the other side wall and is now heading toward the back wall. All three particles have travelled the same distance, but because of the longer paths taken by bundles 2 and 3, these have not yet reached the observer.

You may also note that particles 2 and 3 have decreased in strength. This is due to the fact that some of their energy has been dissipated—absorbed by the walls from which they are reflected.

The amount of energy lost due to absorption depends upon the material of the reflecting surface. A heavily draped wall, for example, would reflect very little energy. The final character of the signal reaching the listener therefore depends, to a large extent, upon the materials in a room.

In Fig. 3, taken still another instant of time later, the second particle has reached the listener and he perceives either a continuation of the original trumpet blast, or an echo, depending upon the difference in arrival time between the first and second particles. In either case, the sound actually received by the listener has undergone a change from the original sound produced by the source—due entirely to the characteristics of the room. It is this characteristic which is known as reverberation. In the instant depicted in Fig. 3, the third particle, having been reflected off the rear wall, is now headed toward the listener to change the sound still more.

Under actual conditions, there will be a large number of particles traversing many different paths. The end result is a *gradual* decrease of sound from the time the listener first hears the initial blast. The time taken for this sound to decrease to nearly zero is the reverberation time and this, too, is largely governed by the characteristics of the listening room. See Fig. 4.

Obviously, the characteristics of a living room differ vastly from those of a concert hall. While a particularly "live" room may generate a good deal of reverberation, the reverberation time and the time delay between reception of the individual reflected signals in the living room bears no relationship to their counterparts in the concert hall. No matter how "live" a particular room may be, the feeling of spaciousness associated with a concert hall is not duplicated in the home.

Until recently, reverberation in the home has been entirely a function of the techniques employed during the recording process and of the characteristics of the playback room. Now, thanks to a unique development by the *Hammond Organ Company*, we are able to duplicate the reverberation characteristics of a large hall even in the restricted confines of the ordinary living room.

The operation of the basic *Hammond* reverberation unit, together with its associated circuitry as employed by *Philco* and *Zenith*, was described in the August issue of ELECTRONICS WORLD. The *Motorola* circuitry for its top-of-the-line reverberation stereo consoles is described in the following paragraphs.

The Motorola System

For the reproduction of the stereo effect alone, three separate power-amplifier channels are employed. In the preamplifier, the two-channel stereo signal is divided into three portions, each one going to its own power amplifier. The combined bass frequencies from both stereo signals (below 200 cycles) are amplified by the center power amplifier, while the mid-range and high frequencies of each stereo signal are separately amplified and reproduced by individual left and right amplifiers and speaker systems. Because frequencies below 200 cycles contribute nothing to the directional effect of stereo, the three-amplifier system provides a full measure of stereo while offering greater IM-reduction possibilities than the more conventional two-amplifier systems.

At the same time, the extreme bass frequencies have little or no effect on reverberation. In fact, the basic reverberation unit supplied by *Hammond* cuts off at about 200 cycles. Consequently, the signal to be delayed and reverberated is a combination of the stereo signals provided by the two outside stereo amplifiers.

Mixing of the two stereo signals for subsequent delay and reverberation is accomplished in the input transducer of the reverberation unit. As shown in the partial schematic of Fig. 5, the field coil of this transducer is center-tapped and the center-tap is grounded. With opposite ends of the coil connected to the "hot" terminals of its respective stereo speaker, each half of the field coil is effectively connected in parallel with one of the speaker voice coils. The signal energizing the field coil, however, is a composite of the two stereo signals.

Before being mixed in the reverberation unit, the two stereo signals are passed through individual pilot-bulb limiters which serve as automatic reverb compressors at high volume levels. The use of this unique feature is based on the experimentally verified premise that, at high volume levels, the volume ratio between the reverberated and the direct signal should be smaller than at low volume. A little deliberation will point up the reason for this requirement.

At low volume levels, the reverberation due to the acoustics of the listening room, being lower in intensity than the direct sound, might well be masked by the ever-present room noise, thus becoming entirely inaudible. Without the addition of artificial reverberation, the resultant sound becomes relatively uninteresting. At high levels, however, the natural room reverberations contribute a good deal to the total reverberated signal so that the artificial reverberation ratio should be considerably reduced. The pilot bulbs, connected in series with the reverberation unit, automatically accomplish this function by increasing their filament resistance at high signal levels.

Acoustic vs Electronic Mixing

In an effort to simulate concert-hall conditions as realistically as possible, *Motorola* has elected to blend the reverberated signal with the main signal

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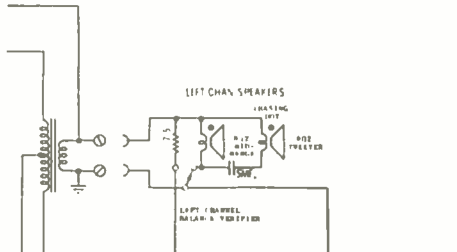


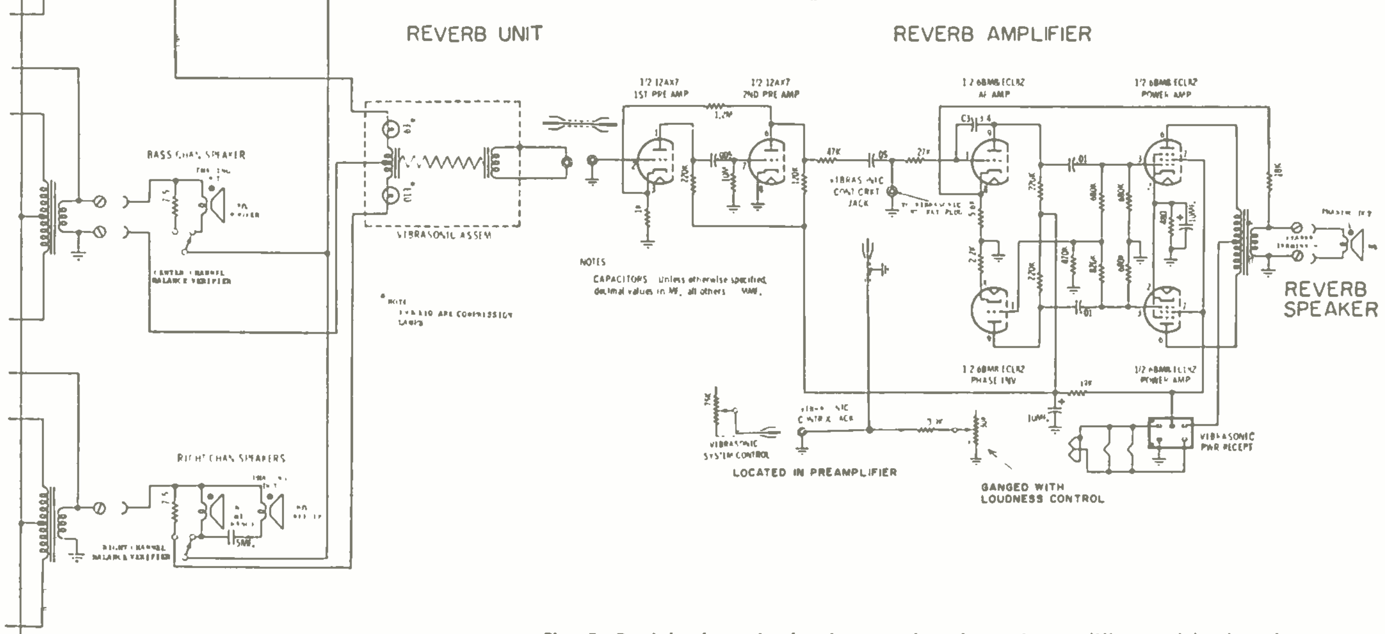
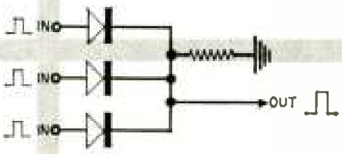


Fig. 5. Partial schematic showing reverberation unit, amplifier, and loudspeaker.

COMPUTER LOGIC CIRCUITS



By **ED BUKSTEIN**
Author, "Digital Counters and Computers"

Function of "decision-making" elements used in computers was described in a preceding article. Here are the actual circuits used in these blocks.

LOGIC circuits are the decision-making elements of the digital computer. Such circuits are designed to "recognize" certain combinations of inputs, and to produce outputs only when these combinations exist at the input terminals. The *and* circuit, for example, will produce an output only when all of its input terminals receive inputs; the *or* circuit will produce output when input is applied to *at least one* of its input terminals; the *not* circuit produces output only when input is not applied; and the *inhibitor* produces output when it receives input if a signal is not present at the inhibit terminal. In a preceding article, logic circuits were considered in terms of block diagrams. This article deals with the actual circuitry.

Fig. 1 shows a number of *and* circuits, including vacuum-tube logic, transistor logic, and diode logic. The circuit of Fig. 1A uses a tube with two input grids, both normally biased below cut-off. A mixer type tube may be used in this application or, as shown, the suppressor of a pentode may be used as a second control grid. Since both input grids are biased below cut-off, a positive input to either one of the two grids will not produce a flow of plate current. Plate current can flow only when both input grids are above cut-off simultaneously, and the circuit therefore produces an output only when positive inputs are applied to both input terminals. This type of *and* circuit is sometimes referred to as a *pentode switch*.

In the circuit of Fig. 1B, the parallel triodes share a common load resistor. Since both tubes are normally at saturation (positive bias) the current flow through the load resistor is sufficient to drop most of the supply voltage. As a result, the voltage at the output terminal is relatively low. If a negative input

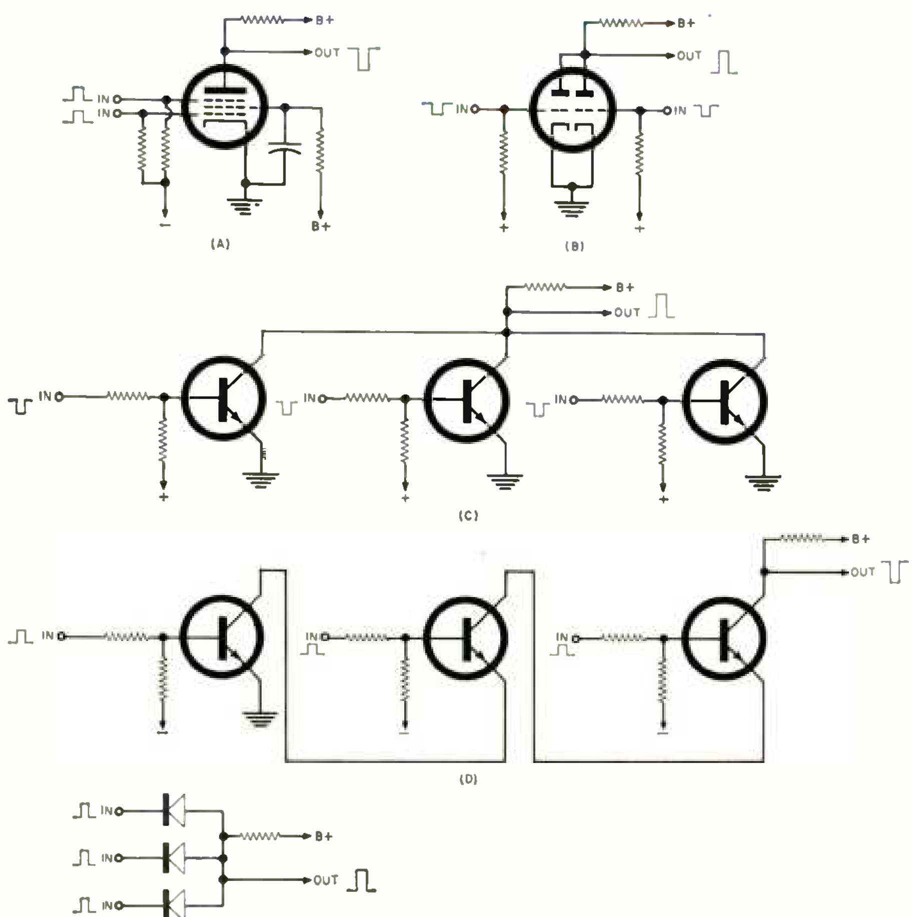
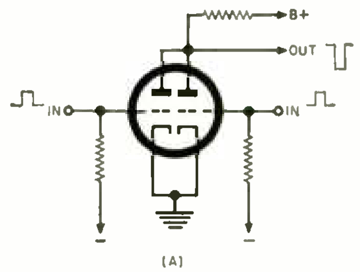


Fig. 1. "And" circuits may use (A, B) tubes, (C, D) transistors, or (E) diodes.

is applied to only one of the two input terminals, the corresponding tube will be driven to cut-off. The other tube, however, is still at saturation and most of the supply voltage is still dropped across the load resistor. Since the internal resistance of the saturated tube is considerably lower than the value of the plate load resistor, the voltage at the output terminal does not change significantly when only one of the tubes



are shown, but *p-n-p* units may be used if all polarities are reversed.

In the *and* circuit shown in Fig. 1D, all transistors are biased below cut-off (negative bias to *p*-type base material). Since the transistors are connected in series, current can flow through the load only if *all* transistors are made conductive. The voltage at the output terminal will therefore decrease when positive inputs are applied to all input terminals.

In the diode *and* circuit shown in Fig. 1E, all diodes are biased in the forward direction. The pathways for current flow are completed through the driving circuits connected to the input terminals. Since all diodes are conducting, most of the supply voltage is dropped across the load resistor. The voltage at the output terminal is therefore relatively low. Because the resistance of even one conducting diode is very low as compared to the value of the load resistor,

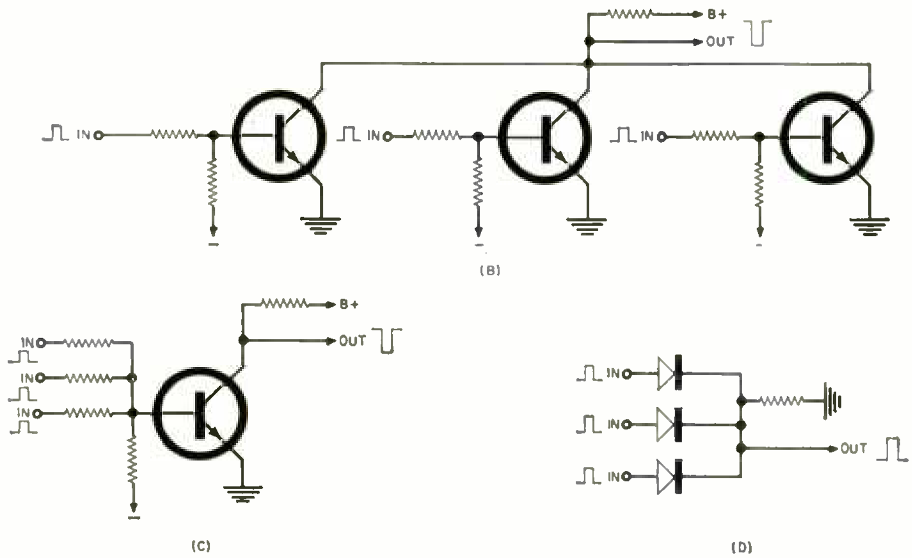


Fig. 2. Four different circuits that act alike. Each provides the "or" function.

one (or both) of the input terminals will produce a flow of plate current. Voltage at the output terminal therefore changes in response to *at least* one input. More triodes may be added in parallel if a greater number of input terminals is desired.

In the transistorized *or* circuit of Fig. 2B, the transistors are all biased below cut-off. A positive input to any one (or more) of the input terminals will therefore cause a decrease of voltage at the output terminal. A simplification of this circuit is shown in Fig. 2C. Here, only one transistor is required, and resistors provide isolation of the input driving circuits. Since the transistor is biased below cut-off, a positive input to any one (or more) of the input terminals will make the transistor conductive and will produce a change of output voltage.

This circuit is representative of a type often referred to as *nor* logic. This name is derived from the polarity-reversing characteristic of the circuit: a positive input pulse produces a negative output pulse. Since inversion represents the *not* function, the circuit may be referred to as a *not or* circuit, which is generally shortened to *nor*.

The diode *or* circuit shown in Fig. 2D consists of a number of diodes sharing a common load resistor. An input to any one (or more) of the input terminals will cause the corresponding diode (or diodes) to conduct, and an output will appear across the load resistor.

The *not* or *inverter* circuit consists essentially of a conventional amplifier stage. In the circuit shown in Fig. 3, a voltage divider is connected between the plate and a source of negative voltage. The output terminal will therefore be at a potential somewhere between the value of plate voltage and the value

(*Continued on page* 77)

is driven into the cut-off condition.

If negative inputs are applied to both of the input terminals however, both tubes will be driven to cut-off and the voltage at the output terminal will rise to the value of the "B" supply. Simultaneous inputs are therefore required to produce a significant change at the output terminal. This type of *and* circuit is sometimes referred to as a *parallel gate* or a *Rossi* circuit. More triodes may be connected in parallel to provide a greater number of input terminals.

The circuit shown in Fig. 1C is a transistorized version of the circuit shown in Fig. 1B. All transistors normally conduct heavily because of the positive bias applied to the *p*-type base material. Since each conducting transistor is practically a short circuit, the voltage at the output terminal will be very low as long as one or more of the transistors are conducting. The voltage at the output terminal will therefore change significantly only when *all* transistors are driven to cut-off (negative inputs to the *p*-type base material). More transistors may be added in parallel if a greater number of input terminals is desired. Type *n-p-n* transistors

most of the supply voltage will be dropped across the load as long as one (or more) of the diodes is conducting. Output voltage will therefore increase significantly only when *all* diodes become nonconductive. Simultaneous inputs are therefore required to produce an output.

By definition, an *or* circuit produces an output when input is applied to at least one of its input terminals. In its simplest form, the *or* circuit would therefore consist of several pieces of wire connecting the input terminals to the common output terminal. In this form however, the *or* circuit would not be practical because it would permit interactions between the driving circuits connected to the input terminals. A signal applied to one of the input terminals could feed back into the driving circuits connected to the other input terminals. The *or* circuit must therefore be of such design that it will isolate the driving circuits from each other. For this reason the *or* circuit is also known as a *buffer*. Vacuum - tube, transistor, and diode *or* circuits are shown in Fig. 2.

The triodes in Fig. 2A are biased below cut-off. A positive input to either

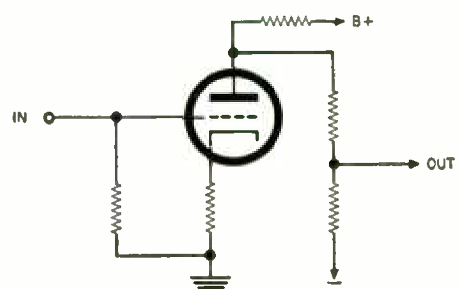
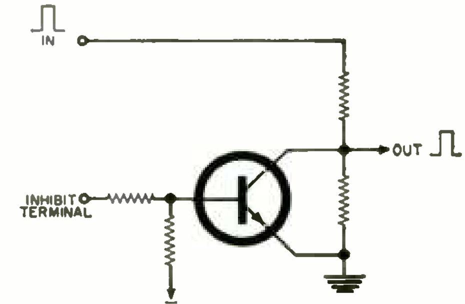


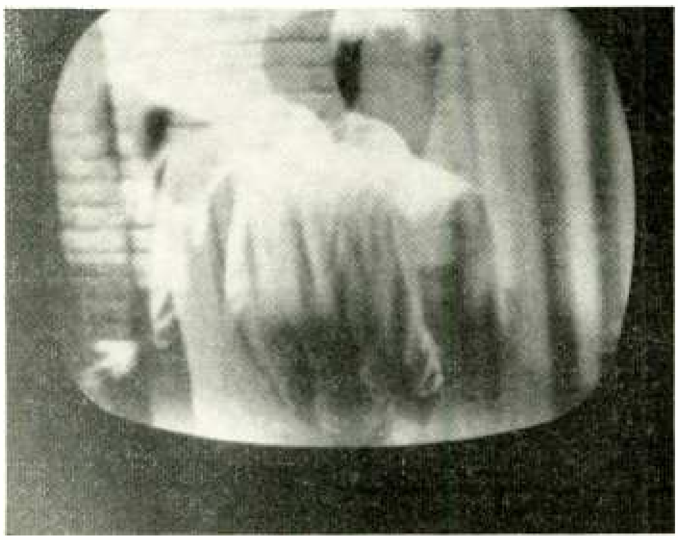
Fig. 3. A "not" circuit. Output can be at either of two different levels. These can represent binary "1" or "0".

Fig. 4. The inhibitor circuit produces output when it receives input—unless a potential is applied to inhibit terminal.

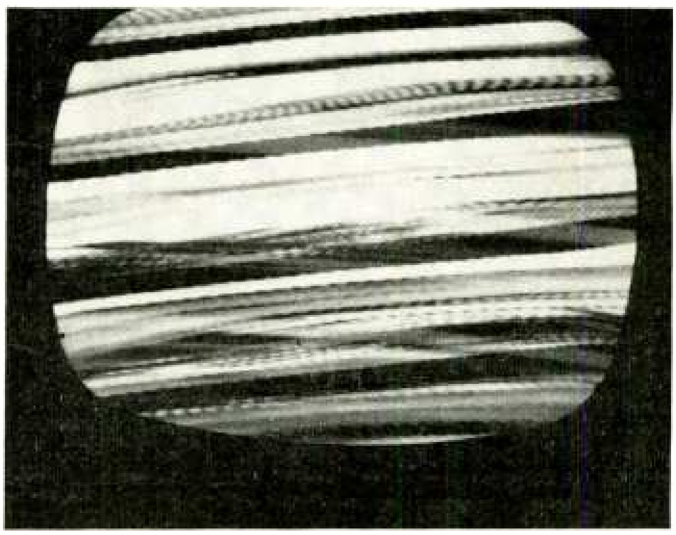


Symbols for Symptoms

By WAYNE LEMONS



AWP4



ANHY

Editor's Note: *On first reading, the author's scheme struck us as being wild and improbable. Second reaction: some plan of this sort would be useful in any shop, but we know all too many where this particular one would collapse in a week. Final decision: each shop owner might have to work out his individual variation of the system—but the author's version, which works for him, is as good a starting point as any for a worthwhile method.*

EVERY SHOP must have some way to note and record the trouble symptoms for which a TV set is brought into the shop. There are many reasons for doing so, not all of them obvious. For one thing, it will clearly prevent anyone from overlooking the primary complaint with which the set was brought in. This "oversight" is far from unlikely, especially when a tough set with more than one defect or intermittent symptoms is on the bench.

Unfortunately, writing out the complete symptoms on a shop ticket is time-consuming. Thus a harried technician might not do a thorough job or he might omit the chore altogether.

Some years ago we decided to put a small sticker on the back of every TV set that came into the shop. It has room to write the customer's name, the date, and the trouble. This gave us many advantages. For example, let's say that a set we worked on is brought in again by the customer. We can't recall his name right at that moment, but a quick glance at the sticker (while we are maneuvering the set and engaging him in conversation about the weather) enables us to impress him with the fact that we remember him. This always helps. In the second place, we know for certain when we last worked on the set. This saves no end of trouble when it comes to warranties, complaints that "you just worked on it and it still isn't right," and other matters.

Finally, a specific notation as to the trouble lets the technician who handles the set on the bench (and who need not be the one who brought the set in or took it when it was brought in) know exactly where he stands. It also "forces" the person who takes the set to listen to and digest the customer's complaint carefully, usually picking up the sort of helpful information that can help us do a better job.

Everything was fine—except that the stickers just didn't have enough room for the complete story. A bigger sticker would be too conspicuous. Besides we sometimes had trouble interpreting our own scribblings, let alone make them understandable to someone else. It soon became apparent that we would have to develop some kind of a code. It would have to have brevity to fit on the sticker. It would also have to be clear, simple to use, and certainly understandable to all of us.

The first thought was to use numbers arbitrarily to represent symptoms, but there were obvious disadvantages. With so many possible symptoms, nobody could memorize the entire code reliably. Constant reference to a wall chart for the code would be distracting to technicians and customers. Besides, if someone happened to jot down a wrong digit, there would be no way of knowing this or determining what number should have been written down instead. The code had to use symbols that had meaning, so that it could be remembered almost automatically. This would tend to eliminate errors and make them easier to correct.

We think the alphabetical system presented here fulfills our requirements nicely. After extensive use, we have yet to find a trouble that it cannot cover (although, of course, we are not covering any bets).

Six of the thirteen letters used are adjectives or descriptive words to clarify the nature of the trouble. The other seven suggest portions of the TV set in which the symptoms exist or appear. Where difficulty occurs only on one or more than one channel, corresponding numbers are used, but no other use of numbers is made. The complete code appears in Table 1. In every case, there is enough connection between the letter and the idea it represents to make remembering easy.

The descriptive letters include *B* for Bending, *D* for Distorted, *I* for Intermittent, *N* for No, *W* for Weak, and *Z* for Noisy or Snowy. Note that all letters used except *Y* and *Z* are the initial letters of the words for which they stand. *Y* is for Sync and *Z* is for Noisy. These two symbols warrant some explanation.

Why not use *S* for Sync? We did for a while, but found it was leading to confusion. It was sometimes taken to mean Sound, Sweep, or Snowy. However, since *Y* is the second letter in Sync rather than the initial, it is easy to remember. *N* could not be used for Noisy, because that letter already stands for No. However, if you think of the familiar cartoon depiction for a snoring (noisy) man, which is *Z-Z-Z-Z*, there is no problem. Or else you may wish to think of a phonetic spelling, *noy-Z*.

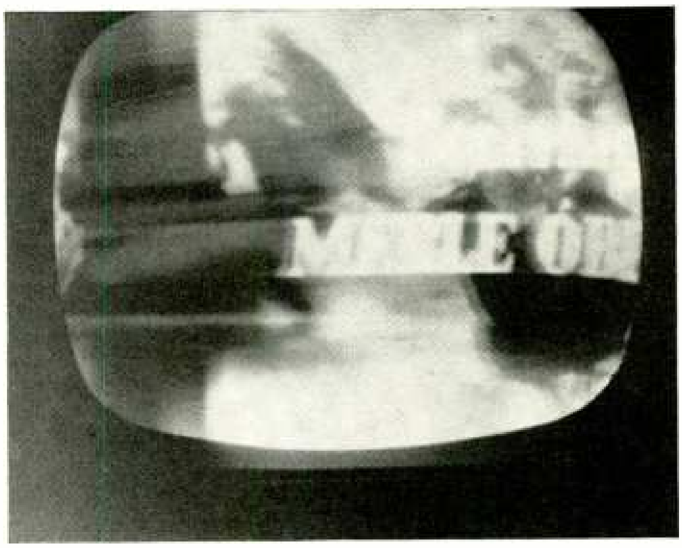
Our experience has shown that the best way to write the trouble symptom is to note first the portion of the TV set that is *not* giving trouble, wherever possible. This is followed by a coded notation describing the symptom itself or the portion of the set where the trouble is suspected. This is not as complicated as it sounds, as you will see from some examples.

Suppose a set comes in with a good picture but no sound. You write *PNA* for picture OK but no audio. You might try to cover the copy and successively uncover the "translations" only after you have tried to interpret each one yourself: *NAR* = no audio or raster (dead set). *ANV* = audio, no vertical (deflection is understood). *ANVY* = audio, but no vertical sync. *AZP* = audio, but noisy (snowy) picture. *PIA* = picture, but intermittent audio. *AIR* = audio, but intermittent raster. *ABP* = audio, but bending picture.

The use of the word "Bending" requires some additional explanation. In the case of a picture or raster, it could mean 60- or 120-cps hum. To represent audio hum, we cannot use *H*, since this already means Horizontal. Thus *B* will stand for hum whenever it is used with reference to audio. For example, *PBA* would mean the picture is OK, but there is hum in the sound. As a final exercise in translating code into English, try this: *AP3NAP10*. Puzzling? Well, it might help to know that the two active channels in the service area are 3 and 10. So the symbols simply mean audio and picture (OK) on channel 3, but no audio or picture on channel 10.

Streamline your bench work, prevent servicing errors, and keep your customers happy with this orderly method for making a record of all complaints and defects. It has been time-tested in a successful shop.

ADV



AWHY

would write *PWA* for picture OK with weak audio. What if picture and sound were both weak? In this case, you might skip noting that any portion of the set is not giving trouble, but you would start the notation with one of the six descriptive letters — *WAP* for weak audio and picture. Suppose you had no video (picture) but there was a raster and sound was weak. You write *RNPWA*—raster OK, but no picture and weak audio.

To help you pick up the knack, additional examples of the code follow. You

Now let's reverse the procedure. Try to put this fairly complicated symptom into code: there is no vertical deflection and the sound is weak, but the customer also says that the horizontal hold was critical before the set went out. What do we have? We have a raster (light on the screen, even if it's only a thin line), so we put down *R*. We follow this with *WA* for weak audio and *NV* for no vertical deflection. Then we add *WHY* for the customer's mention of weak horizontal sync. Translated back, *RWANVWHY* becomes, "Raster, but weak audio, no vertical deflection and weak horizontal sync." A complicated fault reduced to eight letters.

Try a few of the recent symptons you have run into. You'll see how easy it is to master the code and teach it to others. There is another important advantage in adopting it. Putting the complaint into "shorthand" compels you to interpret the customer's complaint logically, so that you're much more likely to get it straight. You can't reduce the symptoms to code unless you understand them yourself. You'll find yourself asking the customer much more intelligent and useful questions. You'll not only know what his complaint is, but also (and often just as vital) what it isn't. —30—

Table 1. Put any fault into "shorthand" with these 13 letters plus channel numbers.

LETTER	MEANING	LETTER	MEANING
A	Audio	R	Raster
B	Bending (or hum in audio)	U	U.h.f.
D	Distorted	V	Vertical
H	Horizontal	W	Weak
I	Intermittent	Y	Sync
N	No	Z	Noisy (or snowy)
P	Picture (video)	2, 3, etc.	Channel numbers

R-C BRIDGES:

Operation and Repair

By **DAVID R. ANDERSON**

Popular service versions use similar circuitry. Troubleshooting procedures are also similar.

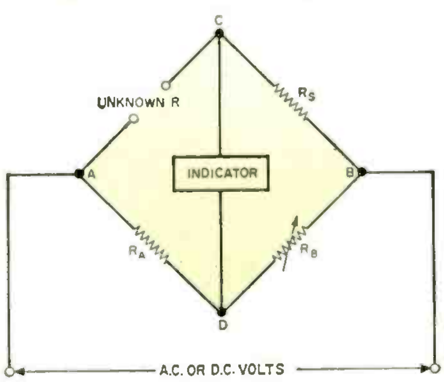
THE R-C BRIDGE, a useful test instrument in the well-equipped shop, has at least one thing in common with other test gear: it may break down. When this happens, although the bridge is not a familiar unit to work on, there is no reason that the owner cannot fix it himself.

The first step in approaching the fault is an understanding of operation and the roles played by specific circuit sections and components. To this end, a simplified diagram of a resistance bridge is shown in Fig. 1.

Assume that, when an unknown resistor is connected where shown, the ratio between its value and that of R_S is the same as the ratio between R_A and R_B; that is, unknown $R:R_S = R_A:R_B$. A voltage applied across points *A* and *B* will appear across each series pair of resistors. If the two resistance ratios noted are indeed equal, then voltage division across the upper series pair will be the same as that across the lower pair. Thus the voltages at points *C* and *D* will also be equal, and there will be no potential difference across the meter or other indicating device.

In practice, R_B is made variable so that it can be adjusted for a zero reading or null on the indicator for different values of unknown resistance, and the dial on its knob is calibrated to give readings for the value of the unknown. Also, for indication over a wide range of values, a switch selects different range-setting resistors for R_S. In most commercial *R-C* bridges, an electron-ray or eye tube is the null indicator (Fig. 2) instead of a milliammeter or voltmeter, because of the tube's low cost and convenience.

Fig. 1. Basic resistance bridge circuit.



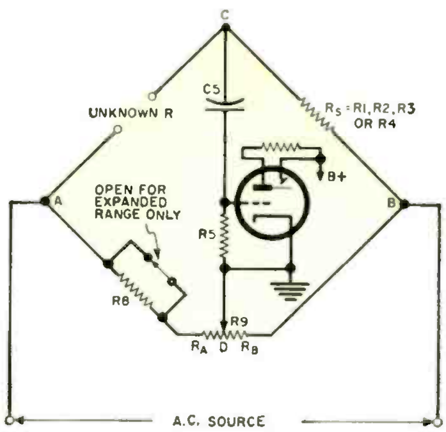


Fig. 2. Typical resistance-measuring circuit used in a commercial bridge.

The electron-ray tube, a sensitive device that causes very little circuit loading, enables a high degree of accuracy. And, since it can also rectify, a.c. may be used as the test voltage. This makes it possible to measure capacitance too. The only necessary circuit change is the substitution of a range-setting capacitor for R_S.

Another refinement in Fig. 2 is the grounding of one side of the indicator—in this case, the tube's cathode—to give the instrument greater stability. Also, R_A and R_B are both made variable, in the form of R_9, greatly increasing range and sensitivity.

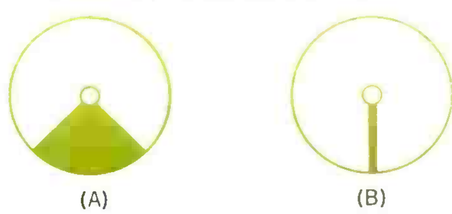
To understand the eye tube's function as a null indicator, assume we are checking the value of an unknown resistor on the bridge of Fig. 2. The unknown is connected where shown. The bridge will probably be unbalanced and the eye tube will be closed, as shown in Fig. 3B. R_9 is then rotated until a null is indicated by maximum eye opening (Fig. 3A).

With the bridge unbalanced, the eye is closed because there is a voltage difference between points *C* and *D* of Fig. 2. This a.c. voltage, proportional to the unbalance of the bridge, is fed to the grid through C_5, then rectified and filtered by the grid, C_5, and R_5. The resultant d.c. bias voltage is also proportional to the unbalance of the bridge. When this negative bias is high, the eye of the tube is closed.

As R_9 is rotated toward balance, the voltage difference between points *C* and *D* is reduced. This, in turn, causes the grid bias to become less negative and the eye begins to open. With balance achieved, bias voltage is at a minimum and the eye is fully opened.

Changing the value of R_S to R_1, R_2, R_3, or R_4 changes the range over which the bridge operates. There are several ranges to be found in all commercial instruments, including what is known as an expanded range. On the expanded range, R_6 is switched in series with R_A

Fig. 3. Indicator tube with (A) bridge balanced (eye open) and (B) eye closed.



(part of R_9) in one arm of the bridge to do just what the name implies: increase the highest range of the instrument.

Capacitance Measurements

The operation of the capacitance bridge, shown in Fig. 4, is essentially the same as that of the resistance bridge. There are, however, a few differences to be noted. First and most obvious is that capacitor C_8 is used to set

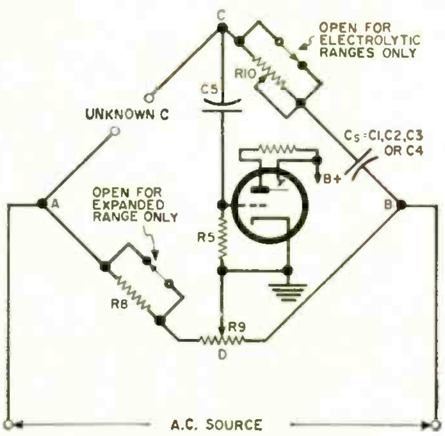


Fig. 4. How bridge measures capacitance.

the range in place of resistor R_8. Also, when measuring the capacitance of an electrolytic unit, it is necessary to switch potentiometer R_{10} into the circuit.

R_{10} is necessary to balance out the large leakage resistance of an electrolytic capacitor. It must be adjusted, along with R_9, to obtain a true null. R_{10} is usually calibrated in percentage of power factor, which gives a good indication of the condition of the capacitor being measured. In general, a unit with a power factor larger than 15 per-cent should be discarded.

In addition to the bridge circuits, most instruments incorporate a circuit for testing the leakage resistance of capacitors. An example of such a circuit is shown in Fig. 5.

The capacitor to be tested for leakage is connected to the test jacks, and potentiometer R_{11} is set to the working voltage at which the suspected unit is rated. If the capacitor is leaky, some of the applied negative voltage will be passed to the grid of the electron-ray tube, and the eye will tend to close. If no leakage is present, the capacitor will block any d.c. voltage from reaching the grid of the tube, and the eye will remain open.

The sensitive circuit, shown in Fig. 5A, is used when paper or mica capacitors are being measured for leakage. However, when electrolytic capacitors are being checked, less sensitivity is desirable because of the relatively large leakage resistance normal for this type. To cut down the sensitivity an additional resistor (R_{12}) is shunted across grid resistor R_5 in Fig. 5B. Under this condition, a small voltage at the grid of the tube will not develop enough bias to close the eye of the tube. Only when leakage exceeds the normal value for an electrolytic will the developed bias begin to close the eye.

A d.c. power supply that is capable of supplying "B+" for the positive electrodes of the electron-ray tube and a high d.c. voltage for the leakage test is necessary. An example of such a supply is shown in Fig. 6. It consists of a half-wave rectifier and an appropriate filter network. "B+" for the positive electrodes of the eye tube is taken from the cathode circuit, while the high d.c. voltage (negative) for the leakage test is taken from the plate circuit of the rectifier.

Also necessary is an a.c. source for operating the bridge, to be connected across points *A* and *B* in Figs. 1, 2, and 4. The 50-volt transformer secondary, shown in Fig. 6, supplies this voltage. Resistor R_6 provides safety by limiting current flow to the bridge.

Troubleshooting

When a failure in this test instrument develops, the first step in determining the cause is to divide the entire unit into functional sections. Based on an understanding of operation, such a division enables a quick determination of the section likely to be at fault. Thus troubleshooting may be confined to a relatively limited area, instead of becoming a hit-or-miss procedure.

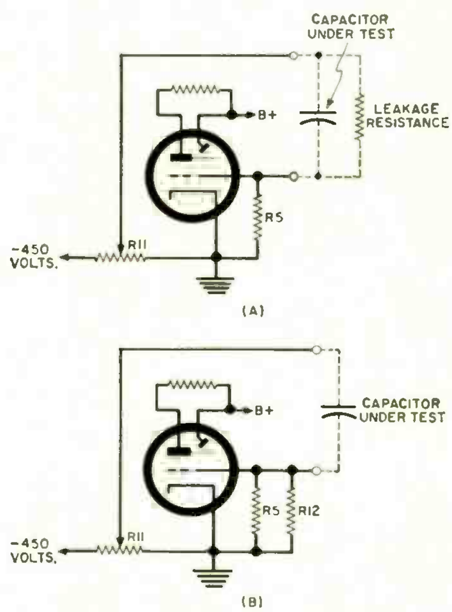


Fig. 5. Capacitor leakage tests for (A) low-value and (B) electrolytic units.

The four basic sections are the resistance bridge, the capacitance bridge, the leakage test circuit, and the power supply. For our purpose, it is not important that certain elements are common to more than one section. In fact, this can be helpful in isolating the problem. For example, examination of the built-in indicator can assist greatly in localization. Let us assume, to illustrate, that the instrument gives normal indications on all capacitance ranges and all resistance ranges but one.

The power supply and the capacitance bridge must be operating normally for such indication to occur. The leakage test circuit, which is not likely to affect the operation of the bridge circuits, can be kept out of consideration. The defect appears to be in the resistance bridge. An examination of Fig. 2 suggests that the only component that could be involved in this trouble is the range-setting resistor for the defective range—unless the latter happens to be the expanded range, in which case R_8 might also be involved.

The same reasoning would apply if the capacitance bridge failed to operate on one range only. The only exception would be when the defect appeared on the range (or ranges) used for checking electrolytic capacitors. In this case, R_{10}, the power-factor control shown in Fig. 4, must also be checked for an open or short.

Now, let us assume the eye gives no indication on any bridge range, that is, it remains open no matter what resistance or capacitance range is used, and varying R_9 has no effect on the eye.

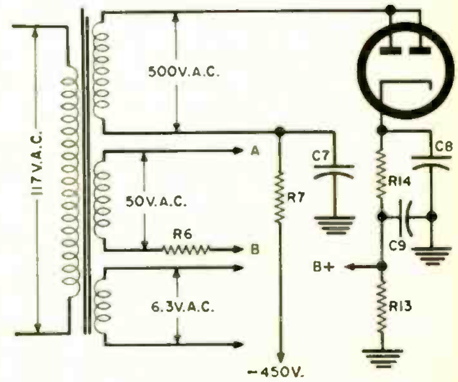
Here again, by observing the eye, we can eliminate a number of components from suspicion. If it is lit, the "B+" supply must be working and we can eliminate it from suspicion. Also, the range-setting resistors and capacitors may be disregarded, since each one is used on one range only and the defect is common to all ranges. The leakage test circuit, of course, does not enter into bridge operation, and it may also be disregarded.

This leaves only those components that are used for all ranges of both bridge sections. As can be seen from Figs. 2 and 4, these are R_5, C_5, R_9, the electron-ray tube, and the a.c. source. R_5 and R_9 may be quickly checked with an ohmmeter. C_5 and the tube are best checked by substitution. The a.c. source may be checked with a voltmeter.

With trouble in the leakage section only, the negative high-voltage should be checked first. If it is present, the other components may be checked with an ohmmeter. If it is absent, the power supply is checked in a conventional way.

An important point to consider is that the various sections of the instrument are, of necessity, connected together through switches. These can develop such defects as open, intermittent, dirty, or broken contacts. Since switching in most commercial bridges is important, a visual inspection of the contacts is recommended as the first troubleshooting step. It may save much later time and effort. -30-

Fig. 6. Common R-C bridge power supply.



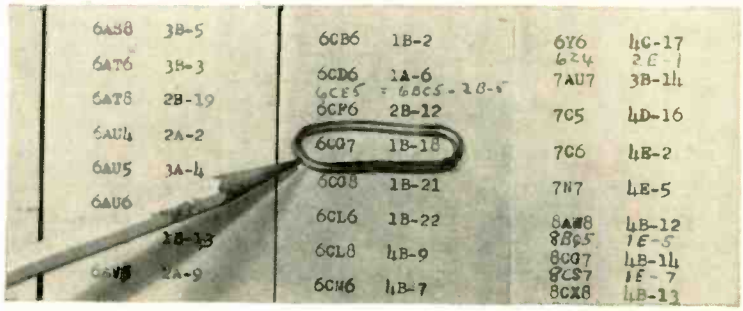
A

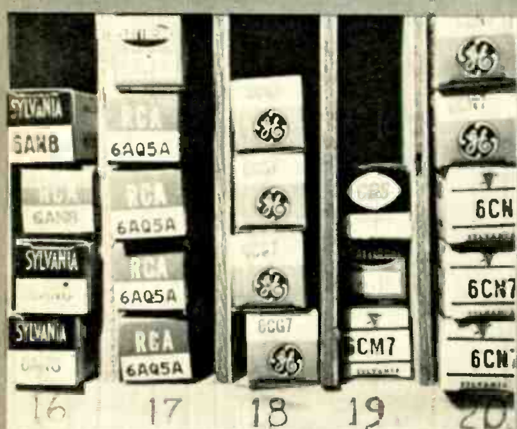
"Filing" System for Parts

By J. O. PAINE

Replacement components are at your fingertips with this tested method.

B

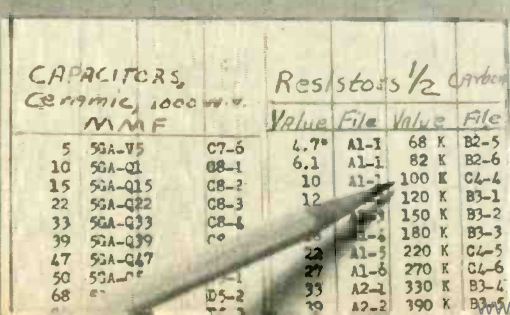




C

D

E



SHORTLY after he opened his TV service shop in Moultrie, Ga., several years ago, Howard DeLaughter learned an important fact: the accumulated time spent looking for replacement parts can take a big bite out of profits. Five unnecessary minutes spent trying to locate a new tube or capacitor, repeated several times a day, had the effect of taking quite a bit of cash out of the register per week.

This, plus the fact that DeLaughter is an orderly sort of person anyhow, led him to devise a system for "filing" tubes and small parts. As a result, he says that a new resistor is generally installed in a set in his shop in less time than it would take a technician to find the item in some other establishments. In use for nearly four years, the technique has proved itself not only with tubes and conventional parts, but with the steady flow of new items.

Tubes are stacked in shelves located above and within easy reach of the work benches that line one wall at *Ray & DeLaughter TV Co.* Stacks are separated (Fig. A) by vertical boards of thin plywood. Each of the five shelves is assigned a letter beginning with *A* (bottom shelf) and working up to *E*. Each group of shelves is also assigned a number (section 1, shown in Fig. A, is indicated by the "1" at the top of the photo) and, on each lettered shelf within the group, individual stacks are numbered, from left to right.

The order in which tube types are assigned to various compartments does not have to follow any pattern. This makes it simple, as each new tube comes on the market, to stock it in the very next unoccupied compartment. However, its shelf location is listed on the index chart to the left of the tube shelves, mounted on hinges.

This is how the system works: a technician needs to replace a 6CG7 just found to be defective. He goes to the index, which lists all tubes in conventional numerical-alphabetical order, and finds 6CG7 (Fig. B). Reading across, he finds "1B-18" next to it. This means if he goes to section 1 and sights along shelf B, he will find the type he wants in compartment 18. Fig. C is a detail showing this location.

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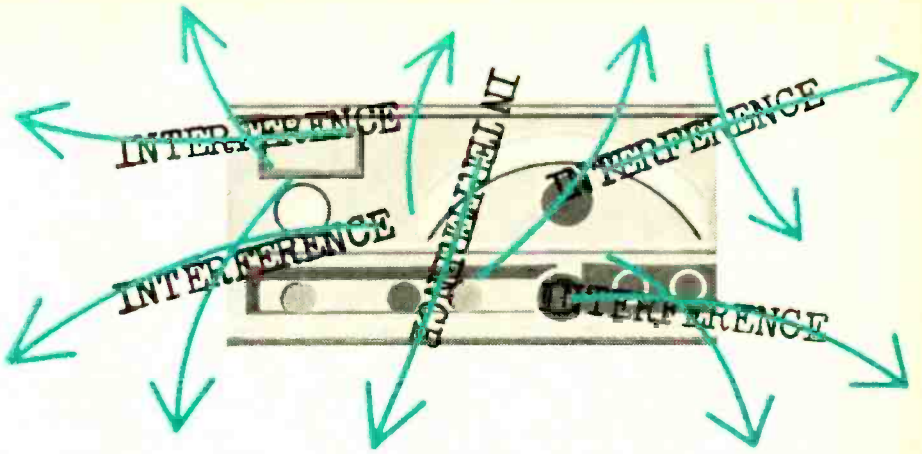


Reducing Transmitter Interference

Part 1. Harmonics & Spurious Signals

With increasing use of the radio spectrum by police, industrial stations, taxis, hams, and CD, transmitter originated interference must be eliminated. Here are some very practical ways of accomplishing this.

By JAMES G. ARNOLD
Surface Communications
Defense Electronic Products
Radio Corporation of America

TRANSMITTERS that do not generate unwanted signals simply do not exist. Unless specific effort is made to reduce these undesirable signals, a transmitter will become a source of radio interference. It is important to every transmitter operator to avoid this situation. It is no secret to the ham operator that once he has been designated as the cause in a single case of interference, he automatically becomes the perpetual community scapegoat. From an over-all point of view, each interfering signal is equivalent to the firing up of an additional transmitter, and eventually all radio spectrum users must suffer from this unnecessary congestion.

While these undesired signals are never absolutely eliminated from a transmitter output, they can be and should be reduced to a level that will not be sufficient to affect even the nearest receiver. Very little, other than conscientious effort, is required to achieve this.

Harmonics

The most common form of interference generated in a transmitter is harmonics. Harmonics are always generated in the power amplifier of a transmitter. Harmonics in a power amplifier are produced in precisely the same manner as distortion in an audio amplifier. Tube non-linearity is the culprit. In the case of a power amplifier in a transmitter, however, the tube is purposely operated in a most non-linear fashion in order to achieve a reasonable efficiency. Since it is seldom practical to generate r.f. power with a class A amplifier, the power amplifier in a transmitter must be permitted to generate harmonics. The reduction of harmonics must then be accomplished between the plate of the power amplifier and the radiation of the signals into space. This generally means, as in the transmitter shown in Fig. 1, that the harmonic reduction must be made in the power-amplifier plate circuit, the output coupling circuit, the transmission line, and the antenna.

The power-amplifier plate circuit is extremely important in the reduction of harmonics and the really important characteristic of the circuit is the loaded "Q." The "Q" is a primary consideration in any coil. It is defined as the ratio of inductive reactance to the coil resistance:

Table 1. Design parameters for the construction of practical low-pass filters.

CUT-OFF FREQ. (in mc.)	LINE IMP. (ohms)	L_1 L (μhy.)	L_1 No. of Turns	L_1 Winding Type	L_2 L (μhy.)	L_2 No. of Turns	L_2 Winding Type	L_3 L (μhy.)	L_3 No. of Turns	L_3 Winding Type	C_1 (μμf.)	C_2 (μμf.)
6	51	1.45	13	2	2.17	19	2	2.71	23	2	300	1000
6	72	2.03	17	2	3.07	25	2	3.82	30	2	220	750
12	51	.72	12½	1	1.08	11	2	1.35	12	2	150	510
12	72	1.02	10	2	1.54	14	2	1.91	17	2	110	360
23	51	.38	7	1	.57	10	1	.71	12	1	82	270
23	72	.53	9½	1	.80	13½	1	.99	16	1	56	180
55	51	.16	3½	1	.24	5	1	.29	6	1	33	110
55	72	.22	5	1	.33	6½	1	.42	8	1	24	82

Winding Type 1: #16 AWG copper wire wound on standard ½-13NC-2 screw.
Winding Type 2: #16 AWG enameled copper closewound on ½" dia. Bakelite tube.

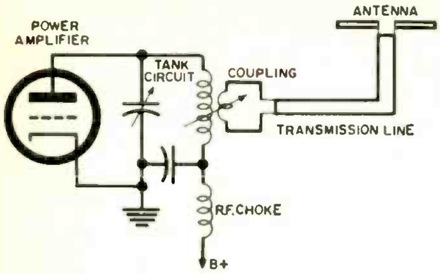


Fig. 1. Typical power-amplifier circuitry.

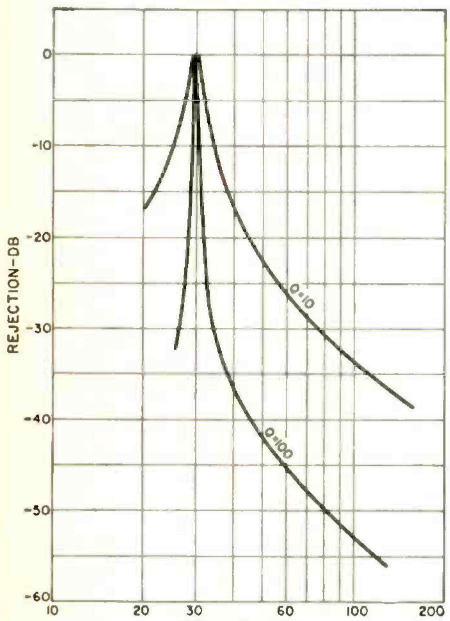


Fig. 2. Response with two values of "Q."

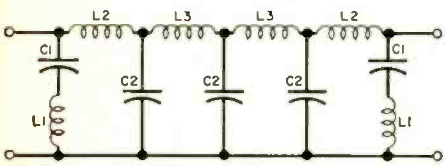


Fig. 3. Circuit for the low-pass filter.

$$``Q" = \frac{6.28\ fL}{R}$$

where f is the operating frequency in megacycles, L is the coil inductance in microhenrys, and R is the effective series resistance of the coil. In the case of a power amplifier such as that shown in Fig. 1, the load resistance and the plate resistance of the tube are in parallel with the tank circuit, and are equivalent to a resistance in series with the coil. The lower these resistances are, the greater will be the effective series resistance.

In the case of a parallel resonant circuit that is heavily loaded by an antenna, "Q" equals the value of the parallel load resistance divided by the reactance. Here the "effective Q" increases as reactance decreases. Hence, the tank circuit must have a large capacitance and a small inductance (high C/L ratio) in order to have a reasonably high "Q."

The *"Q"* of a power amplifier circuit can also be described as the operating frequency divided by the bandwidth:

$$``Q" = \frac{f_0}{f_1 - f_2}$$

where f_0 is the operating frequency of the circuit and f_1 and f_2 are, respectively, the upper and lower frequencies where the power output drops to one-half the power output at the operating frequency. This is why a high *"Q"* circuit is important in reducing harmonics. The response of two tuned circuits is shown in Fig. 2. The db scale shows the amount of rejection by the circuit to any frequency injected into it. In the two cases shown, 30 megacycles has been selected as the operating frequency of the circuits. It is readily seen that the higher *"Q"* circuit rejects (or attenuates) both the second harmonic (60 megacycles) and the third harmonic (90 megacycles) by 20 db more than the low *"Q"* circuit. This, in terms of power output, means that the harmonic output of the low-*"Q"* circuit will be 100 times greater than the harmonic output signal of the high-*"Q"* circuit.

For the purpose of harmonic reduction, it would be best to couple the antenna transmission line very lightly to the power amplifier tank circuit, but since any coupling lighter than "optimum" will result in low efficiency and low power output, it is seldom practical to couple lightly. It is important to realize, however, that overcoupling will seriously degrade the *"Q"* of the circuit and therefore pass larger amounts of harmonic power into the antenna. By carefully coupling to the "optimum" point, a power amplifier will produce the minimum amount of harmonics consistent with good efficiency. While a pi-network is the most effective coupling means for reducing harmonics, a simple loop, as shown in Fig. 1 is a good coupling method for low harmonic output. Since it is an inductive coupling, the harmonics are not coupled in an optimum manner. At any rate, capacitive coupling should be avoided, since this gives greater coupling at the higher carrier frequency. A considerable reduction in harmonics can be accomplished by the use of a tuned coupling circuit. This is simply a tuning capacitor shunted

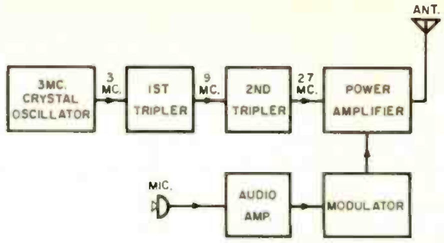


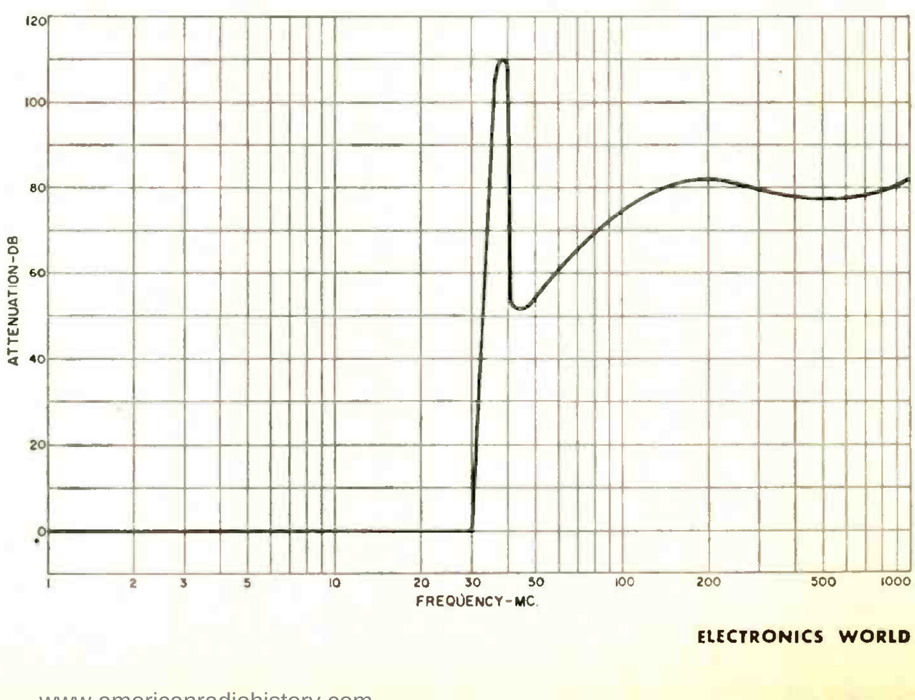
Fig. 5. Typical transmitter block diagram.

across the coupling loop, with the circuit resonated at the carrier frequency. This, in effect, adds another stage of selectivity in the path of harmonics. While it complicates the transmitter with an additional tuning adjustment, it is well worth the trouble.

The transmission line is slightly helpful in rejecting harmonics because the losses of the line are greater at the higher frequencies. From a practical standpoint, however, if the line were lossy enough to give any really significant reduction in harmonics, it would also be a very poor transmission line at the operating frequency of the power amplifier. Similarly, the antenna itself, being cut or tuned to the operating frequency of the power amplifier, generally provides a token amount of rejection at the harmonic frequencies. It is not, however, sufficient to insure that a harmonic-free signal will be radiated by the transmitter.

The best insurance against harmonic radiation is to insert sufficient rejection in the transmission line. Often, where specific cases of interference arise, a simple tuned trap in the transmission line is used to eliminate the particular harmonic that is causing the trouble. The author is vigorously opposed to this approach. In general, if a second harmonic is being radiated at a high enough level to cause interference, then the third, fourth, and higher harmonics are also being radiated at a troublesome level. The fact that the transmitter operator has received complaints only on the second harmonic may indicate that

Fig. 4. Over-all attenuation of the low-pass filter circuit discussed in the text.



there are no receivers in the area presently using the other frequencies, but it is more likely that the receiver users being interfered with on these frequencies have not yet determined who they should accuse of causing the interference.

Low-Pass Filters

Where a power amplifier is operating over a band of frequencies, a low-pass filter is the most desirable way to achieve high rejection in the transmission line. The low-pass filter causes a very low loss up to its highest operating frequency, but is very lossy at higher frequencies. A typical low-pass filter circuit is shown in Fig. 3. A plot of the response of the circuit is shown in Fig. 4. The response shown is for a filter designed to operate below 30 megacycles. For any frequency below 30 megacycles, the filter cut-off frequency, the loss is very low. However, the filter should not be used below 15 megacycles since the second harmonic of lower frequencies would not fall in the region of high attenuation.

Several sets of values of inductance and capacity are given in Table 1 for the filter circuit of Fig. 3. The table lists values for building filters to operate over most of the amateur bands and, as indicated, for lines of 72- and 51-ohms impedance. Details for winding coils for various inductances are also given. In order to accurately wind the proper value of inductance, the windings for the smaller inductances are made on common screw threads. After winding, the coils are unscrewed from the form and are self supporting.

These filters should be constructed in a completely enclosed metal case. The slip cover type of aluminum boxes are widely available and are quite satisfactory. The input and output connectors should be installed on opposite ends of the longest side of the box. Coils L_1 and L_2 should be mounted at right angles to each other to avoid mutual coupling. Partitions should be installed to separate each of the series coils (L_2, L_3, L_4, L_5) but these need not be elaborate to be effective. Even without partitions, good results can be obtained if the filter is not constructed in too small a box. A minimum length of 8 inches is recommended for the 6- and 12-megacycle filters and a minimum length of 6 inches for the 23- and 55-megacycle filters.

The power handling capability of the filter is limited by both the current and the voltage ratings of the capacitors. The standard 500-volt silver mica capacitors will be adequate for up to 200 watts through any of the filters. By using the CM-45 type micas, the 23- and 55-megacycle filters will handle up to 500 watts and the 6- and 12-megacycle filters will be adequate for a kilowatt. For a kilowatt into the 23- or 55-megacycle filter, variable air capacitors, such as the *Hammarlund* MC types, should be used. All the fixed capacitors should be of 5% tolerance.

While harmonics constitute the most common form of interference, these are by no means the only undesirable signals originating from a transmitter. The causes and methods of reducing these other types of interference will be discussed here and in Part 2.

Spurious Signals

A spurious signal is usually defined as any undesirable signal other than harmonics of the carrier frequency which is emitted by a transmitter. In general, these signals are produced by the frequency-generating circuits or in the modulation circuits. They can also be caused by parasitic oscillations in any circuit of the transmitter. A typical transmitter is shown in Fig. 5. The basic crystal frequency of the transmitter is 3 megacycles. This frequency is tripled twice to obtain the output frequency of 27 megacycles. The plate current of the first tripler contains components of the 3-megacycle as well as the desired 9-megacycle signal (third harmonic of the oscillator). Except for the 9-megacycle signal to which the plate circuit of the tripler is tuned, the 3-megacycle signal is the strongest. If the plate circuit is not selective enough, then all these frequencies will appear on the grid of the second tripler in sufficient strength to produce troublesome outputs in the plate current of the second tripler.

Two types of action are important in the second tripler. All the frequencies of the spectrum shown in Fig. 7A produce plate current components of their basic frequency and of their harmonics. In addition, there are numerous heterodyning actions. The original 3-megacycle signal, being quite strong, will produce the most annoying heterodyne. This will result in sidebands 3 megacycles away from the 27-megacycle carrier, as shown in Fig. 7B.

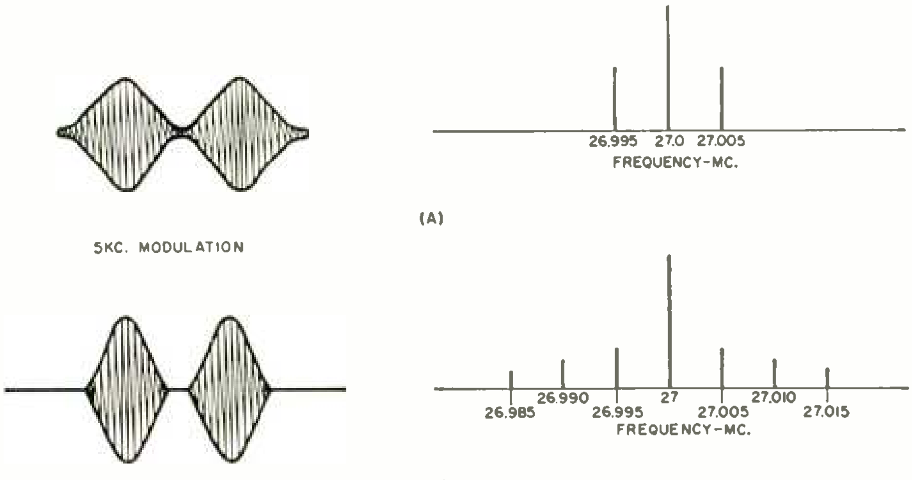


Fig. 6. Waveform and frequency spectrum for (A) proper modulation, (B) overmodulation.

Of course, all these actions occur because of the non-linearity of the individual stages. Since the non-linearity cannot be avoided (it is, in fact, necessary for the tripling action), the actual

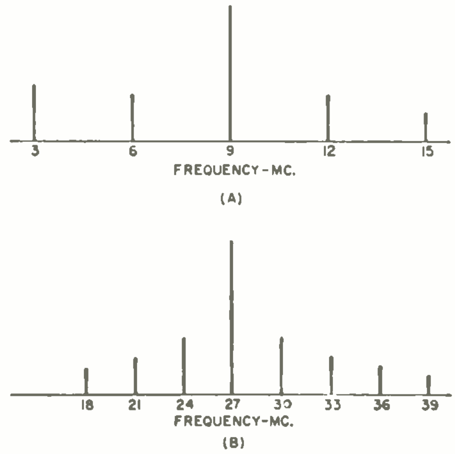


Fig. 7. (A) Output of first tripler. (B) Output of second tripler circuit.

generation of spurious signals cannot be avoided. The important thing is to transmit a signal from the antenna that is free from spurious oscillations.

This should be accomplished by rejecting all unwanted signals at the output of each stage. This, of course, means high-"*Q*" circuits. The response of two tuned circuits with "*Q's*" of 10 and 100 is shown in Fig. 2. Reference to this figure will point out the importance of "*Q*."

If all the circuits are high-"*Q*," many problems do not occur. For example, in the transmitter described, if the 3-megacycle signal is sufficiently rejected in the first tripler, there will be no 3-megacycle heterodyning in the second tripler. The 3-megacycle sidebands are much more difficult to reject in the second tripler output than is the 3-megacycle signal in the output of the first tripler.

The use of good coils in the tuned circuits is the first requirement for high-"*Q*" circuits. It is also extremely helpful to use very light coupling between stages. The power output and efficiency of the lower level stages are not too important compared to the final stages, so that light coupling is practical in the low-level stages. The modulation can also cause spurious output frequencies. It is not news to any ham that overmodulation causes "splatter." This is simply a spreading out of the normal sideband spectrum. Fig. 6 illustrates the sideband spectrum for a properly modulated single audio tone and the spectrum for an overmodulated carrier. The audio component in the second case is distorted considerably and therefore the carrier is not only modulated with the fundamental audio tone but also with the

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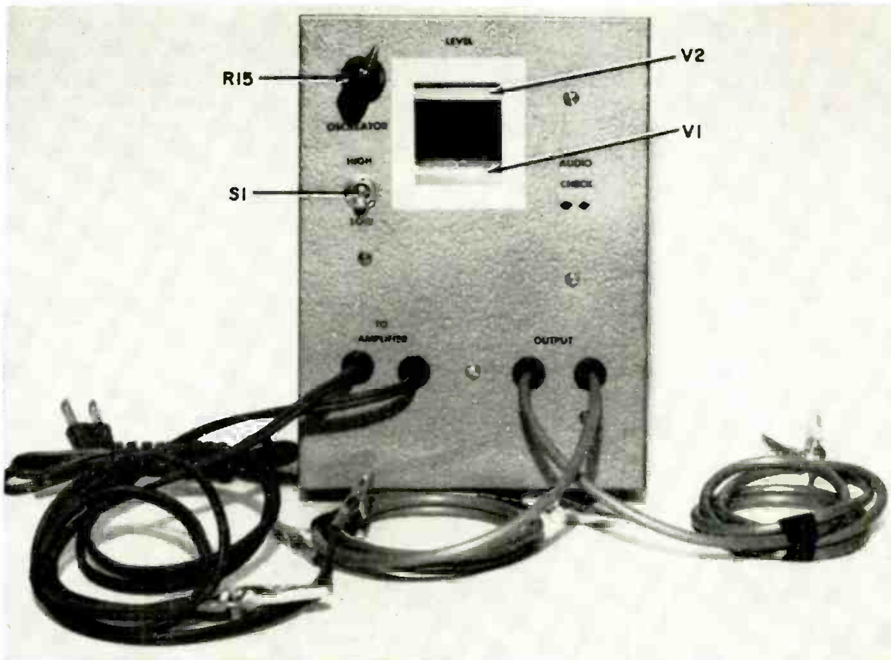


Front-panel view showing two tuning-indicator tubes horizontally mounted in window.

The "Audio Check"

By JOHN POTTER SHIELDS

A simple tester that the audiophile can build checks proper stereo balance and provides audio test signals.

HERE is a little tester that the audiophile will find very handy. It is capable of performing a number of useful and informative checks including:

(1) the visual indication of proper stereo balance by means of two of the new *Amperex* 6FG6/EM84 "wide-angle" tuning indicators. Each indicator is preceded by a stage of voltage amplification so that proper stereo balance can be checked back to the input of the amplifier. These "indicator-amplifiers" possess a very high input impedance, thereby eliminating any circuit-loading problems.

(2) The instrument provides a variable audio-frequency voltage which can be used as a steady-state signal source for simplified balance checking. The output impedance of this signal source is low (1000 ohms) thus simplifying low-impedance measurements such as checking the accuracy of balanced transformer windings.

(3) It offers a source of sharp sub-audio-frequency pulses which are useful for checking the transient response of both amplifiers and speaker systems.

All in all, this instrument will more than repay its small construction cost because of its versatility and simplicity.

Circuit Details

Basically, the "Audio Check" consists of two sections: the indicator- amplifier section and the audio and sub-audio oscillator section. The indicator-amplifier section consists of two channels, each incorporating a 6FG6 indicator tube and half of a 12AX7. In operation, signals from the two stereo channels are applied through blocking capacitors C_5 and C_6 to the grids of the two halves of the 12AX7, V_{3A} and V_{3B}. The amplified signals appear at the plates of V_{3A} and V_{3B} and are coupled by C_3 and C_4 to two half-wave rectifiers CR_1 and CR_2. Fairly high values of cathode-bias resistors are used for V_{3A} and V_{3B} in order to obtain large amounts of degenerative feedback, which tends to maintain constant stage gains of the two amplifiers as the tubes and components age. (See Fig. 1.)

The d.c. outputs from the diodes, CR_1 and CR_2, are filtered by C_1, C_2, R_1, and R_2 and applied as a control voltage to the control grids of the two indicator tubes, V_1 and V_2.

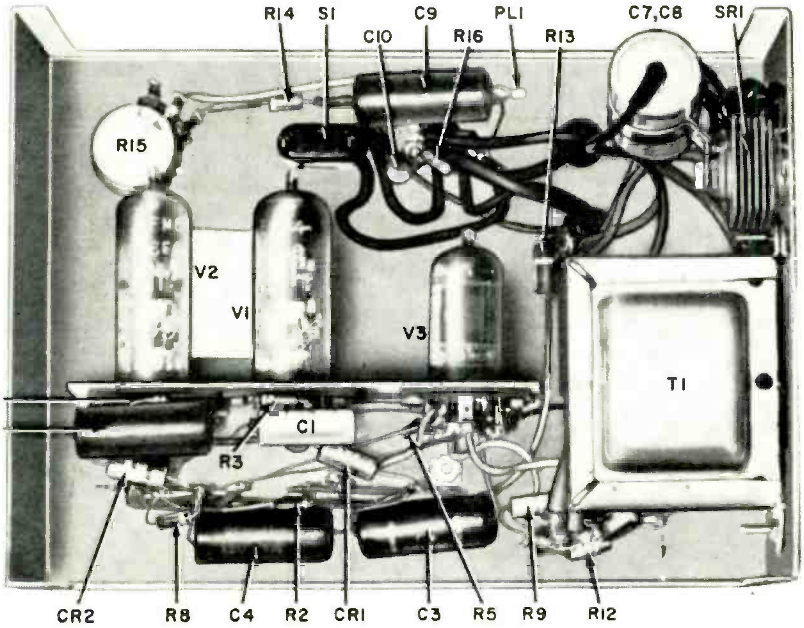
The audio and sub-audio-frequency oscillator section consists of a modified relaxation oscillator made up of PL_1, R_{14}, R_{15}, R_{16}, C_9, C_{10}, and the s.p.s.t. toggle switch, S_1.

Operation of the oscillator is as follows: When voltage is applied, C_{10} charges through R_{14} and the frequency-adjust pot, R_{15} (S_1 open). When C_{10} charges to a sufficient value, PL_1 fires through R_{16}, producing a sharp pulse across R_{16}. This pulse is coupled through the blocking capacitor C_{11} to the "To Amplifier" pairs of zip cord, terminated in alligator clips. Unshielded zip cord is OK here due to the low impedance involved. When S_1 is closed, additional capacity (C_9), is added to the charging circuit. This greatly increases the *RC* time-constant of the oscillator, lowering its operating frequency to about 1 to 25 cps.

The power supply consists of a power/isolation transformer, T_1, in conjunction with a selenium rectifier, SR_1, and the two-section *RC* filter, R_{13}, C_7, and C_8.

Construction

The "Audio Check" was built into a



Under-chassis view. A few of the resistors are hidden under other components.

standard 8" x 6" x 3½" chassis box. As shown in the photograph, a small aluminum angle bracket was used to mount the 6FG6 indicator tubes in the viewing position. In the interests of short leads, the 12AX7 was also mounted on the bracket. Although the cut-out for viewing the indicator tubes could have been made with a square chassis punch, the author used one of the "nibbling" tools to good effect. The finished unit was dressed up by applying decals after which the front panel was given a single coat of plastic spray.

Parts values are not particularly critical so your junk box can be raided to good advantage. For example, a 12AT7 or 12AU7 can be used instead of the 12AX7 with only a slight decrease in sensitivity. The values of the resistors and capacitors may vary as much as 25% without affecting circuit performance. Incidentally, the blocking capacitors C_5, C_6, and C_{11} were added to the circuit after the photographs were taken.

Operation

The "Audio Check" is simplicity itself to operate. As an example, to check the over-all balance of your stereo system, connect the two "Output" clip leads from the instrument to the terminals of the two speakers. Connect the two "To Amplifier" clip leads to the inputs of the stereo amplifier and adjust the amplifier's stereo "balance control" until the illuminated bars in the instrument's indicator tubes are the same length. If desired, you can use a standard record, tape, or tuner program source for balancing; simply adjust the "balance control" for equal indicator-bar lengths. Although the bars will be fluctuating, they are easy to see. The "Audio Check" can be kept permanently connected to the amplifier outputs without degrading the stereo system's performance. It can be quite an "eye catcher" as well as a useful adjunct to your hi-fi setup.

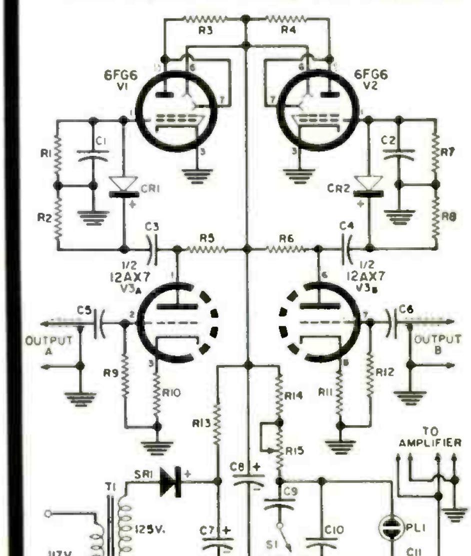
As mentioned earlier, the indicators have good sensitivity so that they can be used for checking balance back to the input of the amplifier. It should be mentioned that the output of the relaxation oscillator has been kept low (300 mv.) to avoid overloading any of the low-level stages.

The sub-audio-frequency output is useful in amplifier and speaker-system "hangover" checks. The "Audio Check" is connected to the system as previously described and S_1 is flipped to the "Low" position. As in the "High" position, R_{15} is used to vary the frequency. If the indicator tubes "bounce back" rapidly after each pulse, it can be assumed that the system has good damping qualities. To check the amplifier without the speaker, simply connect a resistor of the proper resistance and wattage rating to the amplifier's output terminals and note the action of the indicator tubes. This is an excellent over-all check and is much more informative than aural checks, especially in A-B comparisons since the ear has a notoriously "bad memory."

By placing a simple ruled scale alongside the indicator tubes, the "Audio Check" can be used as a "poor man's a.c. vacuum-tube voltmeter." Such a device is handy for making relative-gain measurements.

That is all there is to the "Audio Check." Why not build one since it is a really useful addition to any audiophile's laboratory. —30—

Fig. 1. Two shielded leads with clips on the ends serve as outputs A and B, and two clip-terminated zip-cord leads provide audio signals for testing your amplifiers.



R_1, R_2, R_7, R_8, R_{14}—2.2 megohm, ½ w. res.
R_3, R_4—470,000 ohm, ½ w. res.
R_5, R_6—150,000 ohm, ½ w. res.
R_9, R_{12}—220,000 ohm, ½ w. res.
R_{10}, R_{11}—6800 ohm, ½ w. res.
R_{13}—680 ohm, 1 w. res.
R_{15}—10 megohm linear taper pot
R_{16}—1000 ohm, ½ w. res.
C_1, C_2, C_3, C_4, C_9—.1 µf., 400 v. capacitor
C_5, C_6—.05 µf., 400 v. capacitor
C_7, C_8—20/20 µf., 150 v. elec. capacitor
C_{10}—.001 µf., 600 v. capacitor
C_{11}—.05 µf., 600 v. capacitor
SR_1—65 ma. selenium rectifier
S_1—S.p.s.t. switch
PL_1—NE-2 neon bulb
CR_1, CR_2—1N38, 1N58, 1N34, etc. crystal diode
T_1—Power trans. 125 v. @ 50 ma.; 6.3 v. @ 2 amps. (Stancor PA-8421 or equiv.)
V_1, V_2—6FG6/EM84 tuning indicator tube (Amperex)
V_{3A}, V_{3B}—½-12AX7 tube

Power-Line Carrier Communications

Power companies use their lines for voice communications, telemetering, and signalling. Here is how it is done.

By R. H. MURRELL
Brazos Electric Power Co-op., Inc.

IN THIS age of missiles, u.h.f., microwave, radar, etc., there is one important branch of communications about which few people seem fully aware. As a technician for an electric power distribution co-op, the author often encounters a rather general ignorance about one of the interesting phases of communications work, namely power-line carrier (PLC) and telemetering.

If one takes a sensitive receiver close to a power distribution line and tunes between 50 and 200 kc., he will hear a weird assortment of whistles, pulses, clicks, vibrating tones, and speech. This all takes place over power-line carrier systems which are used in conjunction with most power distribution systems. Uses for PLC include voice communication, telemetering, supervisory control, teletypewriter, telegraph, and signalling. FM is usually used because of its immunity to noise, which can run quite high on 69-kv., or more, lines.

In order to investigate the application of such equipment, let's take a look at the system with which the author is most familiar. Power is generated and distributed through more than 1200 miles of 69-kv. lines extending over a large area in central Texas. At various points on these lines there are switching stations and distribution points, commonly called substations. Key stations have PLC connections to a central dispatcher for directions to line personnel regarding switching, generation and voltage control, troubleshooting, etc.

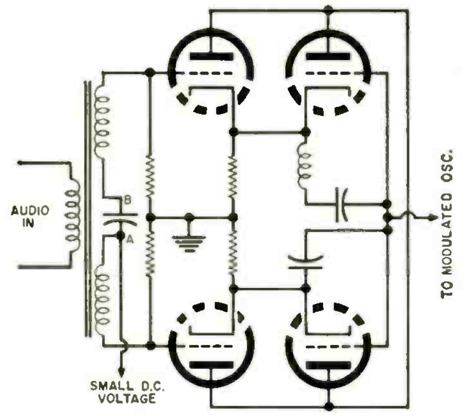


Fig. 1. Balanced reactance modulator used in power-line carrier communications transmitters. A d.c. voltage can be applied to either A or B to reverse frequency shift.

There are four generating plants in the system with a possible peak of 110 megawatts at 69 kilovolts. All pertinent electrical information, including volts, megawatts, and reactive power, is telemetered. There are ties to other distribution systems which are also telemetered. The system includes eleven telemeter stations measuring twenty-eight quantities. Voice channels go to fourteen points in the system. Everything terminates at Whitney Dam where it is put on microwave and received at the central office in Waco, Texas. This is done because the home office is some 20 miles from our nearest power lines and dependable phone service is not available. The accompanying photos and diagrams should indicate how the system operates.

Equipment Employed

The equipment included in the system involves a 10-watt transmitter and associated receiver. Ten watts will give a good signal over about 125 miles of line with a signal loss of about .25 db per mile; more on higher frequencies and less on the lower frequencies. The sets are coupled to the 69-kv. transmission line through coupling capacitors which range from .001 to .005 μf. (see Fig. 2). Obviously these won't do for subminiature circuit work as they weigh over 500 pounds and are about 4 feet tall! Series traps (Fig. 4) are inserted at terminal points to keep the line impedance high, to keep signal paths short, and to keep interconnected

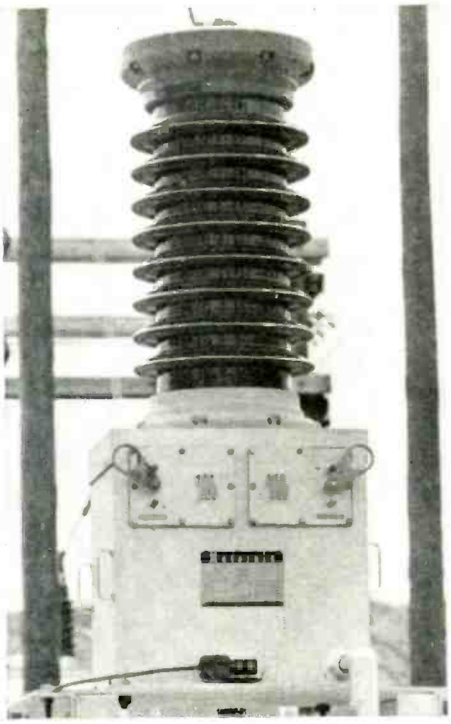


Fig. 2. This is a 69-kilovolt line-coupling capacitor. The unit is made up of a group of capacitors connected in series.

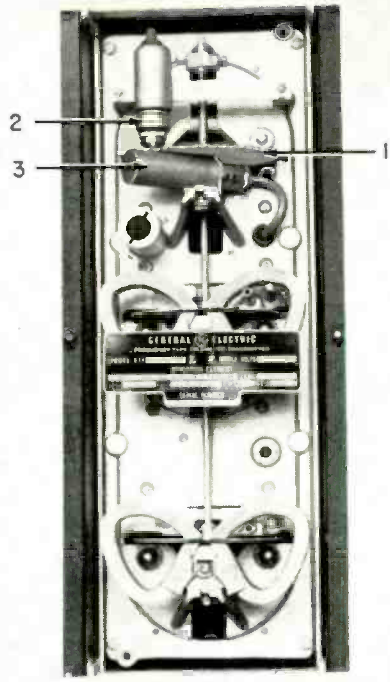


Fig. 3. Telemeter transmitter unit. The serrated disc (1) with associated light source (2) and photoelectric cell (3) can be seen as the top assembly on the shaft.

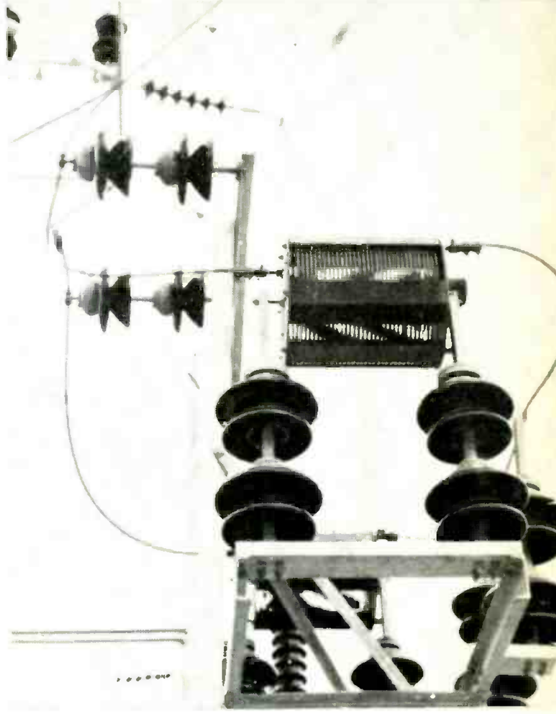


Fig. 4. Series traps used at terminals and at ties with other systems. These are 2 feet in diameter and carry up to 800 amps.

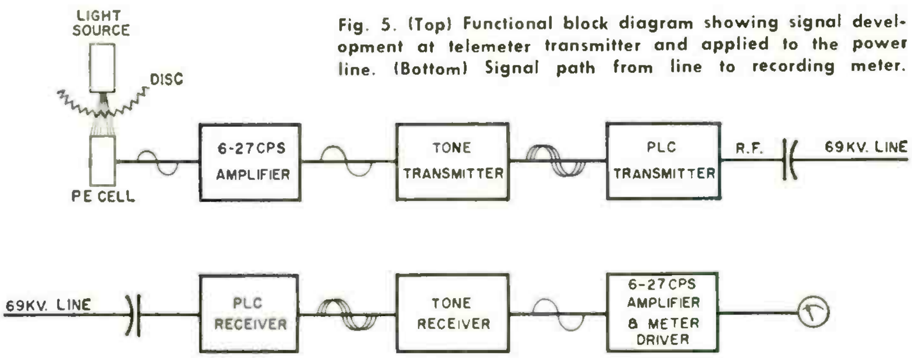


Fig. 5. (Top) Functional block diagram showing signal development at telemeter transmitter and applied to the power line. (Bottom) Signal path from line to recording meter.

systems isolated at radio frequencies.

The receiver, which will be described for voice communication, is highly selective in the front end, having an input filter which is over 100 db down 20 kc. off center frequency. This is important due to a crowded spectrum in this band. The rest of the receiver is typical of good FM circuitry, including a squelch circuit and keying relay facilities. In addition, a frequency shift circuit is used to energize a ringing relay, this being done in the discriminator circuit. When the receiver is receiving its center frequency, discriminator output is, of course, zero. When a slightly shifted frequency carrier is received, the discriminator output swings from zero, rising in voltage as frequency swing increases. This voltage is applied to a control tube which draws plate current through a relay, causing a telephone to ring or actuate other devices.

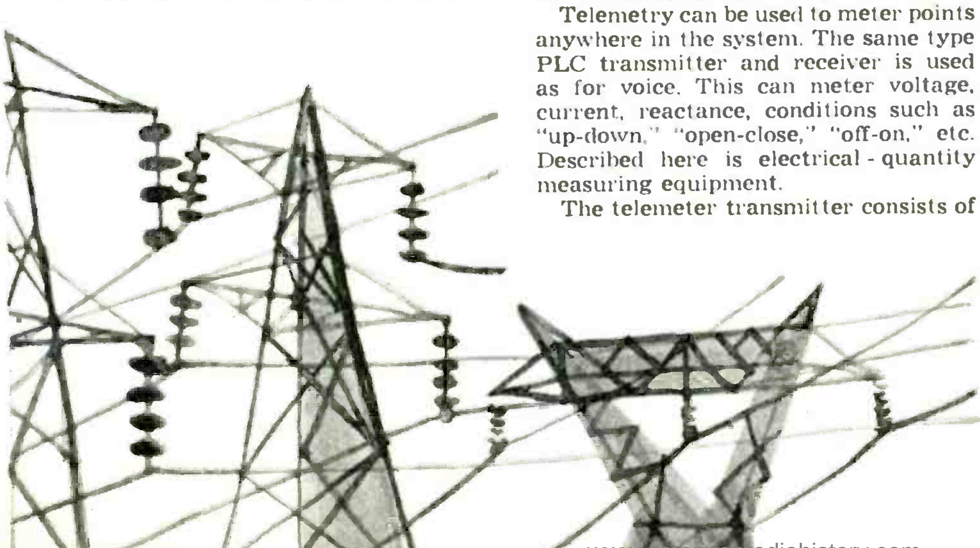
The transmitter uses two 6L6 tubes operated class A as the plate amplifier feeding 10 watts into the line through an appropriate matching unit. A crystal oscillator and variable oscillator are beat to give the operating frequency. A balanced reactance modulator is used to give low distortion and close frequency control (Fig. 1). This type of modulator is sensitive to a difference in d.c. voltage on the grids so this feature makes it ideal for shifting the frequency by applying a small voltage to one grid. This shifts the frequency about 2 kc. which actuates the control relay in the receiver, as outlined previously.

Telemetry can be used to meter points anywhere in the system. The same type PLC transmitter and receiver is used as for voice. This can meter voltage, current, reactance, conditions such as "up-down," "open-close," "off-on," etc. Described here is electrical-quantity measuring equipment.

The telemeter transmitter consists of a wattmeter (Fig. 3) with (1) an added serrated disc, (2) a light source, and (3) a photoelectric cell. As the wattmeter rotates, the teeth on the disc vary the light beam to the photoelectric cell, causing a sine wave to be developed across its load. This signal, ranging from 6 to 27 cps, is then amplified and used to frequency-modulate the tone transmitter which operates between 500 and 3100 cps. This FM tone then modulates the PLC transmitter which is coupled to the 69-kv. line (Fig. 5).

The PLC receiver takes the signal from the 69-kv. line. The audio output couples to the tone receiver which removes the high-frequency component. The remaining original 6-27 cps tone is then applied to the telemeter receiver where it is rectified and applied as a quantity to recording meters. As can be seen, this is a very complex system which contains frequency-modulated FM signals. This technique provides a high immunity to noise.

In addition to the features described, repeater stations may be used for long distance operation or microwave can fill in gaps where wire lines may not be accessible, such as is the case from Whitney Dam to Waco. —30—



By **JOHN T. FRYE**

MAC'S service shop

Business Nobody Wants

THINGS were a little slow in the service shop. Christmas was over, everyone was broke, and income-tax-paying-time was already a low cloud on the horizon. Barney had spent all morning giving the service department a thorough cleaning, wiping and waxing the instruments, repairing frayed test leads, and putting the hand tools in order. Now he was perched on a high stool watching Mac, his employer, working carefully and gently on the printed-circuit chassis of a transistor receiver.

"You know something, Mac?" he finally said; "you're getting a reputation I don't envy a bit. In the last few months several people have remarked you're a real hot-shot on transistor sets. That's a compliment like having someone going around telling everybody you're a soft touch for a loan. I've a sneaking hunch some of our competitors are starting the nasty rumor because they don't want to fool with the exasperating, time-wasting, money-losing little sets. I don't blame the boys for feeling that way, but I think it's a nasty trick foisting the transistor jobs off on you. But you—you actually act like you *enjoy* working on the little cusses!"

Mac reflected a few moments before he answered: "Barney, for a long time now I've tried to keep from thinking about my work in terms of what I like to do and what I don't like to do. It all has to be done, and the less emotional you are about it the better. You can waste more energy dreading a job than it takes to do it.

"I guess I'm kind of simple minded, for it has always been easy for me to become interested in what I'm doing, whether that be running down a cause of audio distortion, curing a case of vertical jitter, stringing a dial cord, or even resuscitating a dead transistor set."

"But you can fix three a.c.-d.c. sets in the time it usually takes to locate trouble in one of these little transistor jobs that has been dropped—and most of them have been, whether the owner admits it or not," Barney pointed out. "Freeing components from the compact printed circuit in order to test them is about six times as hard as it is in the uncrowded wired chassis of the tube receiver. Most transistor components are special jobs, difficult to obtain except from the manufacturer. It is practically impossible to keep a really adequate stock of replacement transistors without danger of being stuck with a lot of them that will never sell. There are a zillion types out already, and new ones are coming out every day. The new ones are better and quickly make obsolete the old ones. You can't charge on the same time-rate basis you use for a.c.-d.c. receivers, for the original cost of new transistor sets simply will not permit it. If the service charge becomes substantial, the owner simply junks the set and buys a new one. How do you square all that with your Scottish instincts?"

Mac's face crinkled into a grin as he replied, "Hoot,mon! I'll admit I wrestled with that one for quite a spell, and here's how I finally pinned it to the mat: I know I'm making less money working on transistor sets *now* than I could make working on a.c.-d.c. receivers, but I tell myself that part of the pay for the tedious transistor work comes in the way of valuable experience gained. The only reason I can turn out the little tube sets like hotcakes is that I've accumulated years of experience working on them. Little by little, day by day, I'm acquiring the same sort of experience with transistorized receivers. On the average, it doesn't take me as long to locate trouble with one now as it did a year ago. A year from now it will take less time. I'm beginning to know *where to look* for the causes of many symptoms, and that's how you gain speed in servicing."

Mac hesitated for a moment and then continued. "This will be hard for you to believe, but I can remember when many technicians felt the same way about a.c.-d.c. sets as a lot of fellows feel about transistor sets today. After working on the high-quality, roomy console receivers sold during the late 1930's, the boys felt it was quite a come-down to have to work on the low-cost, comparatively crowded five-tube jobs. They spoke of them disparagingly as 'cracker-box' and 'punch-board' receivers and said you couldn't make any money working on them. After all, when you got a console set in for an overhaul, you usually replaced three or four tubes, several capacitors, and gave it a complete alignment job on all bands. The bill would often run twenty or thirty dollars, especially if you had to replace a power transformer or a dynamic speaker. This was as much as an a.c.-d.c. receiver cost.

"But after a while the smart boys discovered they could locate a bad tube in an a.c.-d.c. set and replace it while they were taking the back off a big console. What's more, the little receivers were harder on tubes. They made two or three trips to the service shop for every one of the console receivers. Most of the troubles with the little radios were easily diagnosed and quickly corrected after you became thoroughly familiar with them. They were easily handled, took up little room in the shop, and were usually brought in and picked up by the owner. You could actually make more money, easier, working on the little sets than on the big transformer jobs; and this was a good thing, for consoles were on their way out."

"And you think you see a parallel," Barney commented.

"That's right. It takes no great seer to predict the transistor receiver will soon become the most popular household radio. The smart technician, realizing this, will stop wasting energy disliking transistor receivers and start learning how to fix them fast."

"If I know you, you have some ideas on how to do that."

"Naturally; want to hear 'em?"

"Since when did I have a choice? I'm your captive audience. Go ahead."

"That's what I like: enthusiasm! Well, the first thing to do is to check the battery voltage *under load*, no matter if the customer assures you he has just installed new batteries. He may have purchased the batteries from a place with a low turn-over, and they may be half exhausted to start with. If they are even a little low, put in new batteries so that the proper source potential will be applied to the voltage distribution network."

"You mean you can't expect to find proper voltages at the transistor terminals if the battery voltage itself is off."

"Right. If the radio is dead, or if all you can get out of it is a click when it is switched on or off, I suggest you next try the 'looking-and-tapping' technique. Look the printed circuit over carefully under a good light for any signs of cracks in the board or conductors or poorly soldered connections. An illuminated magnifier is very fine for this. Quite often you can spot a hairline crack in a conductor more easily by shining a light through the translucent board from the other side.

"If you can't see anything wrong, start a little gentle pushing, flexing, and tapping of the printed circuit board

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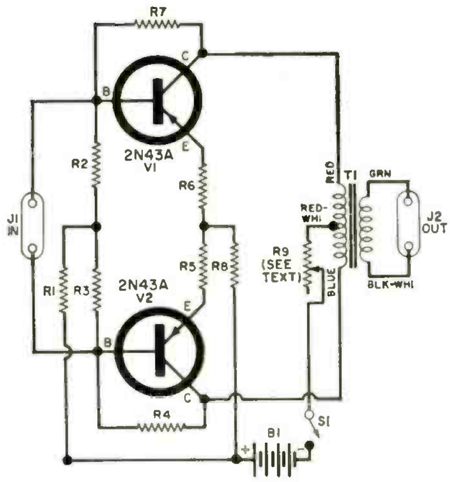

R_1—10,000 ohm, ½ w. res. ±5%
R_2,R_3—1000 ohm, ½ w. res. ±5%
R_4,R_7—16,000 ohm, ½ w. res. ±5%
R_5,R_6—160 ohm, ½ w. res. ±5%
R_8—3300 ohm, ½ w. res. ±5%
R_9—5000 ohm pot (see text)
S_1—S.p.s.t. toggle switch
J_1,J_2—Banana jack, phono jack, etc. (optional with builder)
T_1—Low-level audio output trans. 15,000 ohms c. t. to 500/600 ohm sec. (Triad A65J or equiv.)
B_1—22½ volt battery
V_1,V_2—2N43A transistor

Circuit diagram of the balanced two-transistor audio line amplifier unit.

Transistorized Audio Line Amplifier

Front-panel view of the 600-ohm line amplifier, dubbed "Trans-Line" by author.

By **DAVE STONE**

Build the "Trans-Line," a compact, battery-operated, highly stable amplifier that may be used to boost low-level audio signals over a 600-ohm audio line.

THIS transistorized audio line amplifier, dubbed "Trans-Line" by the author, is particularly useful to the serious audio hobbyist, the public-address system service technician, and the broadcasting or recording studio engineer. It is a compact, battery-operated, highly gain-stable amplifier which can be used to boost low-level signals over a 600-ohm audio transmission line.

This versatile unit can be used between many types of preamplifiers or tuners to drive a wide variety of power-amplifier systems, or it can be used as a general-purpose preamplifier in applications where a fixed amount of dependable and constant amplification is needed.

Two inexpensive transistors, nine resistors, and a good quality audio transformer provide the "Trans-Line" with a frequency response that is ±2 db from 20 to 20,000 cps. It supplies from 3 to 10 times voltage gain, depending upon the supplied battery voltage. The line amplifier can handle a maximum input level of approximately 200 millivolts across the 600-ohm input impedance and delivers a maximum undistorted output of 1.5 volts across the 600-ohm output impedance.

Circuit

The "Trans-Line" amplifier's uncomplicated circuit uses two 2N43A audio transistors arranged as a balanced amplifier to drive an output transformer in class AB operation. Resistors R_1 through R_7 provide shunt and series feedback for utmost stability, and the remaining resistors set the biasing and operating level.

The input signal is fed directly to each base from any low-impedance balanced or unbalanced source. Either base input can be grounded, as well as either side of the secondary output winding, and either output or input can operate as a balanced pair when the other side is unbalanced.

Resistor R_9 sets the voltage level applied to the transistors and, in turn, the amount of gain obtainable from the circuit. It can be either a fixed or a variable resistance, depending on the constructor's need for a fixed or variable gain amplifier. A higher applied voltage will produce higher gain at the expense of higher battery current drain. In the unit shown in the photographs, R_9 is 2000 ohms which allows 14 volts at 4 ma. drain for a fixed gain of 14 db or 5 times voltage gain.

Power is furnished by a standard 22½-volt battery which, for intermittent use, can be the miniature type shown mounted within the amplifier enclosure. If the line amplifier is to be used for long periods of time, a larger battery can be used and mounted external to the unit. Note that the positive terminal of the battery is not connected to the chassis ground.

Construction and Use

The resistors, transistors, transformer, and small battery are all mounted on a 4½"x 2½" perforated board which is fastened inside a 2"x 3"x 5" "Minibox" with small angle brackets. The power switch, S_1, and the input and output jacks are mounted in one wall of the enclosure. There is absolutely nothing critical about the construction or layout so any enclosure or signal jacks can be used. If the constructor desires, the standard phono jack or phone plug with one permanently grounded side can

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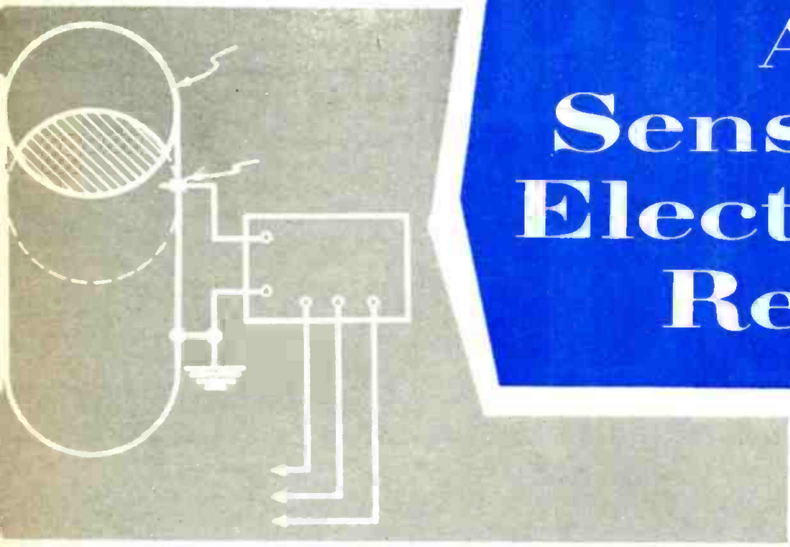
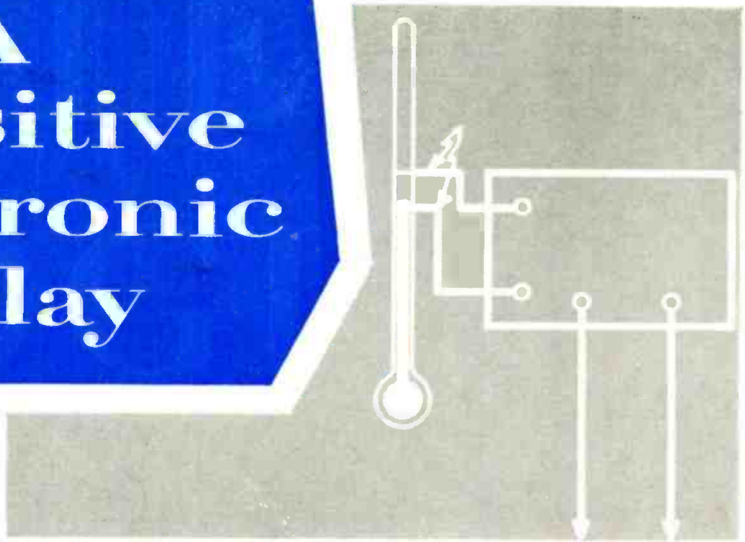


A Sensitive Electronic Relay



By **LOUIS E. GARNER**

Build this simple, reliable circuit that is so sensitive that a breath can operate it. Can also be used to make games, for industrial control, as intrusion alarm.

REALLY sensitive magnetic-type relays are expensive and delicate. In addition, even the most sensitive of electromagnetic relays requires that a comparatively low resistance be placed across the energizing contact terminals if sufficient current is to flow to close the relay.

An electronically operated relay, on the other hand, can be built quite inexpensively, while maintaining high standards of ruggedness and reliability of operation. With a comparatively simple circuit, an electronic relay can be made so sensitive that, quite literally, the human breath can be used to set it off.

The electronic relay shown in Fig. 1 uses only four resistors, one tube, one capacitor, and one inexpensive plate-circuit relay. The average technician should be able to assemble the entire unit in a few hours at a cost not exceeding ten dollars for materials. Irrespective of the simplicity of the circuit, this relay is so sensitive that the moisture condensation from the breath is sufficient to operate it. For example, in Fig. 1, the relay has been operated by a pencil line that has been drawn on a piece of paper.

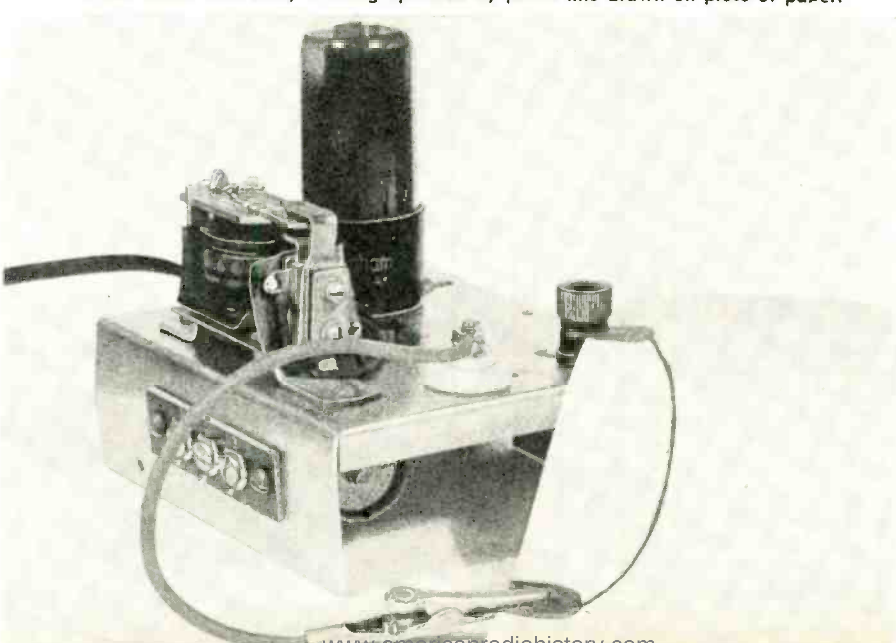
A current on the order of microamperes is all that is necessary and thus any resistance between zero ohms and twelve megohms placed across its input terminals is enough to operate the unit (to close or open the contacts). In fact, even connecting the input leads of a d.c. vacuum-tube voltmeter across the actuating contacts will cause the relay to operate.

With such sensitivity, the applications of the electronic relay are almost limitless. It may be used for experimental work, in the home, as an interesting game, in industrial control applications, as an effective intrusion alarm, or as an auxiliary circuit for other electronic devices.

The Circuit

A conventional half-wave rectifier (V_{1B}) is used to supply a d.c. voltage, with capacitor C_1 providing adequate

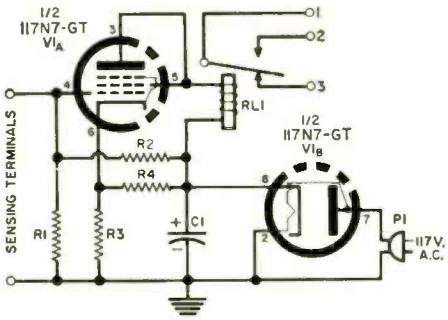
Fig. 1. The electronic relay uses only four resistors, one tube, one capacitor, and one inexpensive plate-circuit relay. The entire unit can be assembled in just a few hours. Here relay is being operated by pencil line drawn on piece of paper.



filtering of a.c. ripple. In order that the input terminal will be sensitive with respect to ground (needed for some applications), the d.c. supply is obtained directly from the a.c. line, rather than using an isolation transformer. Because of this, a polarized line plug, P_1, should be used to reduce or eliminate danger of shock and short-circuits.

V_{1A} is a beam-power tube which is housed in the same envelope with V_{1B}. For purposes of relay operation, a triode is satisfactory and, therefore, the screen grid is tied to the plate of the tube.

The plate-cathode current of V_{1A} flows through R_3 and the plate-circuit relay (RL_1). R_3 is purposely made large in value so that a comparatively high bias voltage is developed across it. This bias



R_1—10 megohm, ½ w. res.
R_2—20 megohm, ½ w. res.
R_3—2700 ohm, 2 w. res.
R_4—10,000 ohm, 2 w. res.
C_1—50 µf., 150 v. elec. capacitor (see text)
RL_1—S.p.d.t. plate-circuit relay, 2500-ohm coil
P_1—Polarized line plug
V_1—117N7-GT tube (see text)

Fig. 2. Circuit of the sensitive electronic relay. Tube selection is not at all critical. Refer to the text for a complete discussion of substitutions.

voltage is increased still further by a bleeder current from the "B" supply, obtained through R_4. The bias obtained in this manner is usually sufficient to reduce the plate current of V_{1A} until the relay is open.

This bias is, however, partially cancelled by a positive voltage applied to the grid of the tube from a voltage divider made up of R_1 and R_2. Thus, with the input or "sensing terminals" open, sufficient current flows to keep RL_1 closed in the position shown.

The relay is a s.p.d.t. model, permitting the unit to be used to either "open" or "close" an external circuit, depending on the needs or preferences of the user. Normally, terminals 1 and 3 in Fig. 2 are closed while terminals 1 and 2 are open.

The resistors in the voltage divider, R_1 and R_2, are purposely made extremely high in value. Under these conditions, shunting even a high resistance across R_1 will reduce the positive voltage applied to the grid of the tube, thus reducing plate current and permitting RL_1 to open. This opens terminals 1 and 3 and closes terminals 1 and 2.

Because of the high degeneration in the circuit, tube characteristics are not critical and a wide variety of tubes may be employed. In addition, the circuit is almost self-regulating, so that the relay

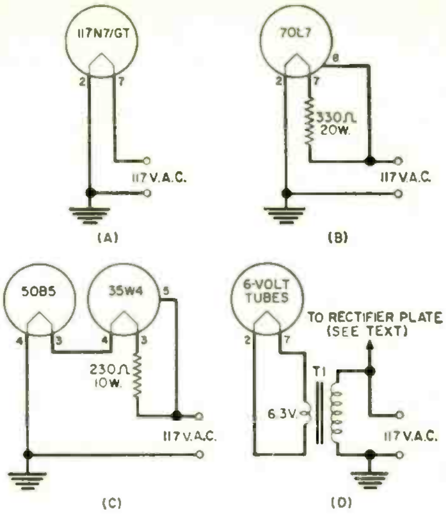


Fig. 3. Here are some of the possible circuit variations for the heater supply that may be used for substitute tubes.

will tolerate fluctuations and changes in line voltage.

Construction Hints

The only critical item to consider when building this unit is the insulation between grid and ground. A good-quality tube socket should be used while the input terminals should be moisture-resistant ceramic feedthrough insulators. As far as the rest of the wiring, layout, distributed capacities, etc. are concerned, they are strictly up to the builder.

The author's model, shown in Fig. 1, was intended primarily for experimental work and hence was built on a small aluminum chassis. However, the unit may just as well be built in a standard metal utility box, inside an intercom cabinet, or, for industrial or commercial applications, inside a standard electrical fuse box or switch box.

Where the tube used by the author is employed, heater connections are as shown in Fig. 3A. However, as we shall see later, quite a number of substitutions may be made in the circuit without appreciably affecting the operation of the circuit.

Parts Substitutions

Even though very few parts are used in this device, parts which are standard and for the most part easily obtainable, it is possible to make a number of substitutions. In this sense, then, this electronic relay is almost an experimenter's "dream" since no difficulties should be encountered in obtaining suitable parts.

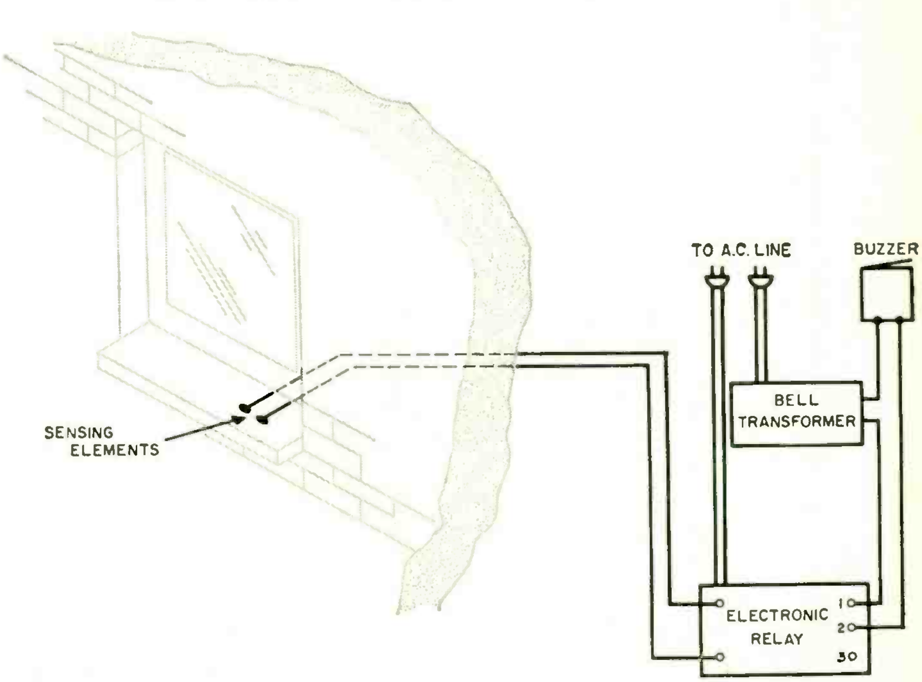
Let us first consider the tube. The author used a 117N7-GT, simply because he had such a tube available. By using a heater resistor or line cord, a type 70L7-GT could be substituted directly. Or, again using an appropriate heater resistor or line cord, a 50B5 and 35W4 may be used. See Figs. 3B and 3C for correct heater connections. Other suitable tubes are 50L6, 35L6, and 35B5 for the relay tube and 35Z4, 35Z5, or a selenium rectifier for the rectifier tube.

If six-volt tubes are available, or preferred by the builder, a 6-volt, 1-amp. filament transformer may be used, as shown in Fig. 3D. Under such conditions, the relay tube may be a 6K6, 6F6, 6V6, 6AQ5, etc., while the rectifier may be a 6X4, 6X5, selenium rectifier, or even another power tube diode-connected.

Almost any plate-circuit relay having a coil resistance of from 2500 to 10,000 ohms will be suitable. The author used a *Potter & Brumfield* Type LB5.

The size of capacitor C_1 is not critical. Use any electrolytic with at least a 150-volt rating and a capacity of from 20

Fig. 4. A very satisfactory rain or dampness alarm may be made by using this setup. Author tried out the unit by using two conductors on a piece of linoleum about 6 inches apart. Breathing on the linoleum produced enough moisture to operate relay.



to 80 μf. Either a tubular or upright capacitor may be employed.

R_1 and R_2 may be made up by using series-connected resistors if the proper sizes are not available.

As far as R_3 and R_4 are concerned, the values are reasonably critical and should be determined experimentally by the builder for the particular tube and relay he is using in his model. If it is found that the relay does not open when the "sensing terminals" are lightly touched with the fingers, increase the size of R_3 or reduce the size of R_4 (or both). If it is found that the relay remains open at all times, reduce R_3 or increase R_4 (or both).

Should the builder use exactly the same tube and other parts as the author, the values given in the parts list for R_3 and R_4 are satisfactory.

Applications

To attempt to describe or illustrate all or even the majority of the possible applications of this electronic relay would require too much space, thus only a few of the more typical uses will be discussed in the hope that these applications will serve as a guide to the builder or experimenter.

Capacitor Checker: This unit makes an excellent tester for leakage in paper, mica, or ceramic capacitors. To use, connect the capacitor's leads across the input terminals. If the capacitor is good, the relay will first open and remain opened until the capacitor has charged through the 20-megohm resistor, R_2, after which the relay will close. If the capacitor is leaky, the relay will remain open.

The time necessary for the capacitor to charge is determined by the size of the capacitor since R_2 is fixed. Hence, with practice it is possible to estimate the approximate value of the capacitor (.01 μf. and larger) by noting the time interval between the relay opening and then reclosing.

Dampness or Rain Alarm: A very satisfactory rain or dampness alarm may be made by using the connections shown in Fig. 4. As a test of its sensitivity, the author placed two conductors, about 6 inches apart, on a piece of linoleum. The relay remained closed. Breathing on the linoleum caused enough moisture condensation to operate the relay.

Burglar or Intrusion Alarm: An extremely thin (#32 or smaller) copper wire or metal foil may be cemented around windows or strung across openings. The free ends are connected to the input terminals of the relay. With these connections, the relay will normally remain open. Should the conductor be accidentally broken at any point, the relay will close. This may be used to operate a buzzer, light, alarm bell, or other signalling device.

Game: A very interesting game of skill may be made by drawing a maze on a piece of paper, using a soft pencil or carbon India ink. See Fig. 5. Two square blocks are drawn on the paper to serve as contact terminals and these, in turn, are connected to the input terminals of the electronic relay. One of the squares is connected through a heavy line to the maze.

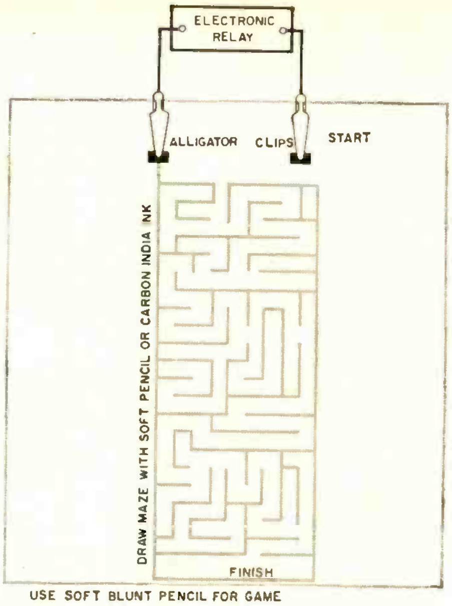


Fig. 5. The electronic relay is used to play games too. If any of the walls or lines in this maze are touched by the player, then the alarm will be set off.

The electronic relay may then be connected to operate a buzzer, doorbell, light, or other indicating device.

To play the game, a soft-lead, blunt-pointed pencil is used to draw a continuous line from the "Start" square through the maze to the "Finish" line. Not only is it necessary to correctly trace through the maze but care must be taken not to touch any of the "walls," otherwise the alarm will be set off.

Any maze design preferred by the builder may be used. However, care should be taken that all "walls" and "partitions" are interconnected electrically so that the relay will work, irrespective of which wall is touched. Reasonably thick lines should be used to insure a continuous circuit throughout the maze.

If desired, several electronic relays may be built and duplicates of the maze prepared. Each player can be identified by a different buzzer tone or a different colored light. A time limit can be set on solving the maze without setting off the alarm.

The degree of skill required is dependent on the complexity of the maze and the spacing permitted between walls and partitions. By using a fairly complex maze, together with very narrow passageways, the game can be made interesting even to adults.

Another Game: Still another game involves placing extremely small holes in a thin metal sheet, connecting the sheet to one of the relay input terminals. Next, connect a small needle or probe to the other terminal of the relay through a thin, flexible, insulated wire. The trick here is to pass the needle through the small hole without touching the sides.

The closer the needle size is made to the diameter of the hole, the more difficult the game becomes. If the tolerances are sufficiently close, only those with the steadiest hands and the greatest skill will be successful.

Floatless Liquid-Level Control: The level of any conducting liquid in a metallic tank may be easily controlled or indicated without employing a mechanical float by adopting the system shown in Fig. 6A.

The grounded input lead from the electronic relay is connected to the tank while the ungrounded lead is attached to a "sensing probe" in the side of the tank at the desired level. A feedthrough insulator must be used to isolate the "sensing probe" from the tank.

The relay may be used to operate an indicating light, bell, buzzer, or similar device. Or it may be used to control a solenoid valve or pump motor.

For satisfactory operation, the liquid in the tank should be a conductor, even if a poor one. This, however, includes a wide variety of liquids such as water, milk, brine, or acidic or salt solutions.

Temperature Control: Often it is desirable to be able to check or control temperatures electrically if for some reason or another a thermostat of the bi-metallic type is not suitable. Such applications might include rooms where there is explosive vapor, controlling the temperature of liquids in a tank, etc. For such applications, the electronic relay, together with a specially designed mercury thermometer make an ideal combination.

Fig. 6. (A) The level of any conducting liquid in a metallic tank may be controlled or indicated as shown here. (B) Typical temperature-controlled setup employing a mercury thermometer with "built-in" leads.

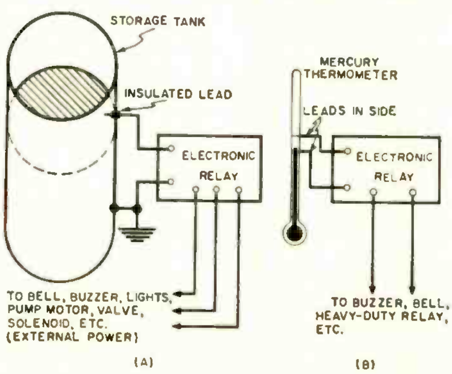


Fig. 6B shows a typical setup suitable for this application. The relay may be used to control an indicating device such as a light, bell, or buzzer when the desired temperature is reached or, if preferred, may be used to switch a heating element on or off to maintain the desired temperature (through an auxiliary heavy-duty relay).

Other Applications

An effort has been made to list typical applications of the electronic relay in the home, in games, and in industrial fields. In so doing, it is hoped that many additional applications will have occurred to the builder. Such applications may include the use of the relay as a pressureless switch, in sorting, as a limit switch, or for insulation testing.

—30—

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Accurate Peak A.C. Measurements

By **L. W. BORN**
Plaza TV & Hi-Fi

Techniques for obtaining highly accurate readings and details for a circuit with laboratory precision.

THERE are many occasions when it is necessary to know the peak voltage of an a.c. signal accurately. A case in point is the measurement of intermodulation distortion produced by a high-fidelity amplifier. Determination of peak power output is usually made by measurement of the peak a.c. voltage developed across a load resistance, and peak power is computed from the well-known relationship, $P=E^2/R$.

Many a.c. voltmeters, even some rated as peak-reading instruments, introduce serious errors. To continue with the example of the intermodulation measurement, the test signals usually used consist of a 60-cycle signal mixed with another signal higher in frequency, usually 6000 or 7000 cps, whose amplitude is one-fourth that of the low-frequency a.c. A peak-reading instrument may respond differently to different frequencies. This article is concerned with accurate measurement of the peak value of complex waveforms, especially when developed across low resistances, such as those normally used as amplifier loads. In addition to the considerations involved and some basic configurations for measurement, a refined circuit for very precise measurement will be presented.

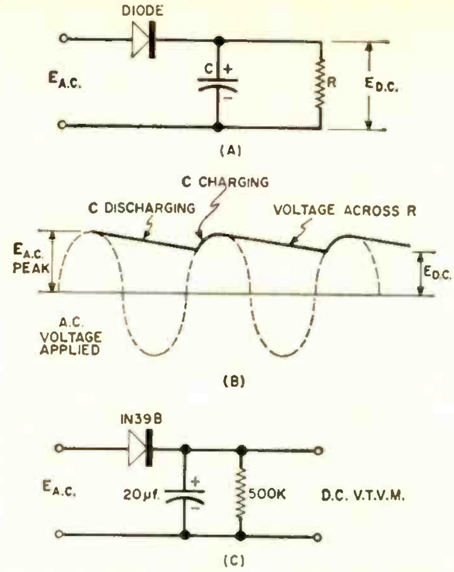


Fig. 1. (A) Basic peak-reading voltmeter circuit. (B) Waveform across R. (C) Test circuit. See text.

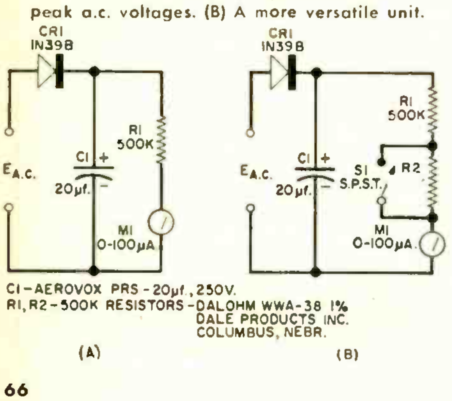
Basically, the peak-reading voltmeter consists of a diode rectifier with adequate inverse voltage rating, operating in series with a parallel combination of resistance and capacitance, as shown in Fig. 1A. The voltage developed across the resistance has a waveform like that shown in Fig. 1B, with the d.c. component approaching closer and closer to the a.c. peak value as the product ωRC (where $\omega=2\pi f$) becomes larger and larger. The d.c. component is about 5 per-cent lower than the peak a.c. voltage when $\omega RC=50$; 1 per-cent low when $\omega RC=180$; and ½ per-cent low when $\omega RC=628$. As an approximation, we may say

$$E_{d.c.}=E_{peak}\left(1-\frac{\pi}{\omega RC}\right)\quad\text{..........(1)}$$

For a frequency of 60 cycles, a resistance of one-half megohm and a capacitance of 20 µf., ωRC is equal to 3768 and the d.c. voltage across the resistance is within one-tenth of one per-cent of the peak a.c. voltage being measured. By using a d.c. vacuum-tube voltmeter of adequate accuracy, the peak a.c. voltage is measured simply by measuring the d.c. voltage across the resistance R.

The input resistance of the v.t.v.m., usually about 11 megohms, will introduce no serious error in the measurement since its only effect will be to alter the product ωRC almost imperceptibly. This simple arrangement, shown in Fig. 1C, may be used to check the performance of an a.c. voltmeter to ascertain whether it does in fact indicate the peak voltage of a complex wave. If there is substantial agreement between the peak value as read by the a.c. voltmeter and the peak value as indicated by the d.c. vacuum-tube voltmeter as per Fig. 1C, when using a complex wave, then the a.c. voltmeter is suitable for such use as IM measurements.

Fig. 2. (A) Circuit for independent check of peak a.c. voltages. (B) A more versatile unit.



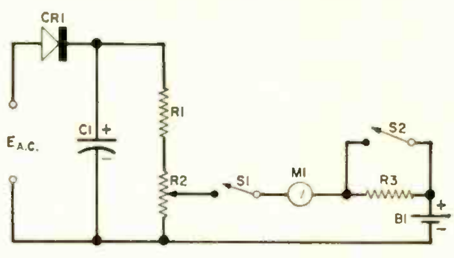
If, however, there is an appreciable discrepancy noted, or if an independent meter is desired for measurement of peak a.c. voltages, a d.c. microammeter may be inserted in series with resistance R, as shown in Fig. 2A. With R equal to 500,000 ohms, a peak voltage of 50 volts will produce a full-scale current of 100 µa. Using a 0-100 µa. meter, the indicated scale reading is divided by two to obtain the actual peak a.c. voltage.

Versatility may be increased by adding another half-megohm resistor in series with the first, with a toggle switch to short out one of the resistors, as shown in Fig. 2B. When the switch is open, both resistors are in series. A full-scale meter current of 100 µa. will be obtained when the peak a.c. voltage is 100 volts, making the meter a direct-reading instrument on this range. (Of course, a 0-50 µa. meter may be used with a series resistance of one megohm to obtain a direct-reading instrument with 50 volts maximum range.) For most audio measurements the 50-volt range will be used, since a peak voltage of 50 volts across a 16-ohm load resistance corresponds to a peak power of 156 watts, or an equivalent sine-wave power of 78 watts. Only the very largest power amplifiers would require the use of the 100-volt range.

Microammeters of the 0-100 µa. range tend to have an internal resistance of around 600 ohms. This value is sufficiently low so that only a very small error (a fraction of 1 per-cent) is caused by not reducing the external resistance R by this amount. Likewise, the voltage drop across the diode is on the order of 0.12 volt for an indicated reading of 50 volts; the error caused by neglecting this drop is considerably less than that produced by the usual meter accuracy of 2 per-cent.

Two notes of caution are in order. First, if a steel panel is used to mount the microammeter, the meter must be specifically designed and calibrated for use on a steel panel. If the meter is not so labeled, it must be used on a copper, aluminum, or other non-magnetic panel. Errors on the order of 8 per-cent may be introduced in the meter indication if this precaution is not taken. Second, the electrolytic capacitor (C_1) must be of the highest quality and in top condition

Fig. 3. Circuit for a precise instrument using the null method and a standard cell.



R_1—900,000 ohm precision res. ±0.05% (Dale Products WWA-38)
R_2—100,000 ohm ten-turn pot ±0.1% (G. W. Borg Model 205 micropot with Model 1320 ten-turn microdial)
R_3—27,000 ohm, 1 w. res. ±10%
C_1—20 µf. 200 v. paper capacitor (Twenty Sprague 2TM-M1 in parallel, see text)
M_1—25-0-25 µa. microammeter
B_1—Unsaturated-cadmium standard cell (Leeds & Northrup Co. Model 7308 ±0.01% accuracy; Model 7310 ±0.1% accuracy)
CR_1—Crystal diode (1N39B)
S_1—Normally open push-button switch
S_2—S.p.s.t. toggle switch

otherwise the leakage through it will produce erroneous results. This problem may be avoided by the use of a sufficient number of 1- or 2-μf. paper capacitors in parallel.

The accuracy of this peak a.c. voltmeter will depend largely on the accuracy of the microammeter and the precision of the resistances used. With ±1% resistors and the usual 2% meter accuracy, an over-all error of about 3% may be expected at full-scale reading. This error may be reduced by increasing the accuracy of the resistors and hand calibrating the meter.

In some instances where increased precision is required and cost is a secondary factor, the convenience of a direct-reading instrument may be exchanged for added accuracy by using null methods of measurement. Null methods simply compare a known fraction of the d.c. voltage developed across the *RC*-parallel combination to a highly precise voltage established by a standard cell of the unsaturated-cadmium type. Cells such as these maintain their open-circuit voltage over long periods of time and show negligible variation with temperature.

Fig. 3 shows such an arrangement. R_1 is a precision resistor of 0.05% tolerance and low temperature coefficient. It is made equal in value to nine times the value of R_2. Thus R_1 and R_2 establish a voltage divider with precisely one-tenth of the applied voltage developed across R_2. R_2 is a precision, ten-turn potentiometer, equipped with a dial, which allows reading 100 divisions per turn or 1000 divisions total; B_1 is an *Eppley* unsaturated-cadmium standard cell whose potential difference (on open circuit) is certified to an accuracy of 0.01%. M_1 is a 25-0-25 μa. meter to indicate null or balance when the normally open pushbutton switch S_1 is depressed. Resistor R_3, in series with the standard cell, is necessary to protect the cell against excessive current drain while the potentiometer is being adjusted. Maximum allowable current from the standard cell is 100 μa., and even this value should be permitted for only a few seconds. As balance is approached, resistance R_3 is shorted by toggle switch S_2 to permit full sensitivity. When the meter indicates zero current with S_1 closed, the potential difference of the standard cell and the peak a.c. voltage is therefore

$$E_{a.c.\ peak} = \frac{10 \times B_1}{dial\ ind.} \qquad (2)$$

where B_1 is the potential difference of the standard cell, and "dial ind." is the indication of the dial on the potentiometer expressed as a decimal fraction of the total number of dial divisions. For example, if balance is obtained with a potentiometer dial reading of 373, this represents 0.373 of the total number of 1000 divisions. With a standard cell of potential difference of 1.01938 volts, the peak a.c. voltage would be $(10 \times 1.01938)/0.373$ or 27.327 volts.

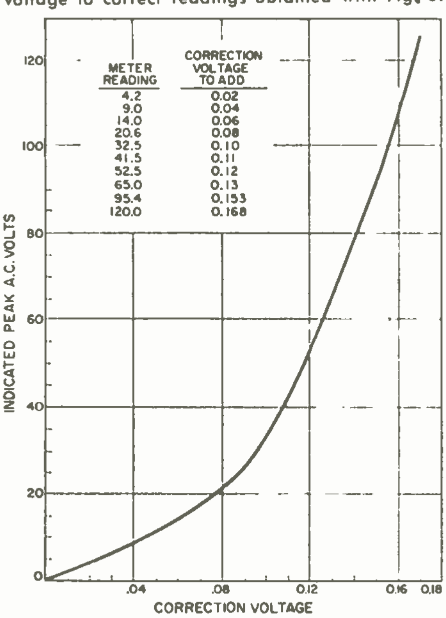
For the most precise measurements, the d.c. drop across the diode can no longer be neglected. Fig. 4 shows the voltage correction to be added to the value computed from Eq.(2) for a type 1N39B diode for the various values of computed voltage. Using a multi-turn potentiometer (R_2) of 0.1% linearity, a calibrating resistor (R_1) of 0.05% accuracy, and with reasonable care in adjustment, measurements may be made within an over-all accuracy of 0.2%.

Where the required precision will not justify the expense of the standard cell, mercury batteries may be used for the reference voltage. For this purpose, straight mercuric-oxide batteries are to be preferred to those containing small amounts of manganese dioxide, inasmuch as the latter type have relatively poor voltage stability compared to the former. Although the straight mercuric-oxide cells will vary in terminal voltage between different lots or batches, cells such as the *Eveready* E-12, E-122, or E-502 will retain their open-circuit voltage to within 0.5% over a twelve-month period, and to within 0.1% over a thirty-day period. (Equivalents of these three types made by *Mallory* are, respectively, RM-12R, TR-133R, and RM-502R.)

If possible, the mercury cell should be calibrated or measured by potentiometer methods in a physics lab of a college or university or other suitably equipped laboratory. If calibration is not feasible, the E-502 cell may be used with assumed terminal voltage of 1.345 volts. Measurements made on a large number of these cells over a considerable period of time indicate the terminal voltage to vary within limits of 0.5% of the value given.

The 1N39B diode, used in the circuits shown, is rated at 190 volts inverse voltage. In circuits of this type, the inverse voltage applied to the diode is twice the peak a.c. voltage being measured. Since the breakdown voltage is subject to some manufacturing variation, it is recommended that two diodes be used in series if voltages in excess of 75 volts peak are to be measured. In this case, double the correction values shown in Fig. 4. —30—

Fig. 4. Values to be added to the indicated peak voltage to correct readings obtained with Fig. 3.



METER READING	CORRECTION VOLTAGE TO ADD
4.2	0.02
9.0	0.04
14.0	0.06
20.6	0.08
32.5	0.10
41.5	0.11
52.5	0.12
65.0	0.13
95.4	0.153
120.0	0.168

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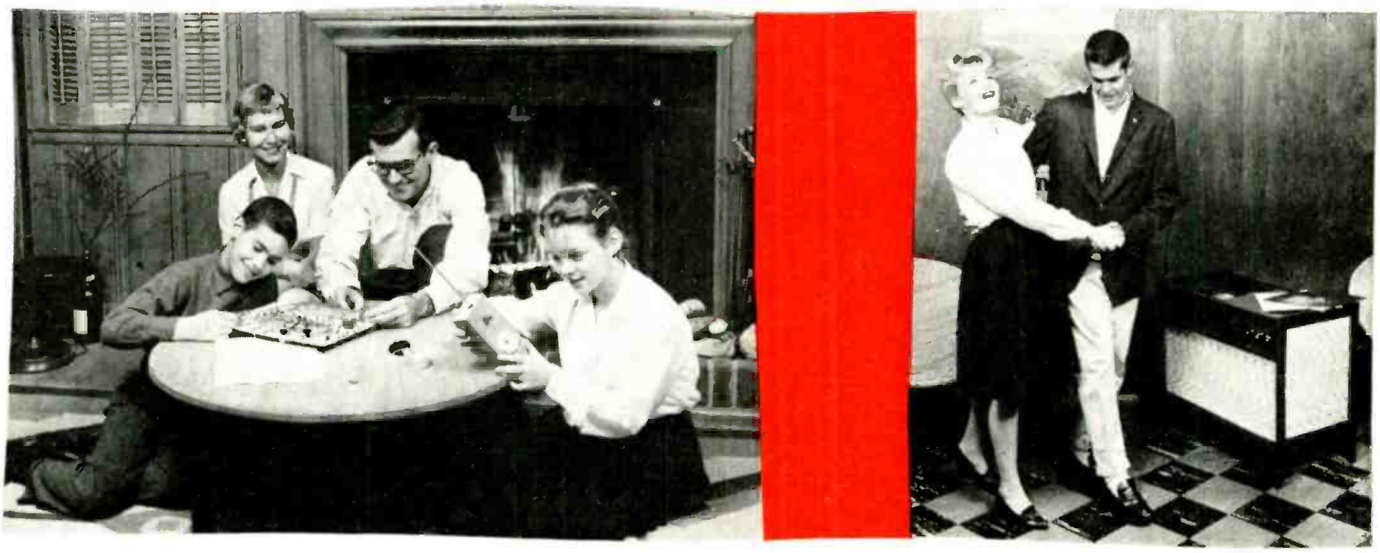

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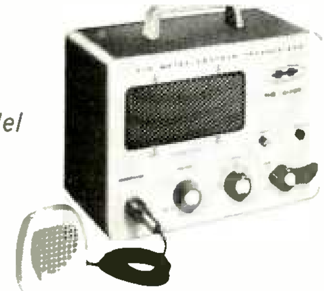

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Hi-Fi-Audio Product Review

STEREO AMPLIFIER KIT

H. H. Scott, Inc., Dept. P, 111 Powdermill Road, Maynard, Mass. has brought out a 72-watt stereo amplifier, with controls, in kit form.

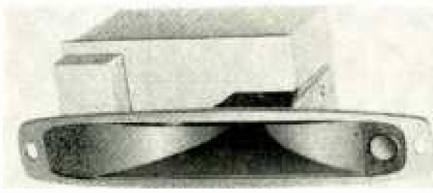
Designated as the LK-72, it provides

36 watts output on each channel, with IHFM power band extending down to 20 cps. Specified total harmonic distortion at 1 kc. is less than 0.4 per-cent at full power; amplifier hum level, better than 70 db below full power output. All stereo controls are provided, including a "center channel" level control, scratch filter, tape recorder monitor, and separate bass and treble on each channel. Tube heaters are d.c. operated.

Like the firm's earlier kit, the LT-10 FM tuner, the present model comes in the newly developed "Kit-Pak" container that opens up to a work table. Wires come pre-cut and pre-stripped. Mechanical parts are pre-riveted to the chassis. All parts are mounted on cards in the order the kit-builder will use them.

NEW IONIC SPEAKER

DuKane Corp., St. Charles, Ill. has introduced a new version of the "Ionovac" high-frequency loudspeaker. The



present unit covers the audio range from about 3500 cps to beyond audibility. It employs an improved electrode and sound-generating cell which is guaranteed unconditionally for 1200 hours of use.

Using no moving parts, this type of speaker produces sound by electrically charging the air with modulated signals that enter from the amplifier and are fed through an r.f. oscillator. The system consists of two chassis. It is available as an add-on tweeter for use with existing speaker systems, as well as part of a new line of full-range systems offered by the company.

STEREO CARTRIDGE

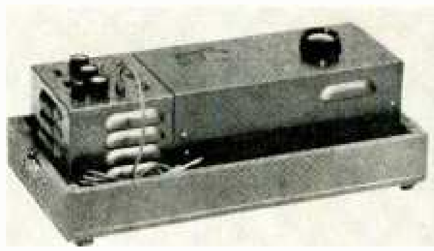
Pickering & Co., Plainview, N.Y. has made available for general use its Model 381 stereo cartridge, known as the "Stanton Calibration Standard." According to the manufacturer, this pickup was produced "specifically for the professional level of the recording and broadcast industry."

Response is claimed to be flat within 1 db from 20 to 10,000 cps, and within 2 db from 10 kc. to 17 kc. Output is 5 mv. per channel. Channel separation is 35 db. Recommended tracking force in professional arms is 2 to 3 grams.

The Model 381 is available in a high-impedance (47,000 to 100,000 ohms) version, or in a low-impedance (250 to 500/600 ohms) type.

REVERB CHAMBER

Ecco-Fonic, Inc., 905 S. Vermont Ave., Los Angeles 6, Calif. has brought out its Model 109B portable "Echo-Reverb Chamber" designed for use by musi-

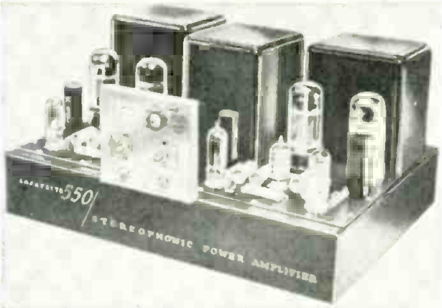


cians and vocalists. The unit attaches to a microphone or musical instrument and provides reverberant effects which, says the manufacturer, were hitherto possible only in recording studios.

The device uses a variable dial which allows the performer to adjust the delay time before the echo begins, from 0 to 0.7 second. A reverberation dial provides from 0 to a multitude of echo repeats. A playback switch re-plays 14 seconds of whatever was being played, and continues to do so until switched to "normal" position. Thus the unit can serve as an "accompanist."

DUAL 50-WATT AMPLIFIER

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N.Y. has introduced its Model KT-550, a dual 50-watt power amplifier in kit form. Capable of 50 watts per channel for stereo or 100 watts for mono operation, the new amplifier boasts response from 2 to 100,000 cycles within 1 db, without evidence of ringing or instability. The circuit uses a "multiple loop" design to increase the amount of feedback and achieve very low distortion, said to be less than 0.5% at 50 watts and less than 0.1% below 10 watts, from 20 to 20,000 cps. Hum



and noise are better than 90 db below 50 watts, according to the manufacturer.

The KT-550 uses two printed circuit boards to facilitate assembly by the kit builder.

NEW FISHER STEREO TUNER

Fisher Radio Corp., 21-21 44th Drive, Long Island City 1, N.Y. has announced its Model 202-R stereo FM-AM tuner,

said to provide precise, automatic tuning. When the FM tuning knob is touched, the a.f.c. automatically clicks off, permitting precise tuning for maximum signal. When the knob is released, the a.f.c. clicks back on, automatically adjusting tuning errors and locking in at the point of maximum noise suppression and minimum distortion.

The FM tuner uses the company's "Golden Cascode" front-end and six i.f. stages. Sensitivity is stated as .5 μv. for 20 db of quieting with a 72-ohm antenna. Electronic switch-muting eliminates inter-station noise. This noise suppression functions during multiplex operation as well.

The AM section features a four-position bandwidth switch, a rotatable ferrite antenna, and a high-gain, low-noise r.f. stage for maximum suppression of image and i.f. signals.

CERAMIC MICROPHONE

Sonotone Corp., Elmsford, N.Y. has introduced a low-impedance ceramic microphone, the Model CM-12.

Designed for public - address work or any installation that requires long leads, it has an impedance of 150 ohms, an output of minus 63.5 db. and a frequency response that extends to 8000 cps. An easy-to-reach interrupter button cuts off the mike with a touch of the finger.

According to the manufacturer, a substantial increase in the low-frequency range, plus control in the flatness of the response without loss of high frequencies, has been obtained in the CM-12 by a finely controlled acoustic port between the microphone chamber and a sealed chamber in the handle.

STEREO CARTRIDGE

Audio Dynamics Corp., 1677 Cody Ave., Ridgewood, N.Y. has announced a stereo cartridge that can track at less than one gram and also provide what is claimed to be the highest lateral and vertical compliance available today—10×10^{-6} cm./dyne. Reduced record wear and distortion combined with improved tonal response are said to result with the use of this pickup.

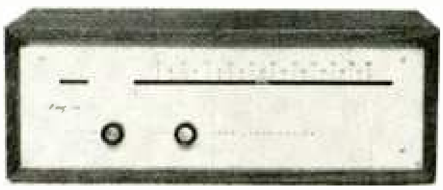
Designated as Model ADC-1, the new device reportedly uses a dynamic mass for its moving system that is smaller

than that of any cartridge now available. Excellent channel separation at all frequencies is claimed. Stylus replacement is said to be easy and fast, requiring no special skills or tools. Sensitivity at 1000 cycles is given as 7 mv. ± 2 db.

FM TUNER

Karg Laboratories, Inc., South Norwalk, Conn. has introduced a new FM tuner, the "Primata" Model CT-3.

The tuner has a sensitivity of .8 μv. for 20 db of quieting. Distortion is stated as under .7 per-cent at 100 per-cent modulation. The 8-tube circuit uses printed r.f. coils for stability, a dual-function gated-beam detector, wide-band Foster-Seeley discriminator, and is factory aligned. Flywheel tuning is

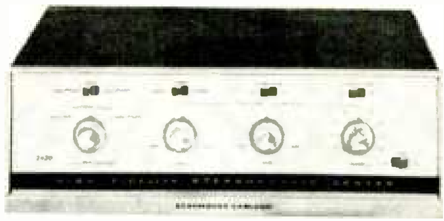


featured and a multiplex jack is provided.

DUAL 12-WATT AMPLIFIER

Stromberg-Carlson, division of *General Dynamics*, Rochester 3, N.Y. has announced a 24-watt stereo amplifier (12 watts per channel) with controls. Designated as Model ASR-2-20C, the new unit features low distortion, low hum and noise levels, and inputs and controls that have been, in the words of the company, "human engineered."

Separate clutch-type bass and treble adjustments are provided for each channel. Also included are: scratch filter; rumble filter; A + B center speaker terminals; channel reverse switch;



stereo-mono switch; program selector; loudness control; and an a.c. convenience outlet.

NEEDLE STOCK SYSTEM

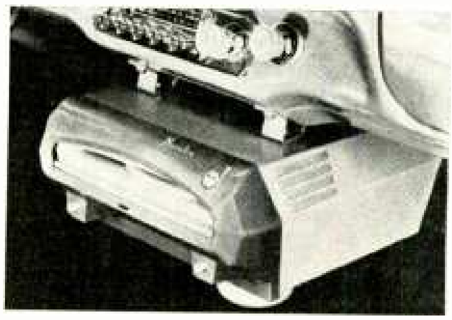
Astatic Corp., Conneaut, Ohio is offering a new system called "Asta-Stock" to simplify the distributor's job of maintaining a balanced stock of its line of phono needles.

Included in the "Asta-Stock" are small cabinets with drawers, a custom-designed package for each needle, complete cross-reference material with each needle package, and similar data on the index tabs of the stock cabinet.

PHONO FOR AUTOS

North American Philips Co., Inc. (Norelco), High-Fidelity Products Division, 230 Duffy Ave., Hicksville, Long Island, N.Y. has announced its "Auto Mignon," a fully automatic record player designed for use in automobiles.

The "Mignon" plays 45 rpm records with the large center hole. To operate it, the user pushes a record into a slot.



After the record is played, it slides out of the slot for removal.

According to the manufacturer, the "Mignon" is compact enough to be installed readily in any car. It plays through the car radio; operating power is supplied by the car battery. Switching from phono to radio is done by pressing a push-button on the front panel.

STYLUS INSPECTOR

Robins Industries Corp., 36-27 Prince St., Flushing 54, N.Y. has announced a new stylus inspection device, called "Syl-A-Scope." Claimed to be a precision instrument, it shows stylus wear by magnifying the contours of a stylus and reflecting the image upon an illuminated screen.

It can be used without removing the stylus or the cartridge from the tone arm. Designated as Model No. SG-66, the new instrument also is said to be useful for examining small parts, tools, and instruments.

NEW CROSBY COMPONENTS

Crosby Electronics, Inc., Syosset, Long Island, N.Y. has brought out the first two models of its new line of hi-fi stereo components. These are the Model 690 FM tuner, shown here, and the Model 680 28-watt stereo amplifier with controls.

Both models are identical in size and are designed to form a matched pair for the "heart" of a stereo system. The amplifier features push-button program selection, individual channel bass and treble controls, mono/stereo blend control, and "center channel" output. It furnishes 14 watts (music-power rating) output per channel.

The tuner, for FM reception and with

a multiplex output, boasts a sensitivity of 1 μv. for 20 db of quieting. It features variable a.f.c. and variable inter-station muting. Distortion is listed as less than 1 per-cent for 100 per-cent modulation with a 50-microvolt signal.

OUTPUT TRANSFORMER

Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. has recently added a 65-watt output unit to its line of audio transformers.

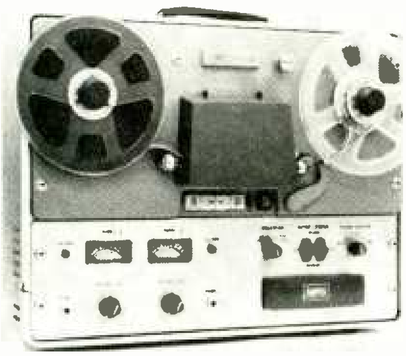
Designated as No. BO-15, it can be used with tube types 6550, EL34, or KT88 for construction of a 40-watt or 60-watt amplifier with tertiary feedback.

High performance and very low distortion are claimed for the amplifiers utilizing this output transformer. Complete details for constructing either model, including illustrations, schematics, and parts lists are contained in Bulletin CT-47 which is available either from the manufacturer direct or any of the firm's authorized distributors.

NEW AMPEX RECORDER

Ampex Products Div., 934 Charter St., Redwood City, Calif. has brought out its Model PR-10, described as a compact, studio-quality recorder.

The PR-10 comes as either a stereo/



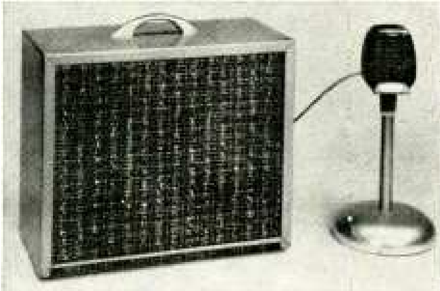
mono machine or a mono model in either full- or half-track versions. A four-position head assembly permits repositioning heads for special requirements, or adding a four-track stereo playback head. The "electronics" of the unit is designed on a modular basis.

Complete remote control of all functions is provided. An exclusive automatic tape-threading accessory enables "no hands" tape handling for greater speed and convenience.

PORTABLE P.A. SYSTEM

Checker Electronics Corp., Grayslake, Ill. has introduced a low-cost, single-unit, portable public-address system.

Called the "Raven 401," the new equipment comprises a combination amplifier-speaker unit, with microphone.



Power output is 8 watts peak. Three tubes are used. The microphone is a controlled-reluctance type; the speaker, an eight-inch driver.

Additional information is available from the manufacturer.

AUDIO CATALOGUES

GOODMANS SPEAKER DATA

Rockbar Corp., 650 Halstead Ave., Mamaroneck, N.Y. has issued a 16-page catalogue on *Goodmans* loudspeakers.

Entitled "For the Discerning Listener," the booklet describes the speakers and includes plans for recommended enclosures.

NEW SHURE PUBLICATIONS

Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. has issued three new publications of interest to audiophiles.

The first is a handsomely illustrated 20-page booklet on "The Art of Selecting, Playing, and Preserving Recordings." It is priced at 25 cents.

The company's general catalogue, available free, lists more than 30 microphone models and accessories, and related components.

Finally, there is a revised edition of "For the Critical Ear," which is a brochure describing the company's high-fidelity components, with emphasis on new pickups and arms. This brochure is also available without charge.

CABINETS AND ENCLOSURES

Rockford Special Furniture Co., 1803 W. Belle Plaine, Chicago 3, Ill. has announced the availability of its Bulletin R-16 which describes this manufacturer's line of high-fidelity equipment cabinets and speaker enclosures. Console and chairside types are included. —30—

NOMINATIONS OPEN FOR EDISON AWARD

THE Ninth Annual Edison Radio Amateur Award competition is now under way with nominations being solicited on behalf of the licensed radio amateur who has performed the most outstanding public service during 1960. To the winner will go the coveted 1960 Edison Award—a $500 cash prize, the trophy cup, and guest-of-honor status at the banquet to be held in Washington next February.

Nominations may be submitted by anyone familiar with the public service performed by a licensed U.S. radio amateur who resides in any of the 50 states. They should be addressed to the secretary, Edison Radio Amateur Award Committee, General Electric Co., Owensboro, Ky. —30—

Allied Radio Corp., Chicago, has expanded its Novice Amateur Radio Course to meet the increased demand for Novice Amateur training. This course, offered free of charge, trains students to pass the FCC exams for the Novice Amateur license. The program, launched more than six years ago, had an initial enrollment of 50 students in a single 14-week course. It was later expanded to three 14-week courses per year with a total enrollment in excess of 400. Now, with the latest expansion to three additional classes per year, an annual enrollment of over 500 is anticipated.

Computer Logic Circuits

(*Continued from page 47*)

of the negative supply. Assume, for example, that the plate potential is 120 volts, the negative supply is −100 volts, and the two resistors of the voltage divider are equal in value. Under these conditions, the voltage at the output terminal will be midway between plus 120 and minus 100 volts, or plus 10 volts. The circuit therefore produces an output of 10 v. with no input applied.

Now assume that a positive voltage is applied to the input terminal and that, as a result, the plate voltage decreases to 100 volts. The output terminal will now be at zero potential. The circuit therefore fulfills the requirements of the *not* function because it produces an output (10 volts) when input is not applied, and produces no output when input is applied.

It is characteristic of the *not* circuit that its output terminal can be at either of two different voltage levels depending upon whether or not an input is applied. In the above example, the two output levels were zero and 10 volts. With other values of resistance in the voltage divider the two output levels could be made +5 and −5, or +3 and −7, or 0 and −10, etc. The absolute values of these levels are not important except that they must be correct to drive the circuits which follow the *not* circuit. More important is the fact that the circuit is capable of *two* output levels. In practice, one of these levels represents binary 1 and the other level represents binary 0. From this point of view, it may be stated that the *not* circuit produces a 1 output when it receives a 0 input, and produces a 0 output when it receives a 1 input.

The *inhibitor* circuit shown in Fig. 4 consists of a voltage divider with a transistor connected across the lower resistor. This transistor is biased below cutoff. When an input pulse is applied to the voltage divider, a pulse will ordinarily appear at the output terminal. The lower resistor of the voltage divider is much larger than the upper resistor, and the output pulse is therefore almost as large in amplitude as the input pulse.

However, the transistor in this circuit functions as a switch to short out the lower resistor of the voltage divider. A positive pulse applied to the inhibit terminal will make the transistor conductive and will reduce the amplitude of the output pulse to an insignificant value. The circuit therefore produces an output (when it receives an input) only if there is no input to the inhibit terminal.

Logic circuits comprise the heart of the digital computer: the arithmetic section in which the actual calculation is performed. They are also used for channeling the flow of information between the various sections of the computer. These applications of logic circuits, however, merit separate treatment in another article. —30—

83 YX 929. Stereo Tape Record-Play Preamp Kit. $79.95 (less case)

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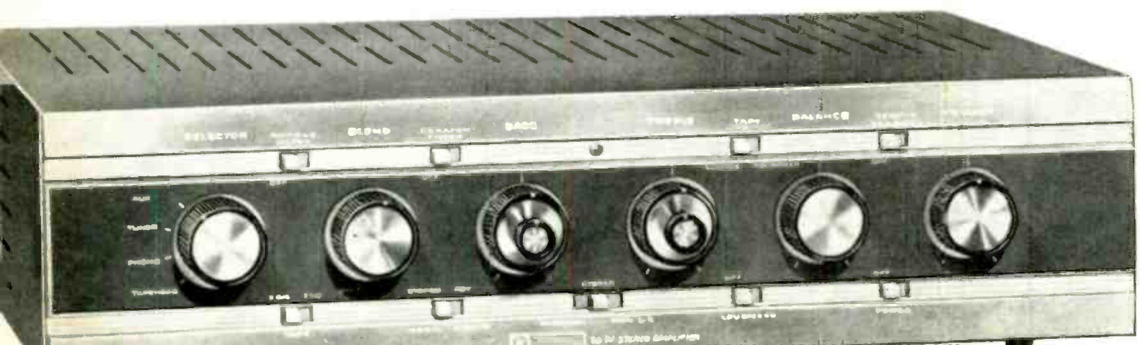

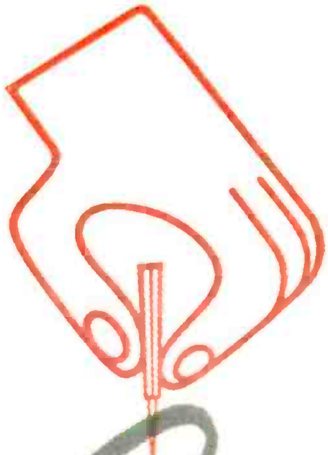

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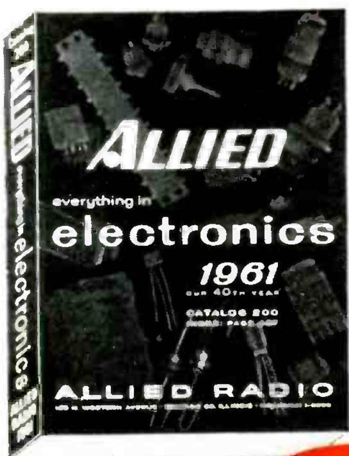

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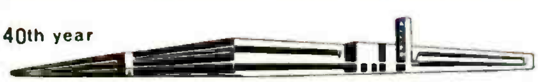

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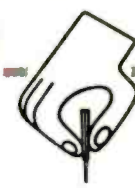

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3C24/24G	6.3	40	6XOY4	1	4X	330
3DG4	3.15	13	60056	1	3	Good
3DG4 Test 2	3.15	13	60076	1	3	Good
5GH8	4.7	17	52362	5	247	3900
5GH8 Test 2	4.7	17	59012	5	489	4500
6AL3/EY88	6.3	13	60096	4	5X	Good
6CD6	6.3	54	458Y2	7	1235	3750
6CL8	6.3	0	51022	4	135	5200
6CL8 Test 2	6.3	0	59762	4	589	3770
6EH7/E183F	6.3	17	52872	4	1259	8200
(Pin 3 also shows short)						
6EJ7/E184F	6.3	0	52872	4	1259	9750
(Pin 3 also shows short)						
6EV7	6.3	18	62012	4	235	3400
6EV7 Test 2	6.3	18	67062	4	578	3400
6EW7	6.3	55	67063	4	578	1300
6EW7 Test 2	6.3	57	52012	4	259	4250
(Pin 3 also shows short)						
6FG5	6.3	0	61652	3	1247	3200
6GC6	6.3	58	554Y2	7	235	3750
(Pins 4 and 8 show short)						
6GH8	6.3	17	52362	5	247	3900
6GH8 Test 2	6.3	17	59012	5	489	4500
6GM6	6.3	0	51652	3	124	8500
(Set "Special-Normal" switch in "Special" position)						
6GM8/ECC86	6.3	0	32012	4	235	5000
6GM8 Test 2	6.3	0	37062	4	578	5000
6GN8	6.3	22	57892	4	567	7500
(Set "Special-Normal" switch in "Special" position)						
6GN8 Test 2	6.3	18	62033	4	125	1750
7DJ8/PCC88	7.5	18	57062	5	478	8200
7DJ8 Test 2	7.5	18	52012	5	234	8200
8ET7	7.5	14	57892	4	567	5700
(Set "Special-Normal" switch in "Special" position)						
8ET7 Test 2	7.5	76	30026	4	15	Good
8ET7 Test 3	7.5	76	30036	4	15	Good
8GN8	9.45	22	57892	4	567	7500
(Set "Special-Normal" switch in "Special" position)						
8GN8 Test 2	9.45	18	62033	4	125	1750
12GA6	12.6	17	31654	3	1247	845
12GA6 Test 2	12.6	17	37654	3	1247	845
12GC6	12.6	58	554Y2	7	235	3750
(Pins 4 and 8 show short)						
14GT8	12.6	27	68094	4	578	650
14GT8 Test 2	12.6	13	60026	4	35	Good
14GT8 Test 3	12.6	13	60066	4	15	Good
16AQ3/XY88	19.6	13	60096	4	5X	Good
35EH5	32.0	21	52672	4	123	9500
(Pin 5 also shows short)						
35GL6	32.0	37	52572	3	124	4875
5751	6.3	7	42014	9	2345	780
5751 Test 2	6.3	7	47064	9	4578	780
5842/417A	6.3	8	54012	3	469	12000
(Set "Special-Normal" switch in "Special" position) (Pins 4, 7, —5, 8 also show short)						
5920/E90CC	6.3	24	56012	3	467	3900
5920 Test 2	6.3	24	55022	3	457	3900
6688/E180F	6.3	8	52972	4	1258	10500
(Set "Special-Normal" switch in "Special" position) (Pin 3 also shows short)						
6689/E83F	6.3	0	52162	4	235	5300
7247	6.3	22	67064	9	4578	1050
7247 Test 2	6.3	53	62013	9	2345	1450
7355	6.3	53	56833	2	567	3800
7408	6.3	16	45433	7	258	2665
7543	6.3	15	51653	4	1237	2550
7551	12.6	43	52363	4	1257	2650
(Pins 1, 3—8, 9 also show short)						
7558	6.3	43	52363	4	1257	2650
(Pins 1, 3—8, 9 also show short)						
7581	6.3	36	55433	7	258	3250
CK6659/CK1042	OFF	25	60016	—	5	Good
CK7576	6.3	10	52032	1	268	6800
(Set "Special-Normal" switch in "Special" position) (Pin 7 also shows short)						

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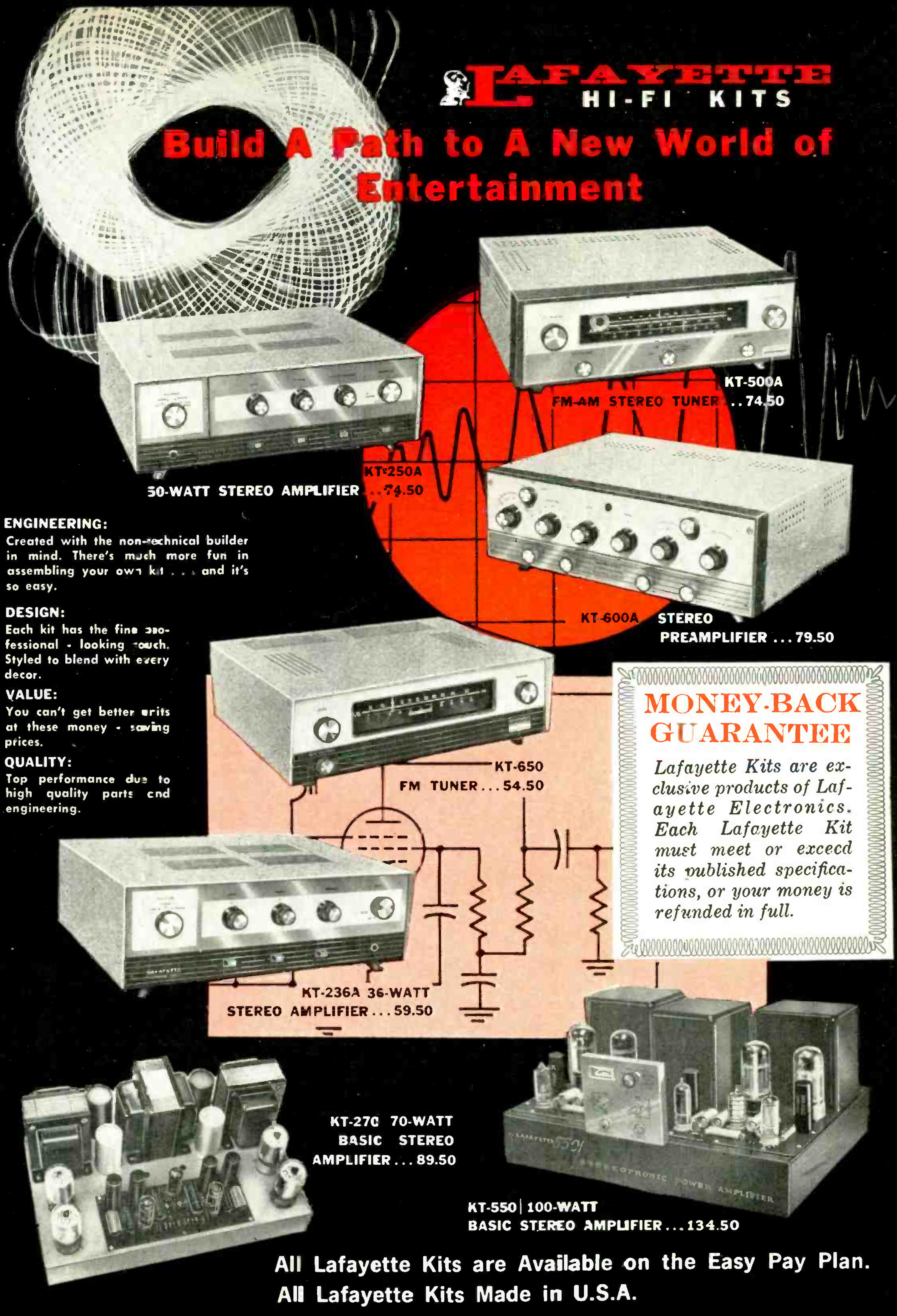
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Reverberation in Practice

(*Continued from page* 45)

acoustically rather than electronically. This involves the use of a completely separate amplifier and speaker for the reverberation signal. While this method is somewhat more expensive than the electronic mixing process, it provides at least two important advantages.

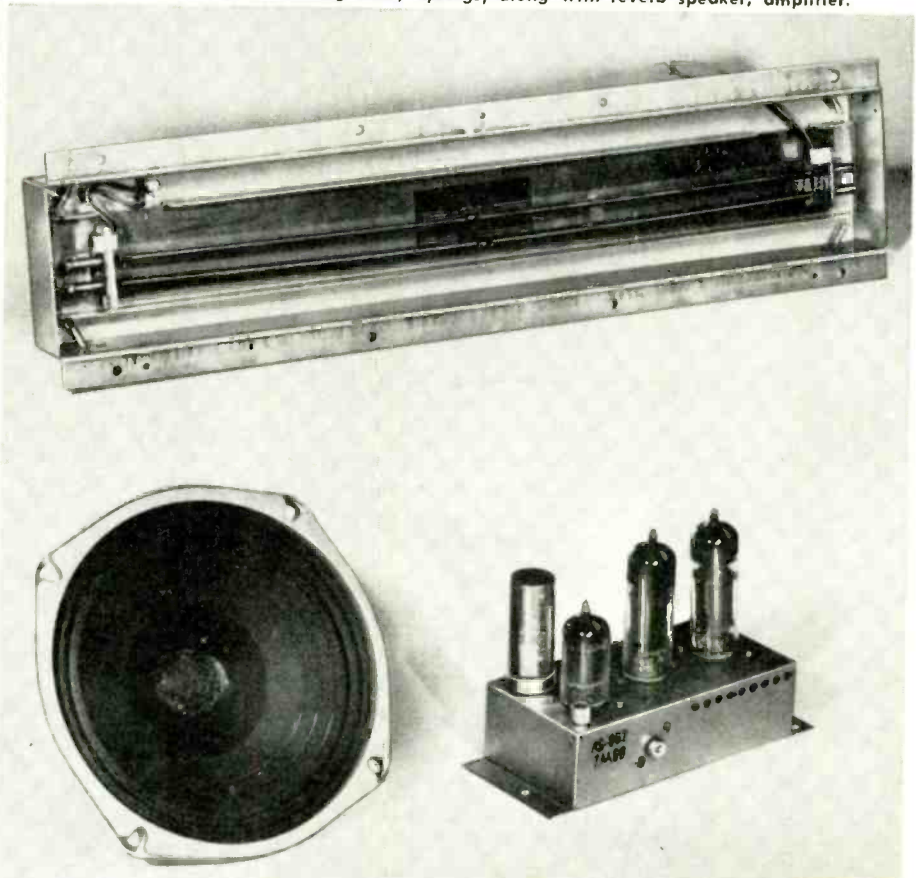
With electronic mixing, the same amplifiers and speakers are employed for both the main signal and the reverberation. Since the latter often represents an appreciable portion of the total signal, the power output capabilities of the main amplifiers are correspondingly reduced. With acoustic mixing, the power output of the reverb amplifier actually adds the total available power.

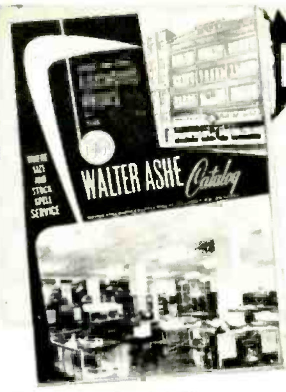
The second, and perhaps most important, advantage of acoustic mixing concerns the fidelity of re-creating concert-hall conditions. When two signals are combined, either electronically or acoustically, a series of peaks and nulls appear in the sound reaching the listener. When the reverb signal is mixed with the main stereo signal in a single amplifier, these peaks and nulls have a fixed relationship which is not affected by the position of the listener with respect to the sound source. In the concert hall, however, this is not the case. Here, because the total sound reaching the listener actually appears to come from a number of different sources, the listener can change the pattern of peaks and nulls often by only a slight movement of his head. Although the introduction of artificial reverberation is not identical to the conditions found in the auditorium, the use of a separate sound source for the reverb signal certainly simulates actual conditions far more closely than electronic mixing.

In the *Motorola* system, the 7-watt reverb amplifier complements the combined 50-watt output (music-power rating) of the main stereo amplifier channels. Cost of this additional amplifier can be held to a minimum because the absence of extremely low frequencies permits the use of a less expensive output transformer than used in hi-fi applications, without deterioration of sound quality.

The available 7 watts of reverberation is considerably more than that required for most listening rooms or program material. A special reverberation volume control, called the "Vibrasonic System" control (Fig. 5), permits adjustment of the reverberation effect from zero to maximum. As shown in the diagram, a portion of the reverberation control system is ganged with the loudness control of the main amplifier. This limits the maximum amount of reverberation available for any specific setting of the loudness control to a level which, although greater than desirable for optimum results, does not overshadow the main signal. The separate "Vibrasonic System" control can then be employed for a more precise adjustment of the reverberation intensity level. —30—

Inside of reverb unit showing delay springs, along with reverb speaker, amplifier.





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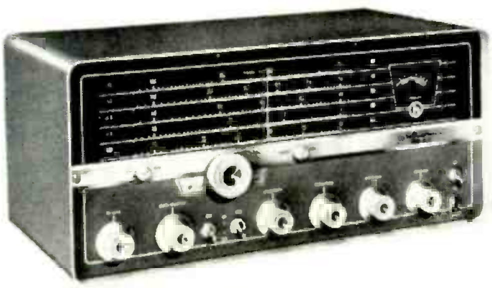

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Checking Tape Recorder Heads

By ROBERT JAMES

Direct tests for continuity and other electrical properties are hazardous. Use this safe technique.

THE SYMPTOMS exhibited by a faulty tape recorder may sometimes indicate the possibility that one of the heads is defective. Inability to record, inability to erase, distortion introduced during recording, or absence of the playback signal, for example, may indicate that a record, bias-erase, or playback head is open or otherwise faulty. It would appear logical that the coil in the head could be checked for continuity before more elaborate tests are used on the circuitry itself. However, this is not as simple as it seems.

What could be more straightforward than placing an ohmmeter across the coil? Danger lurks, however. The test instrument sends d.c. through the coil. To begin with, the current may be excessive for the head. This can be overcome, however, if the ohmmeter's highest resistance scale is used, keeping current down to a low value. However, even a relatively low d.c. may magnetize the head. In addition, the transients produced when the ohmmeter is connected or disconnected may induce magnetization. If this effect should be strong enough, it may not be easy to reverse it by normal degaussing.

There is a method for checking continuity safely that also has other advantages. Even with continuity, there may be some change in characteristics of the head. Specifications generally available for tape recorder heads include d.c. resistance, impedance, and inductance. The suggested technique can be expanded to determine these characteristics, with some calculation.

Basis of the method is the application of a.c. to the coil. This has certain hazards too, but they can be avoided by proper use of the circuit in Fig. 1. The voltage source may be any that is low in value. A bell transformer, filament transformer, or the filament winding of any conventional electronic device, including the recorder's own a.c. heater supply, should do. Connect this source in series with the head, a potentiometer, and the a.c. voltmeter as shown.

To protect the head and also provide usable indication, maximum value of the potentiometer should not be less than one megohm. However, the closer it is to the meter's input resistance, the better. Furthermore, it should be set so that its full resistance is in the series circuit before the a.c. is applied. The voltmeter scale used should be the lowest one on which the maximum voltage of the source may be read without slamming the pointer. If you have any doubts, check the secondary's open-circuit voltage first.

Now decrease the resistance of the potentiometer *slowly*, until the meter reading begins to increase—or until it is apparent that it is not going to rise. If no indication can be obtained, the coil is open and the test is over. In this case, the a.c. source can be disconnected at once. If continuity is indicated, the check is also over, but the connection should not be broken at once. Instead, rotate the potentiometer slowly back to its maximum-resistance position and then disconnect the a.c. This precaution, which provides a gradual decay of the a.c. field surrounding the coil, suppresses any transients that might produce residual magnetization.

With an additional resistor and a slight change in the hook-up, we may determine impedance, resistance, and/or inductance. The voltmeter is removed from the series circuit and a resistor (Fig. 2) is inserted in its place. Value of the latter should be such that the current through it, if it were placed directly across the source voltage, would be only a few milliamperes. A 10,000-ohm resistor should be satisfactory for any case, while also simplifying calculations.

The potentiometer is fully in the circuit when power is applied, but it is slowly rotated to zero resistance. The voltmeter is then used to read voltage across the inserted resistor. With both the resistor and the voltage drop across it known, Ohm's Law may now be used to calculate the current. Since the head coil is in series, this is also the current through the latter. By moving the meter to read voltage across the head, we can now use this value and the known current to detemine impedance.

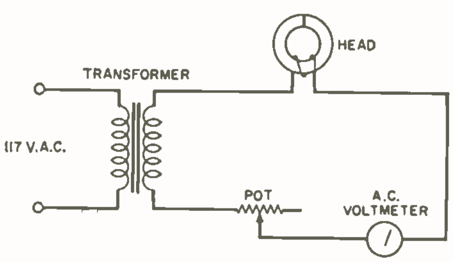
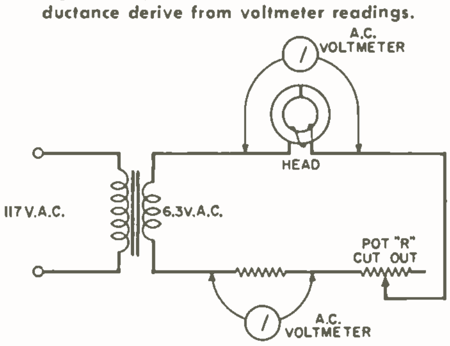


Fig 1. A continuity check that avoids coil damage or permanent magnetization.

Fig. 2. Impedance, resistance, and inductance derive from voltmeter readings.



However, this value is not directly usable, since it is taken at 60 cps. Impedance of record-playback heads is generally given at 1000 cps. For erase heads, the frequency is that of the bias oscillator, which may be from 25 to 100 kc. Furthermore, the d.c. resistance cannot be directly derived from a single-frequency impedance reading. The next step then, using the same basic arrangement as that of Fig. 2 except that an audio oscillator adjusted to 1000 cps takes the place of the 60-cps source, is to take another impedance reading. Once more, the potentiometer is used for a gradual build-up and then decay of the applied voltage. The generator's output level should be adjusted to be approximately that of the original line-frequency source.

From the two figures now available for impedance, it is possible to determine the d.c. resistance by using the following formula: $R = \sqrt{\frac{279Z^2 - z^2}{278}}$, where R is the d.c. resistance, Z is the impedance at 60 cps, and z the impedance at 1000 cps. This formula is based on the fact that there is a fixed ratio, 16.7:1, between the inductive reactance a coil will have at 1000 cps and the reactance it will have at 60 cycles.

Now that d.c. resistance is known, this value can be used in combination with total impedance, at either frequency, to determine inductance. This is done by first finding the inductive reactance. Calculation is still necessary, but the worst is over. The formula is $X_L = \sqrt{Z^2 - R^2}$, where X_L is inductive reactance (either frequency may be used) and Z is the impedance measured at the same frequency.

From this, inductance may be found from $L = X_L/2\pi f$, where L is the inductance in henrys and f is the same frequency at which X_L was calculated. At this point, virtually all the information needed to check the head for changes, by comparing against available specifications, is at hand—or for determining these specifications on a good head for which they are not readily available. A possible additional figure may be wanted: impedance at the erase-bias frequency. The method has already been discussed. With an oscillator at that frequency acting as the a.c. source, the voltage measurements in the test of Fig. 2 are made and impedance is easily calculated.

This method may seem like the long way round. Yet it is seldom that all calculations will be desired, and a slide rule can save much time while preserving high accuracy. Finally, the possible results of using an ohmmeter can be far more troublesome. —30—

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___	12BQ6	1.06
___	12BY7	.74
___	12BZ7	.75
___	12C5	.56
___	12CA5	.59
___	12CN5	.56
___	12CR6	.54
___	12CU5	.58
___	12CU6	1.06
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Like its predecessors in this series, the present volume includes hundreds (456 to be exact) of practical troubleshooting hints on a number of TV sets in current use. Each hint, presented with a diagram or partial schematic, was compiled from practical servicing history.

* * *

"REPLACEMENT GUIDE FOR TV AND AUTO RADIO CONTROLS" by Sams Staff. Published by *Howard W. Sams & Co.. Inc.*.

Indianapolis. 96 pages. Price $1.00. Soft cover.

Expanded coverage is featured in this third edition of a manual intended for use by service technicians. Now listed are 26,970 television and 1072 car radio models produced since 1946. The currently available and recommended replacement controls are shown.

* * *

"DIGITAL COMPUTER FUNDAMENTALS" by Thomas C. Bartee. Published by *McGraw-Hill Book Co., Inc.*, N. Y. 342 pages. Price $6.50.

Intended for readers with a knowledge of basic algebra and electronic fundamentals, this volume comprises a thorough-going introduction to the general subject of digital computers. Computer functions, applications, problem preparation, and typical circuitry all are covered.

* * *

"THE A.R.R.L. ANTENNA BOOK" by ARRL Headquarters Staff. Published by *The American Radio Relay League, Inc.*, W. Hartford, Conn. 320 pages. Price $2.00. Soft cover.

This new and revised edition of a well-known work is a complete treatise on the theory and practice of antennas for use by amateur radio operators. It covers the subject from fundamentals through an extensive discussion of antenna theory to descriptions of simple and complex antenna designs.

* * *

"TELEVISION TUBE LOCATION GUIDE" by Sams Staff. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 96 pages. Price $1.25. Soft cover. Vol. 10.

Positions and functions of tubes in 1959-1960 TV receivers are indexed and illustrated in this compact volume. Over 100 diagrams, each with a tube-failure check chart giving common symptoms and likely tubes producing them, are included. —30—

René Snepvangers (left) receives congratulations from Dr. Harry F. Olson, incoming president of the Audio Engineering Society, upon receiving the Society's Emile Berliner Award, presented to Mr. Snepvangers for his development of the Long Playing record. Mr. Snepvangers, now vice-president and director of engineering for Electrosonic Laboratories, Inc., was project leader for CBS Recording Laboratories during the original development of the 33⅓ rpm microgroove disc.

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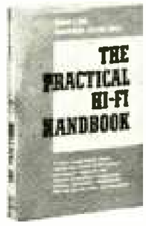

2755. THE PRACTICAL HI-FI HANDBOOK, King

A guide to high fidelity sound reproduction for the service engineer and amateur. Chapters on amplifiers, loudspeakers, pickups, microphones, record players, disc, tape and stereo. $5.95

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A practical manual on repair of mechanical elements of record changers, including pickups, needles, changer actions, motors, drives, tripping, dropping and shut-offs. Also magnetic recorder repairs. $5.95

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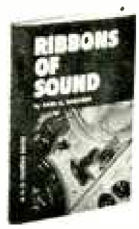
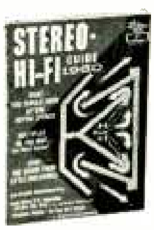


2757. RIBBONS OF SOUND, Barleben

A handbook on the fundamentals of magnetic tape recording simply and interestingly presented. Factual information you can use no matter what type or make of recorder you own. Paper. $2.50. 2772. Cloth. $3.50

2758. TAPE RECORDERS AND TAPE RECORDING, Weiler

An ideal sourcebook of information on all aspects of tape recording. Covers all fundamentals necessary to realize full potential of your tape equipment. Special sections on accessories. $2.95

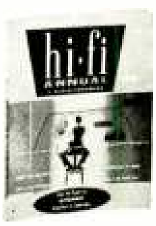


2000. STEREO HI-FI GUIDE, 1960 Ziff-Davis

1960 edition features 60-page exclusive by Joseph Marshall on components and how they work. Includes "what you should know before buying stereo". Complete, interesting, invaluable! $1.00

2002. ELECTRONIC KITS DIRECTORY, 1960, Ziff-Davis

New 1960 edition lists over 750 kits, latest models, prices and features for hi-fi kits—preamps, amplifiers, tuners, speakers — ham radio, SWL, Citizens Band. Fun and education. $1.00

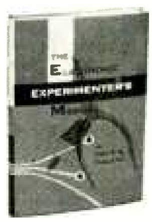


2004. HI-FI ANNUAL & AUDIO HANDBOOK, Ziff-Davis

1960 edition. Prepared by the editors of Electronics World. An excellent advanced guide to theory, construction and circuitry. Over 40 pages on stereo amplifiers and equipment. $1.00

2010. AUDIO YEARBOOK, 1961, Ziff-Davis

Brand new edition. By the editors of Electronics World. Advanced discussions and instructions on every phase of audio. Special features make this an excellent guide for the advanced audiophile. $1.00



2006. ELECTRONIC EXPERIMENTER'S MANUAL, Findlay

With a few dollars worth of basic tools and this book to guide you, you can explore the wonder-world of electronics experimentation more completely than ever before. 10 big sections. $4.95

2769. THE ELECTRONIC MUSICAL INSTRUMENT MANUAL, Douglas

Covers every design phase of the modern electronic musical instrument — including theory, schematics of organ circuits, the science of sound as well as the art of music. $7.50

An Impedance Checker

(*Continued from page* 33)

To measure the input impedance of the same amplifier, the voltmeter and the ohmmeter are connected to appropriate binding posts, as already explained. The amplifier input is connected across the "Test" terminals, and a variable resistor of suitable value is connected across the *R* terminals. However the audio oscillator is connected to the "Oscillator" binding posts in this test, so that it feeds into the amplifier through the added resistance. Adjust the oscillator to produce a 1000-cycle signal at an amplitude that will produce a convenient but low reading on the v.t.v.m. The indication on the latter will be the signal amplitude fed to the amplifier, rather than the total output of the oscillator, part of which is being dropped across the resistor.

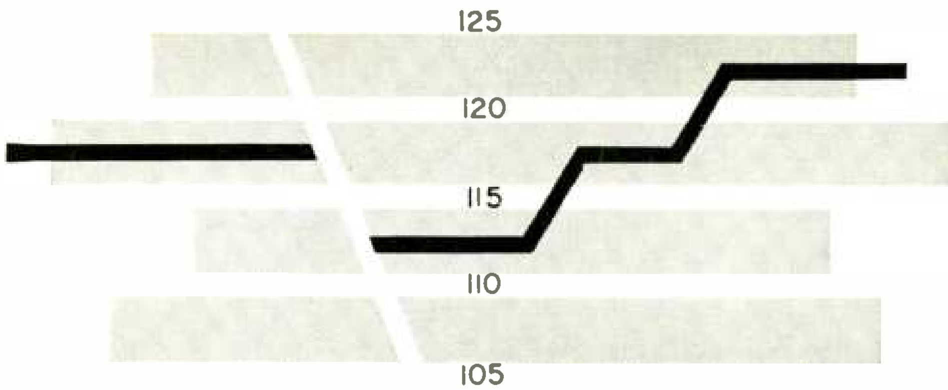
Now depress switch S_1 and hold it down. The voltmeter now reads the voltage across the resistor only. The purpose of this test is to obtain the same voltage reading across the resistor and the amplifier input; in other words, the voltmeter reading should be the same whether S_1 is depressed or released. To achieve this, the resistor is progressively adjusted while the switch is alternately depressed and released. This procedure is repeated as many times as necessary until the desired condition of equal readings is obtained. When the readings are equal, resistance in the circuit is equal to the actual impedance seen at the amplifier input.

Now the oscillator must be disconnected. The Z switch, S_2, is depressed to shunt the ohmmeter across the resistor. The desired impedance is now read directly.

Some further words about choosing the resistor and measuring it. Although its exact value is not critical, it should be of such an order that it is not likely to be set to either of its extremes during the test, for greatest convenience. If the anticipated impedance reading is likely to fall, say, somewhere between 50 and 250 ohms, a 500-ohm potentiometer would be suitable.

Where impedance seen at a low-impedance output (rated at 4, 8, or 16 ohms) of an audio amplifier is to be found, the actual value may be less than 1 ohm. Since the center-scale reading of the lowest resistance range on conventional v.o.m.'s and v.t.v.m.'s is in the order of 10 to 20 ohms, accuracy in the vicinity of 1 ohm or less is not always dependable. Fortunately some ohmmeters read about 1 ohm near the center of the scale on the lowest range. Resistance bridges or other devices using a nulling method against an accurate standard will also give reliable low-resistance readings. It may also be possible to use a calibrated, variable, precision resistor of low value.

Using the procedure for amplifier input impedance measurement, such other devices as speakers, headphones, and transformers can be checked. —30—



A Variable Line-Voltage Isolator

By **WALTER L. STONE**

Three output-voltage steps and isolation at low cost—plus indication and protection for shorts.

PERHAPS you are a member of that large group of technicians who are still looking for that isolation transformer which, for safety's sake, should always be available to the bench. Since one with real current capacity comes high, you may have one that can take care of a single television set. However, you may have found that there are times when another like it would come in handy for a second set. The only problem is that these things cost, and they are not cheaper by the dozen.

If you have an old, junked TV chassis around the shop, with a good power transformer on it, you are nearly half way to solving this problem at low cost and also providing yourself with some other conveniences that the ordinary isolation transformer won't give you. The other half of the job involves picking up another similar transformer, which can come from a similar source, and doing a small amount of assembly.

Generally speaking, the older the sets from which these transformers are salvaged, the better. Older sets used more tubes, drew more current, and had to have bigger power transformers. Thus if they are used to make up the isolator, you have no worries about carrying any TV set or other electronic gear that draws no more current than a TV set. For example, how many chassis are you likely to come across that draw as much as did some of those early, 30-tube affairs?

The pair of transformers need not be identical. The important thing is that their high-voltage secondaries carry the same voltage rating. The current ratings should also be close to each other. If there is any doubt about the latter point, simply check the current or wattage ratings for the two receivers. If they are close, the transformer capacities will be close. Making sure that the two transformers are about the same in size and weight will also indicate that they are reasonably matched as to current capacity.

The suggested set-up is shown in the accompanying schematic. The arrangement is a little bulky, but it will get in nobody's way if you slip it under the bench. If you do this, it will also give you room to use the old chassis on which one of the transformers is already mounted. Mount the second one near it and use the old socket for the 5U4 rectifier to provide tie points for the secondary voltages. The lamp socket, outlets, fuse holder, and switches should be convenient to the bench.

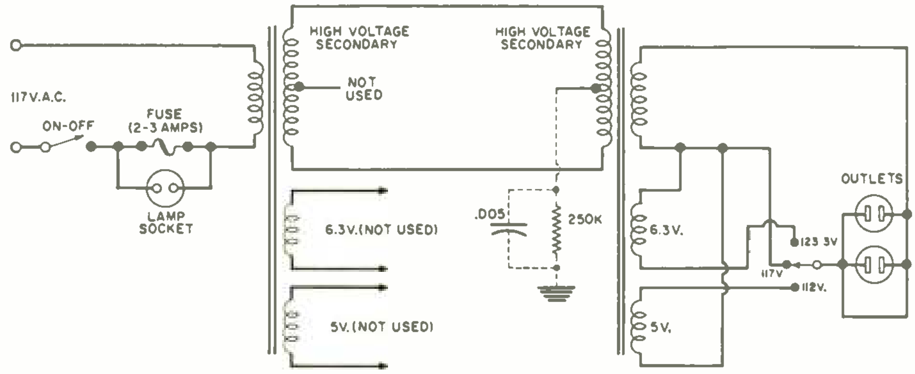
Just to make sure, you will note that the circuit actually isolates line voltage twice, once through each transformer. The optional resistor-capacitor network from the center tap of one secondary to ground will take care of any residual charge that may be left after the device is turned off.

One of the extras provided is the use of the two filament windings of the secondary transformer, one series-aiding with normal output and the other series-bucking. As fed through the switch (virtually any single-pole, triple-throw unit will do) to the a.c. receptacles, they will let you select line voltage or else a slightly reduced (112 volts) or slightly boosted (123.3 volts) source instead. Although this is not a wide, continuously variable range, the three steps will be adequate for most cases where some flexibility is needed. An ordinary a.c. voltmeter is all you need to make sure that the two filament windings are wired in the desired phase.

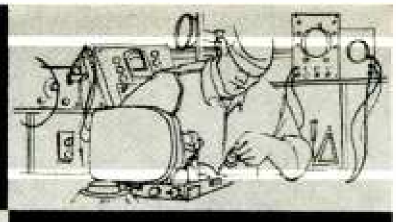
The fuse holder is kept accessible so that you can change the rating of the fuse for individual cases. For example, you might want to put in a ½-ampere fuse when dealing with a radio or some other equipment that draws less current normally, but which has a hidden or intermittent short. You could also pull the fuse altogether and put in a bulb whose rating is such that it will safely limit current when the short shows up. When using a regular 2- or 3-ampere fuse, you can shunt it with a 7½-watt bulb in the socket. The latter lights up to let you know when you've popped a fuse. It will also limit current and voltage to the set after the fuse goes. In fact, the lamp socket provides some additional possibilities. You can drop output voltage to lower levels than 112 volts by using lamps of different wattages as dropping resistors.

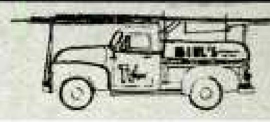
Although it has its own "on-off" switch, you may want to wire the entire unit so that it is turned on or off by the switch that operates the bench light. This makes sure that the unit is off when the bench is not in use. If you have ever worked in a shop with a cement floor in damp weather, you will particularly appreciate this isolator. —30—

A pair of transformers salvaged from retired TV sets are the chief components.



SERVICE INDUSTRY NEWS





THE EVALUATION of licensing in general and of such pertinent legislation as may come before the next session of the New York State Legislature was the main business of an open forum sponsored by the Empire State Federation of Electronic Technicians Associations in Albany, the state capital. At the request of Irving Toner, ESFETA president, Sidney C. Silver, service editor of ELECTRONICS WORLD served as impartial moderator.

Since individuals and groups affiliated with ESFETA are largely in favor of licensing legislation, the chief purpose of the forum was to bring together representatives of other interests, with whom pros and cons could be ironed out. Of special concern was representation by distributors, since many in this category had voiced opposition to an earlier attempt to establish licensing. Of the many distributors invited, only three appeared. These, like Mr. Clifford Allanson, of the New York State Council of Retail Merchants, pointed out that they could not act as official spokesmen for the groups with which they were affiliated or even for other individuals in their classification, but were rather present as observers.

Although an attempt had been made to obtain at least one representative of TV-owning consumers, none was present. Although no legislators in the state were present, a spokesman from the office of the New York State Attorney General did appear.

From some of the informal statements made, it appeared that at least some of the distributors whose names were listed as being in opposition to the bill did not know that they were so listed. Their names had evidently been used without their knowledge or permission. Although they were cautious about either endorsing or opposing any particular bill, depending on its provisions, they did acknowledge that, to an ethical distributor who wished to adhere to a wholesale-only policy, at least one aspect of licensing could assist them. This had to do with the fact that, even with the best intentions, it is difficult to determine which would-be distributor customers are legitimate service dealers. If licensing were in force, possession or non-possession of a license would be a simple, determining criterion.

Mr. Allanson pointed out that he is basically opposed to government intervention and discussed its possible drawbacks. However, he indicated that he might not oppose a particular bill if it were so written as to avoid these drawbacks as much as possible. He felt that the ultimate effect of such laws was not always easy to anticipate before they were put in force and that, once they were in effect, the chances for correcting defects that showed up later were not always good.

Mr. Tynan of the Attorney General's office spoke briefly. He pointed out that his office had supported the McClosky Bill—which had been presented and defeated at the last legislative session—and that this agency would doubtless support any similar bill that would be put before the forthcoming session.

Some evidence was presented to allay distributor fears that their business volume might suffer if licensing reduced the number of service dealers who could legally continue in business. The experience of distributors in areas where licensing is now in force was brought up. It was pointed out that, although distributors suffer a loss in the number of customers, dollar volume is not affected, since the amount of materials needed for service is not reduced. Rather, the same volume is maintained through a smaller number of dealers, which may be more convenient.

Another forum of this kind has been scheduled for February 5, in Albany, while the legislature is in session. It is hoped that, at this one, some legislators, more distributors, and consumer representatives will be present, as well as possible representation by set manufacturers or the service committee of the Electronic Industries Association.

"Used-Tube" Bill

Beginning with October (see "Service Industry News," November), manufacturers, distributors, and service dealers have been required to clearly identify the nature of any receiving or picture tube that is not completely new or made of parts not all of which are new. A problem for the dealer is that he is not always in a position to know himself, especially in the case of a CRT. *General Electric* is the first tube manufacturer to issue a public clarification.

Says this source, "the label on the carton and the tube states that all materials and parts used in the manufacture of a *G-E* replacement picture tube are new except for the envelope which, prior to re-use, has been inspected and tested to the same standards as a new envelope . . . No one can make a better tube simply because he might use new glass . . . The use of a new glass envelope contributes absolutely nothing except a substantially higher cost to the ultimate user without improvement in quality or performance."

To assist dealers, *G-E* is making available through its franchised distributors stickers that the dealers can affix to customer invoices, with a statement intended to satisfy legal requirements.

Missouri Certification

The Electronic Association of Missouri, leaders in the fight against licensing within the ranks of organized service groups, is ready to go into action with a program it feels is more satisfactory. This bonding and certification plan has been worked out in cooperation with the local Better Business Bureau and the Adult Education Division of St. Louis University. Participation, which is voluntary, entitles a dealer to use identifying cards and a shield indicating that he is taking part.

Dealers must adhere to standards of advertising and ethics prescribed by the BBB, pass a test to certify technical proficiency given by the university, and post surety bonds. An employed technician may be certified only if he is in the hire of a bonded dealer. The bonding committee, which will consist of five members and one alternate, is to be appointed by the TEAM president. All actions of the committee are subject to approval by a majority vote of TEAM. Any service dealer who wishes to take part in the program who is not now a member of that association must join TEAM in order to be eligible.

NBBB & Service Problems

Kenneth B. Willson, president of the National Better Business Bureau, had some comments to make about electronic service problems in an address before the service committee of the Electronic Industries Association. As far as volume of complaints to various BBB offices throughout the nation is concerned, he said, TV service ranks third among all fields of endeavor. It follows closely on the heels of the home-improvement business, which ranks first, and service on non-electronic home appliances, which comes in second. Interestingly enough, not all of the complaints involving TV service were those made by set owners against service dealers and technicians. Others included owner gripes against makers, and dealer plaints against other dealers, makers, distributors, and customers!

Mr. Willson also had some things to say about licensing. He pointed out that a chief aim of the NBBB is to promote self-regulation by business in place of government regulation. However, he noted that there was strong, widespread support for licensing throughout the service industry and passed this sentiment on to the EIA committee without comment of his own for consideration.

He also suggested that manufacturers might improve their own public relations as well as those of the service industry by undertaking joint sponsorship, with the NBBB, of a public-service film explaining the nature of the product and service needs, for use by such media as TV, schools, and clubs. —30—

Audio Line Amplifier

(*Continued from page 61*)

also be used. The output transformer can be another type than the one specified provided it is a good quality unit with the same impedance and frequency response characteristics. The resistors must be 5% tolerance or better for best balance and equal amplification on both sides of the amplifier.

Complete the construction of the entire amplifier except for wiring in R_5. To determine the resistance of R_5, temporarily wire in a 5000-ohm potentiometer, hooked up as a rheostat, between the transformer's primary center-tap connection and S_1. Insert a 10-ma. meter in series with the negative battery lead and S_1, rotate the potentiometer shaft to put maximum resistance in the circuit, and switch S_1 to the "on" position. The milliammeter will indicate about 2 ma. if the wiring and transistors are properly connected. If appreciably more current is indicated, check the wiring for wrong connections or test for a possibly defective transistor. If all seems well, obtain an audio signal generator and audio r.m.s. voltmeter to calibrate the "Trans-Line" amplifier's gain.

Place a 600-ohm resistor across the input terminals and connect the audio voltmeter and signal generator, set at 1000 cycles, to the same terminals. Adjust the generator's output level control for exactly 0.1 volt input to the line amplifier. Transfer the audio voltmeter leads to the output terminals and rotate the potentiometer shaft to obtain the desired gain. If 20 db is desired, adjust the pot for a 1-volt meter reading or, if a 14-db gain is needed, adjust the pot for a 0.5-volt reading. Recheck the input level for the 0.1-volt level and re-adjust the potentiometer, if necessary, for the desired output level. Monitor the output with an oscilloscope to make sure the output signal is undistorted.

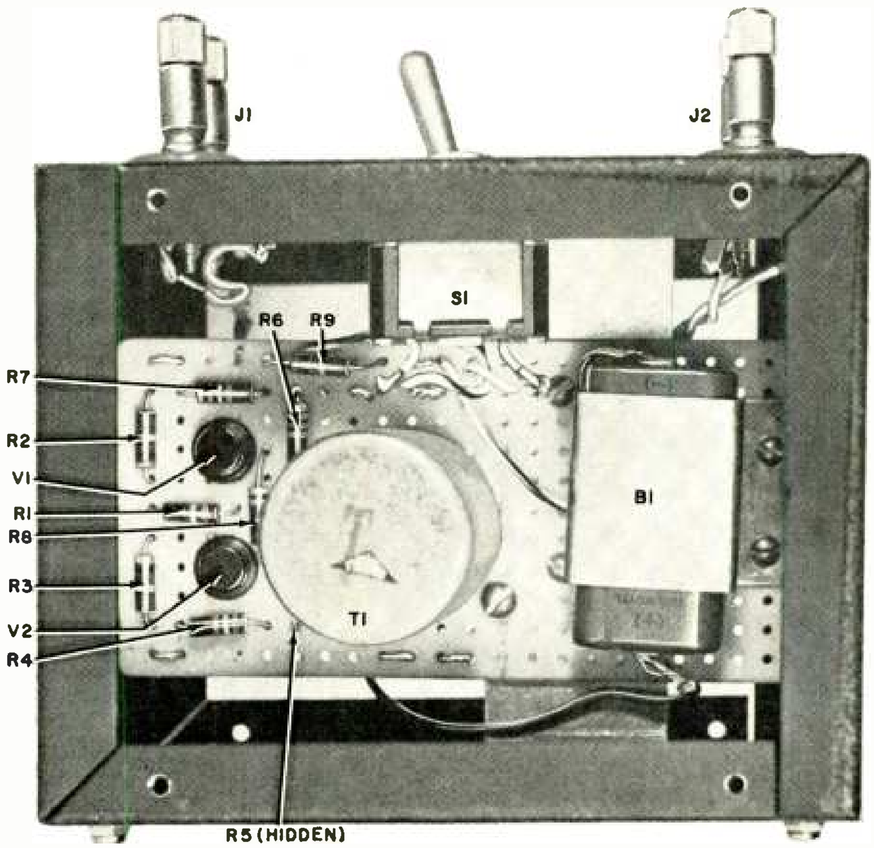
When this procedure is completed, replace the potentiometer with a fixed resistance of equal value, or leave the potentiometer permanently mounted in the enclosure. The line amplifier is now ready to be put to work.

If the line amplifier is to be fed from a signal source containing d.c. as well as a.c., like the cathode of a vacuum-tube cathode-follower stage, insert a blocking capacitor between the cathode and line-amplifier input. Most preamps with cathode-follower outputs have a built-in capacitor.

Many applications requiring signal boosting over long audio lines going from a central studio to a remote amplifier can be handled by this "Trans-Line." It can also be used as a standard fixed-gain preamplifier for audio signal-level measurements, to drive an oscilloscope or r.m.s. voltmeter.

Several of these units can be mounted in a single enclosure for installations requiring more than one transmission line, or they can be cascaded for greater amplification, one feeding the other, if the signal levels are low. Despite its simplicity and ease of construction, the "Trans-Line" provides versatile and dependable performance. –30–

Inside view of the audio line amplifier. Photograph was taken with the top cover removed. All parts except jacks and switch are mounted on piece of perforated board.



Transistorized Phono Oscillator

By **BRONSON M. POTTER**

Circuit makes battery-operated phono possible. Used with portable radios.

WITH at least two makes of six-volt turntables on the market, a battery-operated phonograph is well within the reach of most music enthusiasts. Electrical governors, low battery drain, and reasonable cost of these imported turntables provide an easy solution to many of the earlier problems encountered with battery-operated portable phonos.

The modulated oscillator circuit shown in the diagram permits the use of a portable radio in place of an amplifier and loudspeaker. The oscillator is, in effect, a transmitter with a range of a few feet. It is modulated by the output of a conventional crystal pickup. Placing a receiver two or three feet from the oscillator permits reception of the phono output through the radio's loudspeaker.

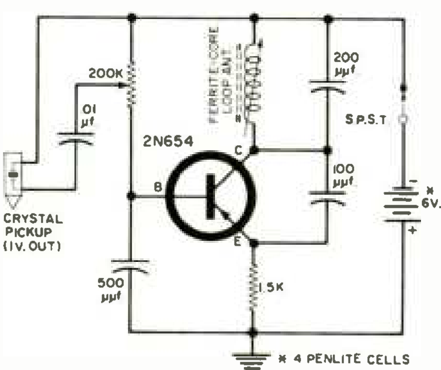
Construction is relatively simple. First mount the pickup and turntable. The turntable should have its own batteries and switch to minimize hash. Four "D" cells in series can provide the current for many hours of listening.

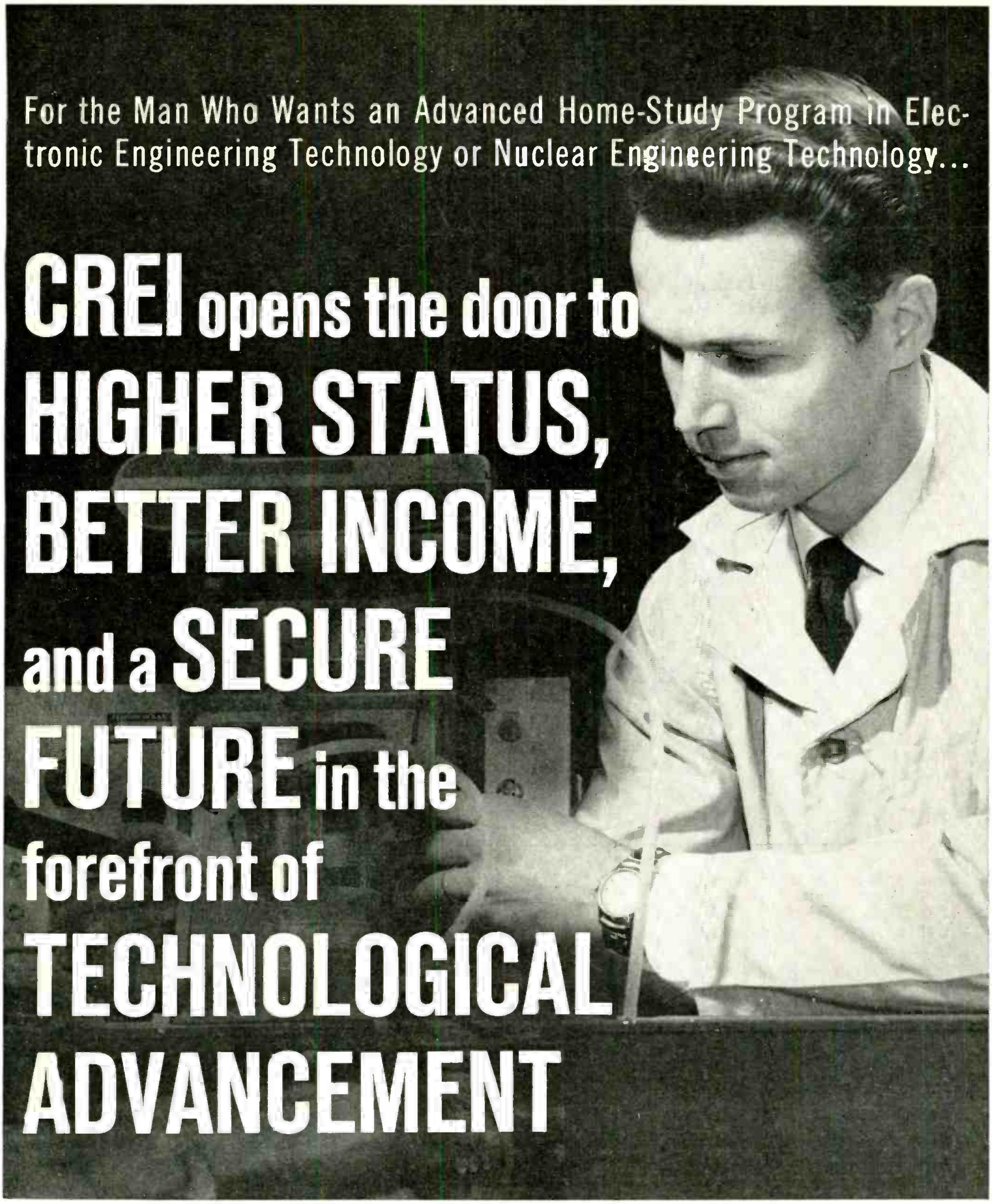
The oscillator parts can be mounted in any convenient arrangement. The transistor leads should be held with pliers while soldering to dissipate heat. The penlite cells, four 1.5-volt units in series, provide one milliampere of current. Be sure to orient the cells correctly.

To operate the oscillator, tune the receiver to a dead spot on the broadcast band. Place a record on the turntable and switch on the oscillator. Set the oscillator's modulation control somewhere near the middle and adjust the slug of the ferrite-core antenna to give the loudest signal at the receiver. Adjust the modulation control for minimum distortion.

This circuit has the advantage of being inexpensive, easy to build, and practical. It can be used at home as well as on the beach or at the summer camp. —30—

Home-built AM broadcast-band oscillator.





The world of science is the world of the future. There is no career more stimulating, challenging, or rewarding than that of working with topflight scientists and engineers to develop deep space probes and orbital satellite systems . . . package nuclear power reactors to provide economical, long-lasting power anywhere in the world . . . electronics and radioisotopes for use in medicine, agriculture and industry . . . missile systems for the Armed Forces . . . computers and data processing systems which will become accepted necessities by finance, industry and government . . . to develop a thousand and one concepts that will make our world a better and safer place for all. You can have a career—or speed up your present career—in one or more of these areas if you are eligible to enroll in a CREI home-study program . . . a program recognized everywhere as excellent insurance for a secure future, high professional stature, and better income.

CREI's Extension Division now offers you college-level programs combining the technological content of advanced residence courses with convenience and economy of home study.

The quality of a CREI education may be gauged by the fact that the demand for CREI graduates and students at the CREI Placement Bureau has far exceeded the supply for several years. Many leading companies and Government agencies send representatives to CREI every year to hire graduates and students for their technical staff. The CREI educational programs were developed in conjunction with leading industrial concerns and government agencies directly interested in the nation's scientific and technological future.

There are now more than 20,000 CREI students in all the 50 states and most countries of the free world. You, too, can follow your CREI program while you remain in your present job. You study at home, when and as you you choose . . . and you avoid the time and expense of commuting to a residence school. Within two to four years, depending upon the courses you select and the time you have to apply, you can complete a CREI program in engineering technology. The courses are written in easy-to-understand format, and your personal progress is carefully guided by CREI's competent faculty.

CREI programs bring you the latest technical advances and breakthroughs.

Recent advances and new techniques have placed great importance on how modern and up-to-date the individual's education is. Recognizing this, CREI maintains a large staff of engineers, educators and scientists who occupy prominent positions in government and industry. These men continuously revise the CREI courses and incorporate all new technical information. CREI courses are the most modern you will find . . . anywhere.

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Product Report | ELECTRONICS WORLD LAB TESTED

"Knight-Kit" Model C-27 CB Transceiver
Sencore "Mighty Mite" TC109 Tube Checker
PACO Model ST-45 AM-FM Stereo Tuner

"Knight-Kit" Model C-27 CB Transceiver

ONE of the most attractive CB transceivers that we have checked recently, both from the viewpoint of appearance as well as performance, is *Allied Radio's* "Knight-Kit" Model C-27. This smartly styled unit has the look and feel of quality from the minute you turn it on, and the entire edge-lighted plastic front panel is illuminated. The transceiver is fairly large and spread out, and this, coupled with the use of two well-marked printed boards, make the construction of the kit fairly simple and straightforward. The clearly presented, well illustrated assembly manual should make it easy for the inexperienced builder to put together the transceiver with little difficulty.

The transmitter section is a two-channel, fixed-tuned rig with a plate input power of 5 watts—the maximum allowed on the Citizens Band. The unit comes with one transmitter crystal, but extra crystals are available for other channels. A single 6AW8A makes up the entire r.f. portion, with the triode section of the tube used as a crystal oscillator and its pentode section used as the power amplifier. Simple link coupling is used to the antenna, with a second-harmonic trap inserted in the output line to kill any 54-mc. signal that might interfere with channel 2 on a nearby TV set.

The receiver portion of the transceiver is worthy of special comment. In using the unit, we were very pleased with the high sensitivity and extremely good selectivity of the dual-conversion circuit. The receiver is continuously tunable over the entire band, but there is also provision for inserting one or two crystals for 2-channel fixed-tuned operation. The set actually uses two separate second local oscillators, one tunable and the other crystal-controlled to accomplish this. The first local oscillator is crystal-controlled in either case. Plate voltages to both local oscillators, by the way, are regulated in order to get the utmost in frequency stability.

The diode noise limiter is unusually effective. We found this out by operating the unit in our office building, surrounded by noise-generating business machines. With the noise limiter switched in, the signals were wiped clean of all interfering noise. The squelch circuit also operated effectively and smoothly.

The transceiver uses its built-in speaker as a microphone when transmitting. Under these conditions, a bar-switch on the front panel provides press-to-talk operation. An optional press-to-talk ceramic microphone or telephone handset is available for use with the unit. In comparing the use of the speaker as a mike with the separate ceramic mike, we found somewhat more talk-power produced with the ceramic mike. This is because the ceramic unit probably has somewhat greater output and you can get your lips quite close to it conveniently.

The transceiver operates from the 117-volt a.c. line, from which it draws 85 watts. An EZ81 full-wave rectifier is used along with an *LC* filter; an 0A2 voltage regulator supplies a constant 150 volts to the receiver's local oscillators. A separate mobile power-supply kit is also available for the unit that permits it to operate from either a 6- or 12-volt storage battery. Still another available accessory is a mounting bracket for mobile use that permits convenient under-dash mounting for the transceiver.

The Model C-27 is available from *Allied Radio* at a price of $79.95. Extra transmitting and optional receiving crystals are also available at a cost of $1.99 each.

Sencore "Mighty Mite" TC109 Tube Checker

THE service technician in the market for a new tube tester may face a dilemma even though he knows exactly what he wants. The trouble is that some of his varied requirements are likely to conflict with each other. He wants something safe and simple to use, small, light, and inexpensive. On the other hand, he hopes for reliable indication of quality on all tubes he encounters, physical sturdiness, and reasonable immunity from obsolescence.

Determined to reconcile these qualities in a single instrument, *Service Instruments Corp.* has come up with a new addition to its line of *Sencore* test equipment, the "Mighty Mite" TC109 Tube Checker. The unit reflects an interesting and original approach.

Measuring 9 inches wide (maximum dimension) in its carrying case and weighing under 7 lbs., the handy TC109 accepts over 1300 radio and TV tube types, including picture tubes. To make sure the checker "gets them all," reliance is placed on three distinct tests: shorts-leakage testing, cathode emission, and grid leakage. In the first, a selector switch is rotated through 9 positions, in each of which one tube electrode is checked for leakage (sensitivity of 50,000 ohms, neon indication) against all other electrodes tied together.

Cathode emission is checked by applying a pulsating d.c. whose value is close to the normal operating value for the particular tube type. Conditions established by the set-up controls are such that normal emission is indicated by a merit reading of 100 on the emission scale, which is safely below full-scale deflection on the meter. However, it is no secret that many otherwise defective tubes will exhibit normal emission.

The final trap for the "sneaky" defect is the grid test. Experience shows, according to some investigators, that many diverse tube malfunctions, whatever the specific cause, will show up as abnormal activity in the grid circuit. This includes gassiness, grid emission, high-resistance leakage, and other deviations, some of which may permit normal indication even on transconductance tests although tube operation in actual use is improper. In a sense, the configuration that makes the grid test may be regarded as an ultra-sensitive ohmmeter that applies 50 volts between the grid and all other electrodes tied together to indicate leakage in the order of hundreds of megohms. The meter's

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grid-leakage scale begins to indicate into the "Bad" region when leakage resistance (or other defect reflected as such) falls to 100 megohms.

The meter itself is in the cathode of the 6C4 that is the heart of the checker's circuitry. In this arrangement, a dead short through the suspect tube or gross misadjustment of controls will not send excessive current through the meter. Thus the tester is protected against damage, even in the hands of an inept customer.

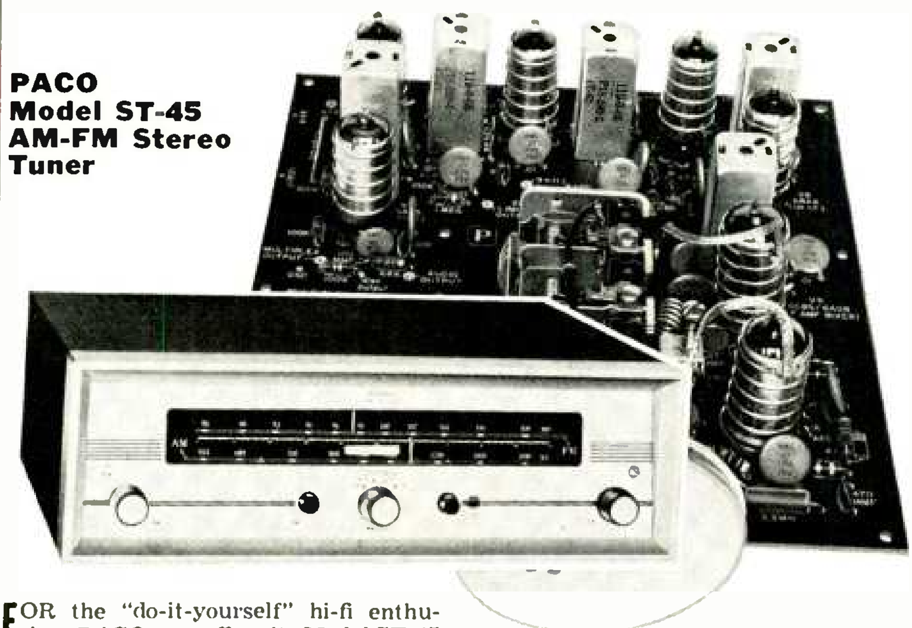
To check the instrument's reliability, we reversed the customary test procedure, observing performance of the TC109 on some two dozen tubes known to be defective. Originally accumulated for another purpose, these had been marked with known or probable defects or the symptoms they had produced in their original circuits. Many had been passed as "good" by other testers. Each failed at least one of the three tests provided by the TC109. On the other hand, every new tube previously known to be in good condition scored very close to 100 on the "Mighty Mite's" emission test and clearly normal on the other tests.

Tube set-up—the adjustment of four switches—is achieved easily and quickly by technicians or laymen. A fifth switch is rotated through the various test positions. The various sections of multi-purpose tubes are checked separately. The tube chart is in the form of a compact loose-leaf book that fits into the tester case to which it is attached and permits easy insertion of new data. Owner registration insures a continuing flow of test data for new tubes, as they appear, at no additional charge. *Sencore's* reputation for supplying such follow-up information is good. This is the chief factor in the prevention of tube-tester obsolescence.

A clear instruction manual includes circuit analysis, schematics, a troubleshooting chart, and delineates added tasks (such as life-expectancy test, open-element test, rejuvenation) achieved with additional, minor manipulation. The "Mighty Mite" uses heavy-duty sockets and switches, plus a sturdy chassis on which parts are well-supported. The meter face lights up in use, for those dark, back-of-the-set spots. Concise instructions are printed on the front panel, which also includes two tube-pin straighteners.

Convenient for carry-about or counter use, the TC109 may also be removed from its case for easy mounting (instructions included) in a tube-tool caddy or on a bench panel. Dealer net price is $59.50.

PACO Model ST-45 AM-FM Stereo Tuner



FOR the "do-it-yourself" hi-fi enthusiast *PACO* now offers its Model ST-45 combination AM-FM tuner, intended for stereo reception, which includes some very fine features. The kit itself contains printed wiring boards which are clearly labeled on the top so that the assembler knows exactly which part goes where. A total of 13 tubes provides completely separate AM and FM receivers and two separate audio-output cathode-followers. A tuning indicator, in addition to a.f.c., which can be switched in or out, helps on all FM settings of the selector switch. When AM only is selected, then the tuning eye works on AM. Separate pointers are moved along the slide-rule dial and each of the ganged tuning capacitors is driven through a gear mesh as well as by the dial string from the front control.

The unit under test had been constructed and aligned according to the instruction manual, without a signal generator, and showed a discrepancy of 1 mc. at the low end of the FM band and it was 2 mc. off at the 108-mc. dial reading. This was later corrected in a signal-generator alignment by careful trimming so that the dial reading was only 0.4 mc. off, at the worst point.

Performance tests on the FM portion were made according to the IHFM (Institute of High Fidelity Manufacturers, Inc.) standards, and yielded the following results:

Volume sensitivity for a 20-db output reduction is 1.8 μv. at 90 mc., 1.5 μv. at

98 mc., and 2.2 μv. at 106 megacycles.

Sensitivity for 30-db quieting is 2.5 μv. at 90 mc., 2 μv. at 98 mc., and 3 μv. at 106 mc.

Over-all i.f. response is 320 kc. at the 3-db points, while the peak-to-peak separation of the FM detector is 410 kc., with a linear portion of 330 kc.

The a.f.c. pull-in range at 98 mc. is +550 kc. and −600 kc., and there is no discernible drift when a.f.c. is on.

Maximum audio output of the FM section is 1.5 volts r.m.s.

Audio response is within ±1 db from 40 cps to 15,000 cps—the limits of our test. This takes into account the standard de-emphasis curve.

The AM portion of the Model ST-45 has an r.f. amplifier, a pentagrid converter, one i.f. stage, and a crystal diode as detector and a.v.c. source. All measurements were made with a 200-$\mu\mu$f. dummy antenna.

Tuning range of the unit is 550 kc. to 1640 kc.

Frequency calibration is −15 kc. at 1000 kc.

Usable sensitivity is 3 μv. at 600 kc., 5 μv. at 1000 kc., and 2.5 μv. at 1500 kc.

Selectivity is −6 db at ±3.5 kc.

Audio response is within ±3 db from 40 to 7800 kc.

The 10-kc. whistle filter effectively eliminates all whistle interference that may be produced.

From the above data it becomes apparent that the unit tested certainly performs very well. Actual listening tests in a difficult location with a minimum of antenna (3 feet of 300-ohm twin-lead) confirmed the effectiveness of the FM portion, while the AM tuner, with its built-in ferrite-core antenna, also operated very satisfactorily as was expected.

The price of the unit is $84.95 in kit form or $99.95 in semi-kit form, in which the printed boards are completely constructed and aligned by the manufacturer. The tuner is also available completely factory-wired at a price of $134.95. —30—

Leo I. Meyerson, president of World Radio Laboratories of Council Bluffs, Iowa, presents the winning certificate to Gene Conley, Columbia TV Service, as WRL's Omaha representative, Rich Switzer, looks on. The certificate entitles Mr. Conley—an Omaha resident—to a week in Hawaii. The trip, based on total purchases of Hitachi tubes from WRL, was entered by 250 dealers. Present plans call for making the travel contest an annual event, according to Mr. Meyerson, who was both surprised and pleased by the enthusiastic dealer response.

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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, saddle-stitched Texon 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.

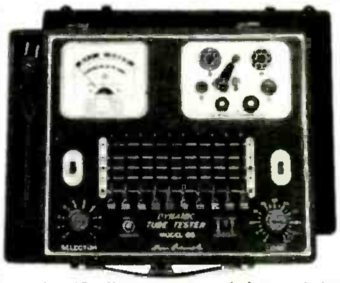
Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage *uniformly* to assure increased life with no danger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

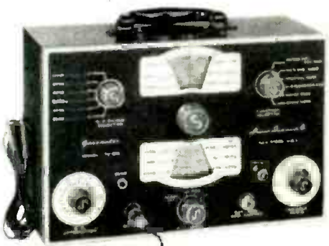


- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method 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.**

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-847, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligations.

- ☐ **Model 770-A Total Price $15.85** $3.85 within 10 days. Balance $4.00 monthly for 3 months.
- ☐ **Model 79 . . . Total Price $38.50** $8.50 within 10 days. Balance $6.00 monthly for 5 months.
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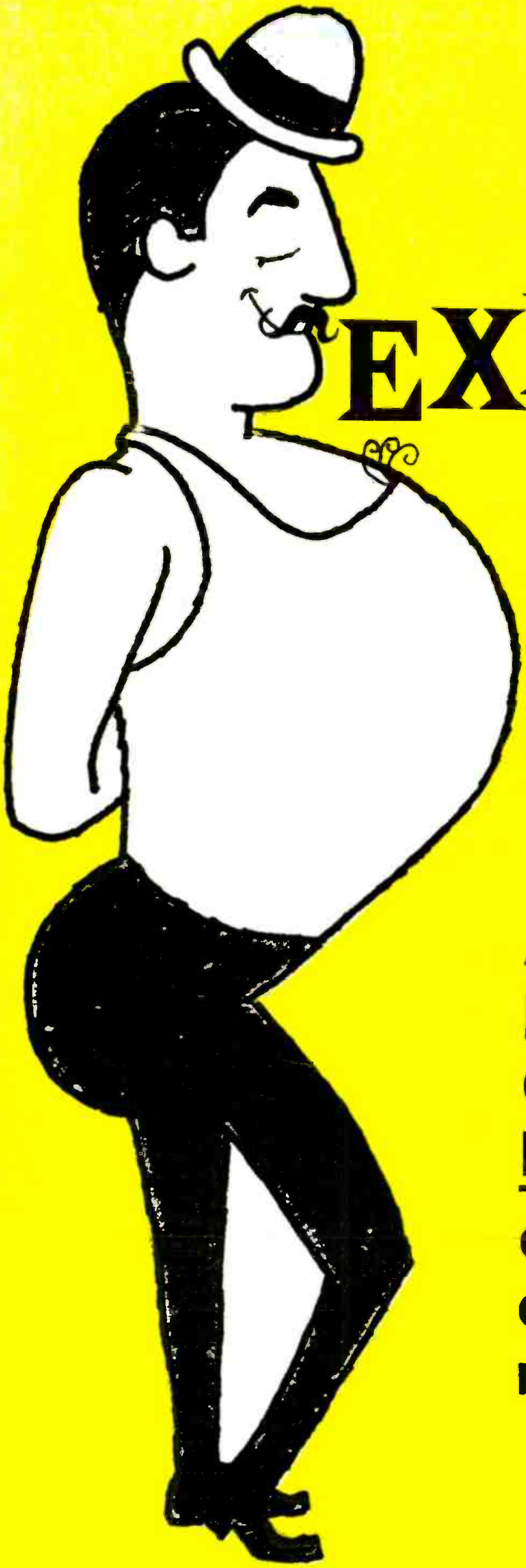
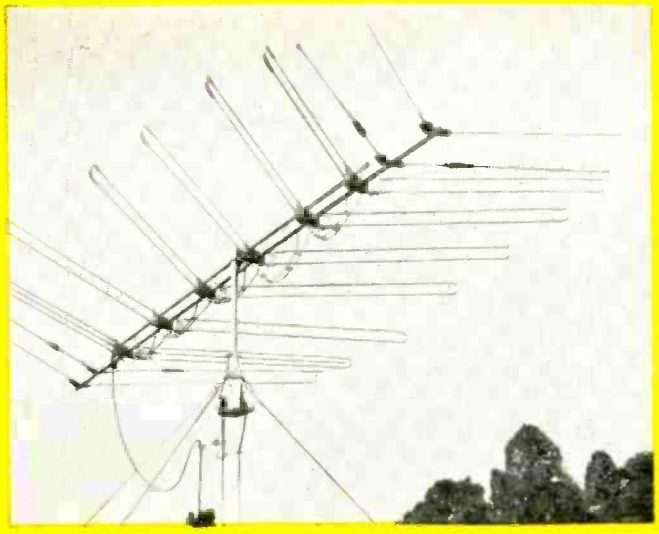
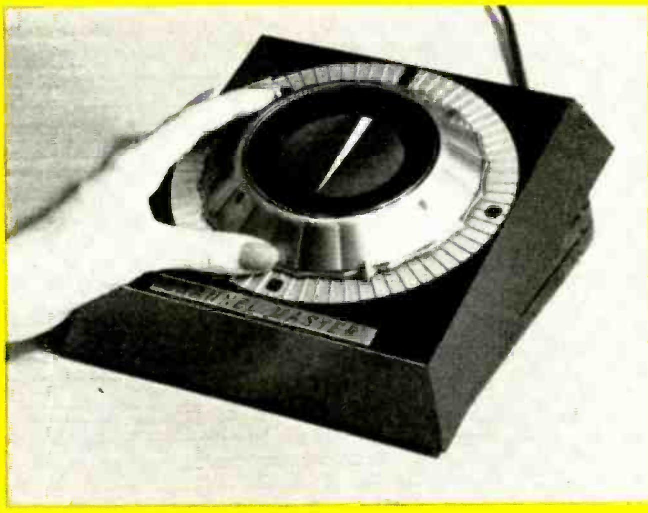




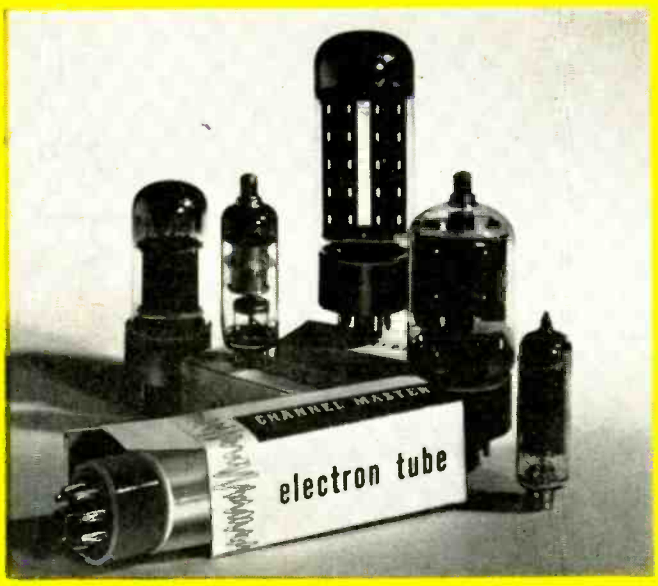
78% more Picture-Power in CHANNEL MASTER T-W ANTENNAS!

The unique Traveling Wave principle—already fully proved and approved in deep-fringe areas—is now further **improved!** The new Super 10, with 10 elements, pushes the fringes back even farther—provides unsurpassed super-fringe performance for "picture-poor" homes. Up to 78% more gain than the famous 7-element T-W. Greater front-to-back ratio, exceptional mechanical strength. Another fringe-area powerhouse is the new Super 8—with 4 driven elements, 4 parasitic elements.



More accuracy in CHANNEL MASTER AUTOMATIC ROTATORS!

For best reception, an antenna must be aimed **accurately**—not in **jumps** of 10 or 15 degrees. The Channel Master Tenn-A-Liner is the only automatic rotator that can be aimed within ONE DEGREE of the required direction. And is so easy to operate even a child can do it! Greater turning power, fool-proof control box, elimination of solenoids means quieter operation. No other rotator compares with this one!



Extra Dependability in CHANNEL MASTER PREMIUM QUALITY TUBES!

Longer life, unfailing uniformity, completely dependable performance—are what your customers expect of their tubes. And Channel Master Premium Quality Tubes give them all three of these qualities to spare! The Channel Master tube line also takes care of over 75% of your service calls. America's fastest-growing line?...You **bet!**

CHANNEL MASTER

works wonders in sight and sound

Ellenville, New York

Packaged Service Problems

(Continued from page 41)

could have been noted between terminals 2 and 3; an increase in value of the resistor at the upper left could have been noted between terminals 2 and 4; the 1000-$\mu\mu$f. capacitor could have been checked between 1 and 3; and so on. Similar techniques could be used with such other common combinations (Fig. 2) as the audio-coupling network (A), a retrace-blanking network (B), and two different configurations involving a pair of encapsulated selenium diodes (C), as phase detectors in horizontal a.f.c. circuits. In the twin-diode combinations, it is possible to check each unit separately for forward and back resistance.

With the fault mentioned for the discriminator network of Fig. 1, it would have been possible to solder the external resistor across terminals 1 and 2 as a permanent repair, if necessary. However, this was not done because the trouble was intermittent. In general, it is wise to replace an entire assembly rather than solder in additions.

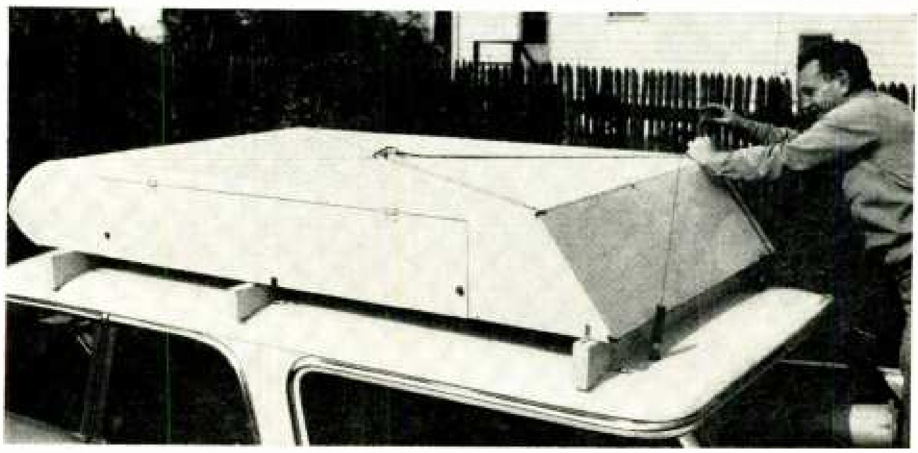
It may happen that an exact replacement is not readily available and the customer is unwilling to wait until one can be obtained. You may or may not want to use the bridging technique then, and it may not be at all possible in some cases. There is still another expedient: make up your own network. Fortunately, most of combinations in use include only a few components, and it is generally possible to put together standard components that will fit into the available space. In some cases, it may be advisable to mount them on a small piece of plastic board; in others, they can be interconnected by stiff bus wire for rigidity.

The phase-comparator horizontal circuit, having retained its popularity for many years, is still in widespread use today. The most significant change has been in the replacement of the 6AL5 dual diode with a pair of miniature selenium diodes sealed in a small plastic block (Fig. 2C). This unit, too, can be replaced by a pair of separate semiconductor diodes. You are not likely to find selenium units available in a small enough size, but commonly available silicons will do nicely. Available types can easily handle the nine or ten volts, peak-to-peak, developed in this circuit; at the low frequency involved, 15,750 cps, response problems should not crop up. Theoretically, it is possible to use germanium rectifiers too. In fact, some *G-E* sets incorporate these. However, the miniature units will probably not last very long and those that combine satisfactory voltage rating with small size are not readily available.

Thus the silicon diodes, in this case, are the most practical expedient. The important point is that, as with other types of combination units, practical methods for constructing the equivalent networks do exist when the exact replacements are not available. —30—

Raymond E. Meyers, W6MLZ, (left) of San Gabriel, Calif. and B. S. Angwin, Los Angeles area sales manager for General Electric, with the citation Meyers received during the Western Electronic Show and Convention in connection with G-E's Edison Radio Amateur Award program. Meyers was cited for his operation of amateur radio service during last year's Ninth Plenary Assembly of the Consultative Committee on International Radio in Los Angeles. A special radio station, K6USA, planned and organized by Meyers, handled some ten-thousand contacts.

Four brass strips placed on the luggage carrier on the top of a car or station wagon can be connected as two paralleled dipoles, fed by twin-lead, to permit FM or TV reception in a car. Of course, the TV set should only be used when car is not in motion. Length of strips is not critical and reception was excellent.



Sound on Tape

By **BERT WHYTE**

WHILE THE QUANTITY of tapes coming in for review hasn't increased noticeably, the quality of performance and selection of repertoire is certainly on the "plus" side, as witness this month's batch of good things for the tape-o-phile.

POPOVERS
Eastman Rochester Pops Orchestra conducted by Frederick Fennell. Mercury Stereo STB90222. Price $6.95.

After a surprisingly long drought, *Mercury* has seen fit to release more tape in the four-track format. For some reason, they turned out a few four-trackers and then stopped. This was especially true of the classical material. This tape qualifies as a "classical" release, even though it consists mainly of material encountered at "Pop" concerts.

It is to be hoped that this tape signals *Mercury's* intention to re-enter the tape field on the scale which made them such a potent factor in the old two-track days. This tape has such diverse items as the "Russian Sailors' Dance," "Liebestraum," "The Golden Age Polka," "Clair de Lune," "Hora Staccato," and others of similar persuasion.

Fred Fennell gives all of them readings appropriate to their natures, tampering with them very little and letting the music stand on its own merits. In other words, unlike some "Pop" conductors, he does not try to garnish the works with interpretive mannerisms. There is fine sound throughout, with a special nod to the smooth string tone and the brilliant, weighty brass and sharply accurate percussion.

Very good stereo balance here, with directivity and depth in equal measure and a particularly good center "ghost" channel. An outstanding tape of its type.

CARAMBA!
Richard Hayman and his Orchestra. Mercury Stereo STB60103. Price $6.95.

This was an outstanding success as a stereo disc and now we can enjoy it even more fully on this tape. Sure, it is corn, but it is good corn.

Subtitled "Day of the Bullfight," it is a potpourri of works supposed to depict the taurine spectacle. Every possible source has been milked for appropriate music . . . from the more or less classic "Maids of Cadiz" to the traditional pasodoble "La Virgen de la Macarena," to music from the picture "Captain from Castile." In fact, the "Conquest" theme from the movie is a rather big, overblown march, but is most effective in this usage.

Add to this the very big and bright sound, with some highly artificial but nonetheless clever stereo effects and you have a tape which generates a lot of excitement. Some huge brass and percussion sounds in "Conquest" and, as an added bonus, the tape was exceptionally low in hiss.

BERLIOZ
REQUIEM ("Grande Messe des Morts")
David Lloyd, tenor: Hartford Symphony Chorale, Hartt Schola Cantorum with Hartford Symphony Orchestra conducted by Fritz Mahler. Vanguard Stereo VTP1610. Price $11.95.

This is one of the most monumental works ever written and by far the biggest thing to appear on tape thus far. The forces required for this score are staggering . . . a full symphony orchestra, four special brass bands which Berlioz stipulated should be located at the four corners of the hall in which it is performed, sixteen tympani, and a chorus of one-thousand voices! I don't believe quite that many choristers were employed in this recording but it was a very sizable group, nonetheless.

It is fitting that the conductor of such a large-scale work should be Fritz Mahler, who is the nephew of the great Gustav Mahler—no stranger to big works himself. This recording first appeared on stereo disc very early after this medium was introduced. It was very courageous of *Vanguard* to attempt a recording of this work in this country and even more courageous to issue this work on the stereo disc of that period, in which many lessons had to be learned as to cutting techniques and how to cope with a work of such enormous dynamics.

Thus, on the relatively primitive stereo disc of the early days, this was something less than a success. Now it is possible to really appreciate this great work and to revel in the glory of its vast sound. It has faults to be sure . . . the chorus is not always as steady as it might be and while the sound in general is quite clean, when the massed forces are at the height of the dynamic scale, there is quite a bit of "fusion" and an obscuring of some of the elements.

In all fairness, I must admit I have never heard this work when complete articulation was achieved. Mahler does very well in marshalling all these forces and in maintaining some degree of cohesion, but he is somewhat lacking in insight and fails to penetrate the score as deeply as have some others. But what he lacks in understanding he makes up for in enthusiasm and no one can deny that he creates a lot of excitement. When all those vast forces are unleashed in the "Dies Irae" and played at a good loud level which this music, above all, demands, the effect and impact are stupendous.

It goes without saying that stereo is the very essence of life for a work like this and here it comes off very well, the brass bands resounding from the four corners and the interplay between the choruses easily discernible. As a passing thought, maybe some day we will have the ultimate recording of this work. Imagine, if you will, a home set-up consisting of a three-channel stereo recorder playing back through three frontally located speakers and then another three-channel stereo playback, wherein the left and right channels feed a speaker to the left and right, located behind your back in the proper spatial relationship of the rear brass bands in the "Requiem." The center track of the second machine could be used to sync the two machines for exact playback. In this way you could finally and fully realize Berlioz' intent. *(You could also catch a performance in the concert hall —Editor)*

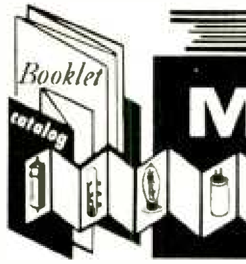
So an "A" for effort to *Vanguard* and thanks for a thrilling listening experience.

BIZET
SYMPHONY IN C
GOUNOD
SYMPHONY #1 IN D MAJOR
New York City Ballet Orchestra conducted by Robert Irving. Kapp Stereo KT19001. Price $7.95.

Gounod's work, which has been used as a ballet score, is known in this context as the "Gounod Symphony." Bizet's work has been treated similarly and they both lend themselves very well to balletic use. As ballets they have been staples of the New York City Ballet for some time.

Robert Irving is one of the top ballet conductors today and his reading of these works is the very essence of the dance . . . beautifully paced and carefully modeled so that one can envision the dancers having no difficulty whatsoever in maintaining rapport with the music.

Unfortunately, all of Irving's good work here goes for naught because of the poor sound pickup. A fairly distant miking was used and then the effects of this were compounded by using a hall with a long decay period. The result may be a striving for a so-called "concert hall sound," but in truth all they succeeded in doing is in blurring the entire audio perspective and the music sounds very formless and disembodied. Too bad, for the conducting and playing are so well done. —30—



Manufacturers' Literature

SUPERIOR CATALOGUE

Superior Electric Co., Bristol, Conn. has issued a ten-page "Product Guide" to the most frequently ordered items in its line.

The catalogue covers ratings and other technical data on transformers, voltage regulators, connectors, binding posts, motors, reactors, and power supplies. Write to Dept. PG at the company for a copy.

MULLARD TUBES

International Electronics Corp., 81 Spring St., N. Y. 12, N. Y. has announced a new bulletin listing *Mullard* preferred receiving tubes for high-fidelity, radio, television, and industrial applications.

Complete specifications and base diagrams for more than 60 tube types are listed. Copies are available at local *Mullard* distributors or by writing to the U. S. distributor at the above address.

COMPONENTS PRICE LIST

Electronics Publishing Co., Inc., 180 No. Wacker Dr., Chicago 6, Ill. has issued a new edition of "Dave Rice's Official Pricing Digest."

Available from distributors at $2.50 a copy, the volume gives list or resale prices on over 63,000 components. It also includes a table of flat rate and hourly service charges based on and showing regional and national averages.

Price data is arranged alphabetically by manufacturers and products, and numerically by part number.

ANECHOIC CHAMBERS

Emerson & Cuming, Inc., Canton, Mass. announces a new "Eccosorb" microwave anechoic chamber brochure.

The 32-page illustrated booklet describes the simplest box type anechoic chamber as well as the transverse baffle type, aperture type, and the latest longitudinal baffle type. Included are details of construction together with illustrations of each type of chamber designed and built to meet specific requirements of frequency range, working conditions, and the like.

SPECIALIZED HAND TOOLS

Xcelite, Inc., Orchard Park, N. Y. has issued a colorful bulletin describing a series of new hand tools designed for use in unusual assembly or servicing work. For a copy, request Bulletin 660 from the manufacturer.

HOFFMAN SEMICONDUCTORS

Hoffman Electronics Corp., Semiconductor Div., 1001 Arden Drive, El Monte, Calif. has published a catalogue listing its line of solar devices, transistors, tunnel diodes, uni-tunnel diodes, controlled rectifiers, general purpose diodes, special purpose diodes, zener devices, reference units, and regulators. Physical and electrical properties are given.

The booklet, in addition, contains a list of sales offices and industrial distributors and an explanation of the company's terms and conditions of sale.

NEW EIA STANDARDS

The Engineering Department, Electronics Industries Association, 11 W. 42nd St., New York 36, N. Y. has announced publication of two new standards.

Standard No. RS-233 is entitled "Phasing of Receiver Loudspeakers" and sells for 25 cents a copy. Standard No. RS-154-B covers "Polarized Dry Aluminum Electrolytic Capacitors for General Use" and is priced at $1.20 a copy.

Either or both of these standards may be ordered from the Association. Payment must accompany the order.

STANCOR REPLACEMENTS

Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. has released Form YFX, a cross-reference index showing *Stancor* equivalents for other brands of replacement yoke and flyback transformers.

The new publication is available from the company's distributors or by writing direct to the manufacturer in Chicago.

FLEXIBLE SHAFT HANDBOOK

S. S. White Industrial Division, 10 E. 40th St., New York 16, N. Y. has published the fourth, revised edition of its "Flexible Shaft Handbook."

This 89-page spiral-bound volume is available to design engineers and potential users of flexible shafts. It embodies a simplified approach to the selection of flexible shafting and provides descriptive material, charts, tables, and drawings.

Hitherto unpublished data includes information on a new, simplified engaging system based on integral formed square drives, and the new, improved Series 7 (remote control) and Series 9 (power drive) shafts.

The handbook is available on letterhead request to Department P of the company.

WIRE STRIPING

Alpha Wire Corp., 200 Varick St., New York 14, N.Y. has issued a 4-page, 2-color brochure designed to help the engineer draw up color-coded wire specifications. The publication covers several areas of wire striping and lists the 100 clearest military-approved color combinations, along with other color combinations that should be avoided.

A feature of the brochure is a chart which breaks down the two most commonly used military specifications covering hook-up wire (MIL-W-76A and MIL-W-16878C). The chart relates the military part number to physical construction, temperature rating, conductor size, stranding specification, and voltage rating.

Also included is a chart relating wire footage and number of pieces per thousand feet for lengths from 1/8-inch through 12 inches in 1/16-inch increments.

DIALCO BROCHURES

Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y. is offering two brochures describing its new developments in indicator lights and pilot-light assemblies.

"Datalites" (Form L-160B) is an 8-page booklet that discusses these ultraminiature lights and their use singly or in multiples as a "Data Strip" or "Data Matrix." Also described are the new "Data Cap" series No. 250 as well as cartridge connectors and speed clips. The brochure gives complete lamp data (neon and incandescent), features, specifications, illustrations, and schematics.

"Lights That Enlighten" (Form L-163) is a 4-page brochure which surveys the subject of read-out indicator lights, the company's assemblies which illuminate digits, letters, symbols, or words. This pamphlet is divided into seven concise sections and is illustrated with a number of full-size photos.

For copies of either or both brochures, write R. E. Greene at the company address.

EICO CATALOGUE

Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N.Y. has issued a 28-page catalogue describing its kit and wire versions of stereo and mono high-fidelity components, test instruments, ham equipment, portable transistor radio, and Citizens Band transceiver. All models are illustrated and fully described. The catalogue is available directly from the manufacturer.

POWER TRANSISTORS

Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix, Ariz. has published a 200-page handbook on the theory, design, and applications of power transistors. Supplemented by more than 200 drawings and charts, the volume can serve as a reference work as well as an introduction to the subject.

Copies are available for $2.00 each from the company's semiconductor distributors, or from the Technical Information Center, at the manufacturer.

RCA PENCIL TUBES

Radio Corporation of America, Electron Tube Division, Harrison, N.J. has published a booklet entitled "*RCA* Pencil Tubes."

Designated as Form No. 1CE-219, the 28-page booklet provides information on the design features of pencil tubes, their application to systems, and electrical and mechanical circuit design considerations.

A tube data section covers the full line of available commercial and military types. Copies of the booklet may be obtained from the company's tube distributors, or by sending fifty cents to Commercial Engineering, at the company.

ELECTRO SALES CATALOGUE

Electro Sales Co., Inc., 50-58 Eastern Ave., Boston 13, Mass. has issued its 1961 catalogue of items for electronic and industrial laboratories.

The 176-page illustrated brochure covers rotating equipment, including motors, blowers, reducers, and electronic components. New lines have been added and up-to-the-minute items have been included.

Over 5000 industrial motors and gear reducers and over 25,000 industrial electronic parts are listed. The catalogue is available to purchasing agents or engineers who request it on their company letterhead, specifying their position.

—30—

Five-Minute CB Timer

By **LEO MORGAN**, K1LRX, 1W1612

FCC rules limit duration of CB contacts. This timer will help.

HERE IS an electronic device which should be of interest to those readers who operate on the Citizens Band. Since FCC regulations state that calls between CB stations (that are not different units of the same station) shall not exceed 5 minutes, a timer is needed.

A diligent search for a 5-minute timer, electronic or mechanical, that would operate just by throwing a switch, failed to reveal a suitable unit. There are many mechanical timers but they are clumsy and awkward to use since it is necessary to reset the dial after every time cycle.

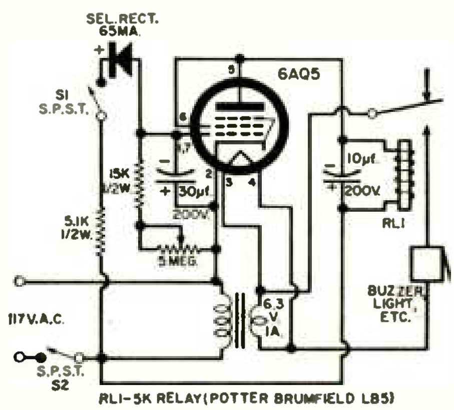
The circuit shown in the schematic below is a modification of a photo-timer. The design calls for a minimum of parts and, if the unit were to be built from scratch, parts would run less than $7.00. This figure can be considerably reduced if a well-stocked "junk box" is available. It will be noted that no power supply, as such, is required. It is necessary, of course, to use an insulated terminal strip for tie points and no components or leads should go to chassis ground.

Operation of the unit is as follows. When switch S_2 is closed, the filament heats up and the tube begins to draw current and the relay is energized. Close switch S_1. This places a high negative voltage on the grid of the tube and charges the capacitor. The tube stops conducting and the relay is de-energized.

When ready to start the time cycle, open switch S_1 and the capacitor will start to discharge. When the minus voltage drops to approximately −3 volts d.c., the tube will conduct and the relay will energize. The 5-megohm pot will set up the 5-minute time cycle. Other time cycles can be selected if desired.

The entire unit can be housed in a 3" x 4" x 5" "Minibox," using an "L"-shaped chassis. Placement of parts and wiring is not critical.

Schematic diagram and parts values for a simple, easily built timer for your CB station.



Reducing Xmtr. Interference

(Continued from page 55)

harmonics of the tone. Now if the transmitter is not overmodulated but the modulating signal contains distortion, the same condition occurs. Therefore, the distortion in the modulator can cause the same unwanted sidebands as can audio distortion in any of the audio amplification prior to the modulator. The peak levels in normal speech are about 20 db above the average level. It is readily seen that overmodulation can easily occur in a transmitter if a fair degree of modulation is used. It has been determined, however, that speech can be quite intelligible when these excessive peaks are clipped. However, if the clipping is done by overdriving the modulating stage, the harmonics caused by the clipping will be modulated on the carrier and the result will be "splatter."

It has also been determined that intelligible speech can be transmitted with an audio passband of 500 to 2500 cps. This is doubly important since if the speech bandwidth is reduced the ratio of the peak-to-average power is also reduced. A system taking advantage of both these factors is shown in Fig. 8.

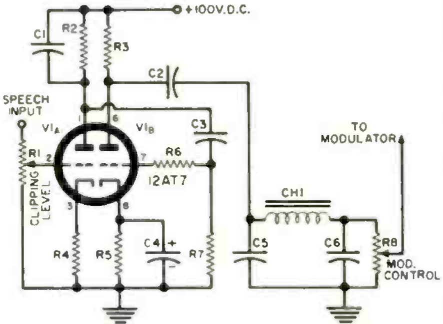
The first stage, V_{1A}, is a band-limiting amplifier with 3-db points at 400 and 2800 cps. The second stage, V_{1B}, is a clipper which will limit the output peaks to 30 volts. After clipping it is necessary to remove the higher harmonics produced by clipping. This is accomplished by the low-pass filter CH_1, C_5, and C_6.

In operation, the modulation-level control, R_8, is adjusted to produce 100% modulation with the 30-volt peak output (21 volts r.m.s. for a single tone) and the clipping level is adjusted by the input potentiometer.

In the concluding article next month, we will delve into the role played by proper shielding in reducing interference. We will also consider r.f. intermodulation as another source of interference.

(Concluded next month)

Fig. 8. Peak and bandwidth limiter circuit.



R_1, R_8—100,000 ohm pot
R_2, R_3—22,000 ohm, ½ w. res. ± 10%
R_4, R_5—470 ohm, ½ w. res. ± 10%
R_6, R_7—33,000 ohm, ½ w. res. ± 10%
C_1—2700 µµf., 200 v. capacitor
C_2—.01 µf., 200 v. capacitor
C_3—.001 µf., 200 v. capacitor
C_4—10 µf., 10 v. elec. capacitor
C_5, C_6—620 µµf., 200 v. capacitor ± 10%
CH_1—Smoothing choke, 13 hy. @ 65 ma. (Stancor C-1708)
V_1—12AT7 tube

Hamming in Britain

By PATRICK HALLIDAY

Amateur operations in England differ widely from our practices. Here's how some 9000 British hams work.

THE first DX calls logged by many American hams and SWL's are from Britain, yet the background of British ham licenses, which differs considerably from American ones, is known to few.

There are about 9000 British amateurs, about 1000 of them also holding the separate permits needed for mobile operation and almost 100 with television transmitting licenses for 420 mc. and above. To obtain an amateur license, issued by the British Post Office, it is necessary to pass a three-hour written examination in elementary radio theory and amateur operating as well as a 12 w.p.m. Morse test.

Only one class of license is issued for normal operation, authorizing phone and c.w. operation on all the bands with an input of 150 watts (except on 1.8 mc. which is also used for maritime radio services and on which only 10 watts input may be used). No novice or technician licenses are issued and, as soon as a license has been granted, the newcomer is on equal footing with all other amateurs.

To hold a transmitting permit costs the British amateur $5.60 a year in fees; if this becomes overdue he may have to take another Morse test before the license is renewed.

British amateurs are not allowed to handle third-party traffic hence cannot legally accept messages from the States for anyone other than himself or from anyone other than the amateur he is working. Because of the lack of any reciprocal licensing agreement with the FCC, American service personnel stationed in the United Kingdom cannot obtain transmitting permits, but there are arrangements for Canadian amateurs in Britain to obtain local licenses, usually without taking any further examinations.

The British authorities do not attempt to impose any division of bands between phone and c.w. but most European amateurs voluntarily keep the low-frequency portions of the main high-frequency bands for c.w. only. As recommended by the Region 1 Bureau of the International Amateur Radio Union, 3500-3600, 7000-7050, 14,000-14,100, 21,000-21,150, and 28,000-28,200 kc. are kept clear of phone stations.

There is no equivalent of the Citizens Band, although two-way mobile v.h.f. licenses are issued for "business radio" purposes.

Interests are spread widely with keen enthusiasm for most forms of hamming, including ragchewing, DX contests, RTTY, and a strong contingent of v.h.f. adherents, working mostly on 144 and 420 mc. There is also a special band—available in other parts of Europe—between 70.2 and 70.4 mc., in place of the 50 mc. band which falls inside one of the British TV channels and is not normally available. On 144 mc. a zone system is operated by the Radio Society of Great Britain to encourage amateurs in different parts of the country to use different sections of the band, to prevent weak DX signals from being swamped by local stations. —30—

REGULATOR CIRCUIT FOR MINIATURE MOTORS

By GEORGE ERICKSON

MOTORS used in battery powered circuits have an inherent tendency to slow down as the battery becomes weak. Wanting a constant-speed motor for use in portable equipment, this is how the author got around the problem.

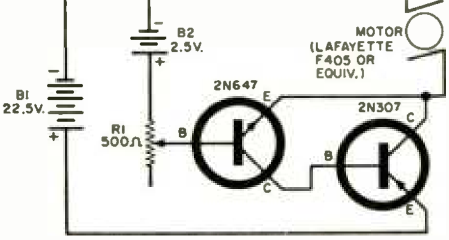
Normally, a d.c. motor's speed is directly proportional to its supply voltage; but if this voltage can be regulated, the motor's speed will remain constant. This circuit is then merely a series-transistor voltage regulator. The 2N307 power transistor is controlled by the 2N647 "n-p-n" transistor which is biased by battery B_2. B_2 should be a mercury battery because of its constant voltage output despite age. B_2 supplies very little power and will outlast many of the larger batteries.

In the author's circuit, B_2 was a Mallory mercury battery TR-132R, 2.5 volts, and R_1 was 500 ohms. R_1 was adjusted to give a speed of 1500 rpm, which varied less than 2% as the battery voltage dropped from 22½ volts to 3 volts—a better than 700% change in supply voltage.

A word of caution. This particular motor draws approximately 100 ma., so the 2N307 should have an adequate heat sink.

The regulation feature of this circuit might also be useful to stabilize a transistor circuit by replacing the motor with the circuit. —30—

A simple circuit for motor regulation.



By **BERT WHYTE**

CERTIFIED RECORD REVUE

DESPITE THE FACT that some people consider the recording industry in the doldrums and a bit moribund, an amazingly large number of good recordings in both mono and stereo are being offered to the public. In order to keep you abreast of the new offerings which I think you will enjoy, here is a magnum serving of reviews.

MOZART
CLARINET CONCERTO IN A MAJOR
HORN CONCERTO #1 IN D MAJOR
HORN CONCERTO #3 IN E FLAT MAJOR

Gervase de Peyer, clarinetist; Barry Tuckwell, horn with London Symphony Orchestra conducted by Peter Maag. London Stereo CS6178. Price $5.98.

A superlative musical experience on all counts, this is the kind of stereo that should be demonstrated to newcomers to the field as an example of how stereo can enhance the quieter, less athletic type of music.

The outstanding item is the clarinet concerto wherein de Peyer favors us with virtuoso playing reminiscent of that of Reginald Kell. The tone is full and rich, with intelligently used vibrato which never obscures the musical line. His is a very facile technique and the more difficult fingerings are traversed with ease.

Tuckwell is first-rate in the Horn concertos, with a big opulent tone to his credit, but he lacks just a shade in meeting the technical refinements of the late Dennis Brain.

Throughout the three works Peter Maag furnishes a completely knowledgeable and sympathetic accompaniment. Soundwise, this is one of *London's* best, with superb balance being maintained between good orchestral detail and just the right amount of reverb to lend rounded spaciousness. Stereo effects are well realized, with both soloists placed securely in the ghost center-fill middle. All is clean and bright and surfaces were pleasantly quiet. A real winner, this!

BEETHOVEN
SYMPHONY #9

Joan Sutherland, soprano; Norma Procter, contralto; Anton Dermota, tenor; Arnold van Mill, bass with two choruses and L'Orchestre de la Suisse Romande conducted by Ernest Ansermet. London Stereo CS6153. Price $5.98.

Any Beethoven "Ninth" commands a review because of its musical eminence and, in most cases, a company marshals its best forces for the recording. *London* has certainly assembled an illustrious cast and, to gild the lily, offers the complete stereo recording of this "Ninth" on one record! The press blurb that came with this record pointed out the advantage of a single stereo disc of the "Ninth," especially as to selectivity and cost, and also claimed that in spite of the single disc there was no "groove crowding" or compromise of sound quality.

Now I have a great deal of respect for *London*. They have to their credit some of the finest recordings ever made and they have the happy faculty of being *consistently* good in their recordings. But with this one I take sharp issue. Frankly, I am unable to understand why *London* would release this kind of a recording for surely they have good playback equipment and good ears.

To begin with, on one side alone is crammed almost 36 minutes of music! This is about 10 minutes beyond what most cutting engineers feel is the limit of quality. To go beyond 25 minutes on a stereo disc, it becomes necessary to compromise one or more facets of quality. Inevitably, the engineer must lower the over-all volume or reduce the bass response, or do both. He may also have to resort to limiting which compresses the dynamic range.

On this disc, in comparison with competing versions, the level is down as much as 4 to 6 db. Bass response appears to have been greatly boosted—out of balance—and the result is too prominent and boomy.

The general effect is of an orchestra and chorus constrained by artificial bonds . . . the strings sound weak and thin, the woodwinds are often obscured, as is the brass. The choral lines get blurred at times and the articulation of the singers and their balance against orchestra and chorus is often out of kilter. Oddly enough, the tympani and bass drum have been projected well forward and, at times, are very prominent.

All this is a pity for the soloists give a fine rendering. Ansermet's idea of the score is very different than most others. It has moments of great excitement, but for the most part he varies tempi so greatly and indulges in other mannerisms as to fall short of the efforts of most of his contemporaries.

This is probably the most severe criticism I have ever leveled against a *London* record, but unless I just happened to get an extremely bad copy, and I don't believe this is the case, I feel my remarks are justified. I can only repeat in conclusion that I cannot fathom why a company with *London's* background and reputation would issue this record in the first place.

GOULD
FALL RIVER LEGEND (Ballet Suite)
SPIRITUALS FOR ORCHESTRA

Eastman Rochester Orchestra conducted by Howard Hanson. Mercury Stereo SR90263. Price $5.98.

Here are two of the best works Morton Gould has written, given exemplary performances by Howard Hanson. The "Fall River Legend" is based on the famous Lizzie Borden murder case and was rather freely translated by Gould and his choreographer, Agnes de Mille. The ballet was first presented by the Ballet Theatre in 1948 and has survived with success to this day.

In a Prologue, Seven Scenes, and an Epilogue, the ballet unfolds the story. Gould has written some very effective music for each section, not wholly derivative or programmatic but utilizing many folk themes and religious motifs as well as some strictly "Gouldian" dissonances. The result is a very interesting score, with some of the writing very stark and dynamic.

"Spirituals" has enjoyed increasing popularity in recent years, probably because it is an ideal vehicle for spectacular "hi-fi" treatment. And, believe me, it gets the "treatment" on this disc. The stereo aspects are superbly realized, but it is the clangorous, thunderous percussion and the overwhelming dynamic range that stands out in one's mind.

The "Legend" is equally well recorded. Hanson performs both works with a great deal of zest and spirit and, as a whole, this is an outstanding production.

PROKOFIEV
ROMEO AND JULIET (Ballet Suite)

Czech Philharmonic Orchestra conducted by Karel Ancerl. Parliament Stereo PLPS132. Price $5.98.

I recently received a batch of "Iron Curtain" recordings, some of which were made in Russia itself, but most of which were produced in the "satellites." This *Parliament* recording is an example of Czech activity and was actually made by the *Supraphon* company which, before the War, was a highly esteemed label.

Before going any further, permit me to point out that I am as rabidly anti-communist as any American, but I also happen to feel that music is a universal language and as long as these recordings in no way reflect or propagandize their ideologies, they should be judged solely on their merits.

In this recording of "Romeo and Juliet," Ancerl has extracted ten of the most representative scenes from the ballet and integrated them into a sort of "tone poem." The first thing one notes is that the orchestral playing is of very high order . . . there is great precision and great tonal beauty. The first and second strings are outstanding for their quality and their ensemble work and the brass is very big and accurate.

Ancerl is a first-rate conductor and it is obvious he knows this score. He evokes from his orchestra an eloquent and passionate reading of great intensity and certainly this is one of the best performances . . . topped only by the ultra-sonorous, lushly sensuous masterpiece by Stokowski.

Now as to matters of sound. Russian tapes have not enjoyed a very high repute for quality and this is, in general, justified since they have turned out some real "dogs." This is the first stereo I have heard from an "Iron Curtain" country and, as I suspected, they appear to be using the M/S type of stereo recording or some variant thereof. The best way to describe the sound here is "variable." There are some splendidly recorded sections, nice and clean and in good acoustic balance. They seem to do very well on low percussion, tympani and bass drum being reproduced with good weight and clarity. The miking can be described as moderately close and the acoustics are good except for a tendency to become reverberant.

They attempt to use wide dynamic range and while they succeed to a certain degree, this is also their downfall. High percussives such as cymbals, especially if the score calls for any weight, are generally distorted. And, as the dynamics build up, they suffer severe

overload distortion. For example, in the very last section, "Romeo at Juliet's Tomb," there is a great build-up, with much high strings, cymbals, and trumpets and the wider the dynamics go, the worse the distortion becomes. After a while the blasting and intermodulation are so bad that one can hardly stay in the same room.

The stereo effects were fairly good in this recording but in others one experiences the lack of directionality and the formlessness that characterizes much M/S style of stereo. To sum up, a beautifully played work, in a recording that is listenable on modest equipment but which, on using top equipment, reveals many flaws.

RIMSKY-KORSAKOV
CAPRICCIO ESPAGNOL
RUSSIAN EASTER OVERTURE
BORODIN
PRINCE IGOR OVERTURE
POLOVTSIAN DANCES
London Symphony Orchestra conducted by Antal Dorati. Mercury Stereo SR-90265. Price $5.98.

Here is an invitation from *Mercury* to throw your saddle across these spritely war-horses and have a good ride! Familiarity sometimes breeds contempt and there have been endless recordings of all these works. However, hearing them in *Mercury's* rich, full-bodied stereo is like meeting an old friend. These tired old pieces take on a fresh, youthful vigor that transforms them and makes you realize, after all, why they are so popular and why there are so many recordings.

Dorati is happier in this Russian milieu than in many others and he turns in a powerful, idiomatic reading which is as serviceable as any. Add to this the plus of the superb stereo sound *Mercury* affords him and the package becomes even more attractive. This is all high-level recording, with great brass, sharp brilliant strings, and thunderous percussion. The directional effects are good and center-fill is ideal. The fine acoustics of Walthamstow Hall in London are used judiciously with the well-detailed mike pickup and the combination has great presence.

My only quibble is that the articulation and intelligibility of the chorus in the "Polovtsian Dances" is somewhat less than ideal. Perhaps cutting down the size of the chorus would have helped, but then we probably would have lost its great impact.

BLOCH
AMERICA
American Concert Choir conducted by Margaret Hillis with Symphony of the Air conducted by Leopold Stokowski. Vanguard Stereo VSD2065. Price $5.98.

Maestro Stokowski makes his first appearance on the *Vanguard* label and in a most appropriate fashion too! It is he, who along with four other eminent conductors, awarded the "Musical America" prize to composer Ernest Bloch for the work herein recorded. Maestro Stokowski also conducted the first performance, which was given in Philadelphia in 1928.

The work is in three parts and depicts the progress of America since the Pilgrim Fathers, through the Civil War, and up to 1926. It is frankly programmatic and ultra-derivative, making great use of folk songs, old ballads, religious pieces, and even Indian war chants. But these are all cleverly welded around the central theme of Bloch's song, "America." Thus there is a unity and a purpose to all the many elements and all are embellished with Bloch's unique orchestration. The choral part is small, being the final pages of the work wherein they declaim mightily the "America" theme.

The work is a little slow in getting started, but once under way is a fascinating journey into musical Americana. Particularly in the Civil War section you will recognize fragments of "Old Folks at Home," "Pop Goes the Weasel," "Old Black Joe," "Dixie," "Hail Columbia," and the familiar "John Brown's Body."

In the battle section of the Civil War, there is one of the most thunderous bass drums ever put on record and there is plenty of it. I predict wide use of this to show off speaker systems! The sound throughout the rest of the work is very clean and well balanced, with good directionality and easily discernible center-fill. Depth effects are well maintained and acoustic perspective suitable to the scale of the work. The choir comes over well in its brief appearance. An unusual work that will really grow on you as you listen to it and a worthwhile experience for those of you blessed with a venturesome mind.

SHOSTAKOVICH
SYMPHONY #7 ("Leningrad")
Czech Philharmonic Orchestra conducted by Karel Ancerl. Parliament Mono PLP-127. Price $7.96. Two discs.

This is another "Iron Curtain" job by Ancerl and his fine orchestra. These records may have their shortcomings but choice of repertoire is not one of them. Herewith, the Shostakovich "Seventh" which hasn't been recorded in a month of Sundays. This work had its premiere in America under the baton of Toscanini, no less, at a time when we and the Russians were buddy-buddy. Since the Cold War, it has practically vanished from the American scene.

Most musicologists do not rate this as one of Shostakovich's best works, feeling that it is rather drawn out and a bit tedious. However, they do admit that the writing of the first movement is unique and masterful. If you have been fascinated by the seemingly simple repetitious figures of Ravel's "Bolero," then you'll be equally stimulated by the second half of the opening *allegretto*. After the more or less pastoral-like first half, there begins, *pianissimo*, a simple military ruffle on a snare drum and then an equally simple 5-note melody, which like the "Bolero" is the central theme. The snare drum figure continues, endlessly repeating and ever so slowly building in dynamic scale. At the same time, the central theme is repeated, but each time with variations and transpositions as instrument after instrument is added. All the time, both the rhythm and the theme are building in dynamics until finally there is a gigantic outpouring of sound triple *forte* and the music slowly subsides.

It is one of the most hypnotic and frenetic things in music and Ancerl plays it for all it is worth. His performance is staggering in its blazing intensity and passion. The rest of the symphony has its moments, but never again reaches the level of inspiration of this first movement.

Soundwise, this is a pretty fair mono recording, miked fairly close and with good use of reverb. I don't think the frequency response extends much past 9000-10,000 cycles, but the good acoustic perspective makes up for a lot of this. The dynamic build-up is very considerable but upon reaching the *fortes*, overload and intermodulation creep in. Outside of that, all is reasonably clean and a tip of the hat to the wonderful strings and the very good sound and projection of tympani and other low percussion. In my opinion, worth the dough for the first movement alone. Now if we could only have that section in a really modern stereo recording . . . ah well, maybe some day! —30—

ELECTRONIC CROSSWORDS

By BRUCE BALK

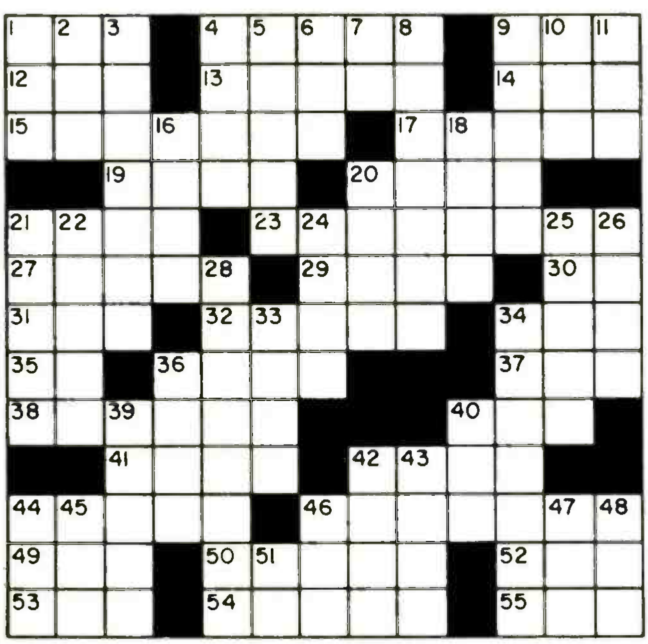
(*Answer on page* 130)

ACROSS

1. Unit of work.
4. U.h.f. tube.
9. Delay.
12. Amperage-voltage-resistance (abbr.).
13. Burn suddenly.
14. Ripen.
15. Pilot.
17. One of the sidebands.
19. Phonograph record.
20. Greek letter (pl.).
21. Boundary.
23. Electronic device for polarizing light.
27. Attempts.
29. Interlace.
30. Products of this equals wattage.
31. Unit of current (abbr.).
32. Dress carefully.
34. Collected miscellaneous data.
35. One of the United States (abbr.).
36. Spring vegetable.
37. Boy's nickname.
38. Hard crust or scab (geol.).
40. Common contraction.
41. Be fond of.
42. Trigger in electronics.
44. Type of modulation.
46. Rotates an antenna.
49. Battering tool.
50. Electronic navigation device.
52. At present.
53. Mischievous child.
54. Tree trunks.
55. Carpenter's tool.

DOWN

1. Present name for RETMA (abbr.).
2. Clergyman's title (abbr.).
3. Useful ham shack instrument.
4. Sterns.
5. Timepiece.
6. Rowing implement.
7. Means of transportation (abbr.).
8. Atomic particle.
9. Time interval.
10. Era.
11. European country (abbr.).
16. Engineers' organization (abbr.).
18. Treaty.
20. Sea eagle.
21. Element in a complex radio mechanism.
22. Girl's name (pl.).
24. Supplements.
25. In TV, horizontal sweeps.
26. Connecting wire.
28. "Output-ers" of audio amplifiers.
33. Inert or noble gas.
34. Aerial.
36. Greek letter (pl.).
39. D.c. restorer.
40. Citizen of (suffix).
42. Unit of stylus pressure.
43. Ventilates.
44. Transformer winding which receives power from supply circuit (abbr.).
45. Radio operator.
46. Poem.
47. To drag.
48. Dx-er (abbr.).
51. Preposition.



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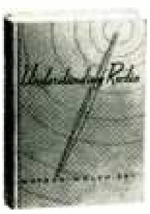

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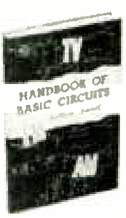

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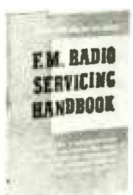

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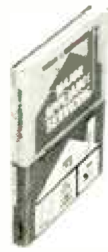

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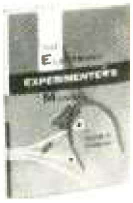

2006. ELECTRONIC EXPERIMENTER'S MANUAL, Findlay

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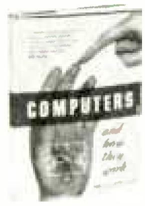

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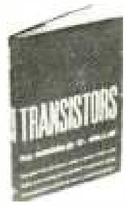

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Tailor Your Speaker

(*Continued from page* 40)

Fig. 6 is the circuit which produces the curve of Fig. 3. It isn't clever or elegant, but it does the job reasonably well. It is built on a separate little chassis which connects between the preamp and the power amplifier. This provides a convenient place to play without endangering the performance of the whole system.

Is It Worth It?

Very definitely yes. The system retains the full spacious quality which I particularly wanted, but the bass is now clean and distinct instead of muffled and muddy. Admittedly, I'm in the habit of trying a new speaker system every six months or so but in my acoustically perverse living room, this is the best mono system I have heard to date.

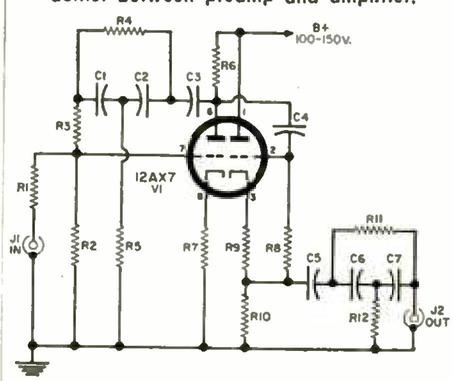
Why not try a similar project in connection with your own hi-fi installation? If you have a fairly small room, chances are that the region between 40 and 300 cps would benefit from equalization.

Corrective equalization can be achieved with a variety of common circuits, depending on what corrective curve is needed and how elaborate a circuit you want to build.

There are, of course, certain things that equalization *can't* do. It won't bring out something the loudspeaker doesn't have. It won't eliminate sharp peaks and it won't clean up muddy transient response. Also, you must be careful not to equalize beyond the overload point of the amplifier or speaker system.

But if you own good equipment, yet the system sounds "thin" or "dull" or "tubby," equalization for room acoustics can do wonders. It should be considered a must for every top-grade component installation. —30—

Fig. 6. Equalization circuit used by author between preamp and amplifier.



R, R, R, R—100,000 ohm, ½ w. res.
R—1 megohm, ½ w. res.
R—220,000 ohm, ½ w. res.
R—390,000 ohm, ½ w. res.
R—2200 ohm, ½ w. res.
R, R_{11}—470,000 ohm, ½ w. res.
R—1800 ohm, ½ w. res.
R—22,000 ohm, ½ w. res.
C_1, C—.01 µf., 400 v. capacitor
C, C, C—.02 µf., 400 v. capacitor
C—.047 µf., 400 v. capacitor
C—.25 µf., 200 v. capacitor
J_1, J—Phono jack
V_1—12AX7 tube

Transistorized Theremin
(*Continued from page* 32)

adjustment (C_{12}) and then by setting the pitch adjustment (C_1). To set C_{12}, place your hand near the pitch antenna, in order to produce an audible note. Increase the capacitance of C_{12} until the note begins to get softer. You will then find that the tone gets softer when you bring your left hand near the volume-antenna, until it is inaudible when your left hand is within an inch or so of the antenna. Now set C_1 so that the pitch oscillators zero-beat when you stand away from the instrument, but the tone begins when you bring your right hand within eighteen inches or so of the pitch-antenna.

Tuning adjustments set? Then play a song! But if you can't quite manage that on your first try, don't get discouraged. The Theremin, like any other musical instrument, takes some practice to be played correctly. Try these simple exercises:

1. Think of a note. Hum it to yourself. Then play it on the Theremin. Hold it steady for a few seconds. Concentrate on keeping your body motionless and erect, and your arms relaxed.

2. Think of two notes, and hum one and then the other to yourself. Play the first note on the Theremin, then glide to the second note. Glide slowly at first, then make the glides more abrupt as you become more proficient.

3. Practice scales and *arpeggios*, slowly at first, then faster as you become more efficient.

4. Do exercises 2. and 3., but bring your left hand near the volume antenna to silence the tone when going from one note to another. This exercise teaches you to "feel" where the notes are.

After you have mastered these exercises, try playing some simple songs. At first, special care should be given to playing the notes correctly. Later, shadings can be added with the left hand. A *vibrato* can be introduced into the tone simply by moving the right hand back and forth a few times a second. This motion should not be more than one-quarter inch, and should be done primarily from the wrist. The *vibrato* gives the Theremin tone warmth and expressiveness.

Once you become a proficient Thereminist, you will find many opportunities to display your talents. Theremin music is ideal for providing backgrounds for amateur plays, for melodic classical and religious music, or for adding a novel touch to dance bands and vaudeville acts. Even if you never take the time to become an accomplished Thereminist, the instrument will provide you and your friends with hours of entertainment. But whether you use the Theremin for playing "serious" music or just for experimenting, you will have an instrument that evokes as much mystery and fascination today as it did in 1928. In short, you will be able to produce "Music from the Ether." —30—

Mac's Service Shop

(Continued from page 60)

with the volume full on. Very often this technique will reveal the location of a break or a loose connection by making the radio burst into song or speech when a particular area is jarred or flexed. In such an event, a concentrated visual search of that area will quickly reveal the cause of the difficulty.

"But if the radio still refuses to talk, or if you are seeking a cause of low volume, distortion, or lack of sensitivity, you may as well get out the v.t.v.m. and start making a systematic check of the voltages your service data says should be found at various points of the circuit. It is most essential that the v.t.v.m. used for this purpose be accurate and that it have a low-voltage range, say 1 or 1.5 volts full-scale. You will be measuring voltage drops produced by small currents through fairly low-ohmage resistors, and very often a difference of only .1 volt can spell the difference between a properly biased transistor and one that will not work at all. Frequently check the v.t.v.m. against a fresh standard-size flashlight cell. It should read close to 1.57 volts."

"You think voltage testing is the best way to shoot trouble in a transistor set?"

"I think it's the best way to start. Later you may have to use signal-injection or signal-tracing. Resistance checking is pretty risky unless you pull all the transistors and are very careful not to subject low-voltage electrolytics to reversed polarity voltage from your ohmmeter probes. Really a high percentage of troubles can be located with a combination of v.t.v.m., Ohm's Law, and a little horse sense. Take this set I was working on, for instance:

"Only the local station could be received, and that was distorted. First I measured current drawn from the battery. It was supposed to be 6 ma. with no signal, but it was 9 ma. Something was drawing too much current and probably upsetting voltages; so I started measuring with the v.t.v.m., beginning with the output stage and working forward. Everything was in order until I reached the first i.f. stage emitter. This read −.5 volt instead of the −.15 volt it should. Unless the emitter resistor had increased in value, emitter current was too high. The base was supposed to read −.3 volt. Actually it was −.7 volt. That explained the too-high emitter voltage, but what was causing the base voltage to be too high? I suspected an 8-μμf. neutralizing capacitor between the collector and base of the transistor of being leaky, but I didn't unsolder it immediately.

"Careful examination of the circuit revealed the bottom end of the i.f. transformer winding feeding the base of the first i.f. transistor was connected to the emitter of the mixer transistor, and a resistor of 3900 ohms went from that point to ground. Maybe something was making too much emitter current flow through this resistor. Checking the mixer base voltage revealed −1.0 volt instead of the −.2 volt that should appear there. A 5000-μμf. capacitor connected this base to a tap on the oscillator coil, one end of which was connected to the oscillator transistor collector. I had built up a pretty strong case against that 5000-μμf. capacitor; so I unsoldered one lead and checked it with the ohmmeter. It was guilty of a very high leakage. A new capacitor restored the set to normal operation."

Barney ticked the points off on his fingers as he said, "As I get it, you say: 1. Make careful checks with the v.t.v.m. and look for even small deviations from proper potentials; 2. don't be too hasty with the soldering iron when you find a voltage that's off—make additional checks to pin down the defective component beyond any reasonable doubt; and 3. use your brains and Ohm's Law all the time to translate voltages into currents, and *vice versa*."

"You've got the idea. Keep doing that, and transistor servicing becomes easier and easier. The guys steering transistor work our way are doing us a favor, even though that's not their intention. Whenever you see an essential service that is going begging because it has some disagreeable features, you are staring an opportunity squarely in the face.

"An excellent example of this is sewer cleaning. A few years back this was hard, dirty, disagreeable work performed only by unlucky devils who could not find anything else to do. Then someone invented the rotary power-driven sewer cleaner. A couple of fellows I know with good white-collar jobs bought one of these machines when they first came out and started doing sewer cleaning on the side. They made more money in two or three hours each evening using the machine than they did at their regular jobs.

"Of course, in a case like this, others soon get the idea and competition sets in; but for a while it's really wonderful having others push business on you."

"Yeah," Barney agreed as he slid off the stool; "and even when competition begins you still have a long running start on your competitors. Let me work with you on the transistor sets from now on!" —30—

"All of a sudden, I lost interest!"

Filing System for Parts

(Continued from page 52)

This system does more than locate tubes quickly. It also shows the owner the condition of his tube stock at a glance. When he sees an empty compartment, he simply consults the reverse side of the hinged index. Here location numbers are listed in sequence, with tube numbers opposite. If stack 3A-3 is empty, the reverse index would tell him, for example, that he doesn't have another 6DN7 on hand. The index numbers are typed on strips of adding-machine paper, about 6 inches long each. They are slipped, top and bottom, through slots cut into the plywood panels of the index. These slots are 8 inches apart. Once every six months, strips are taken down, where necessary, and re-typed to include listings for new tube types. In the intervals, entries for new types are penciled in, like several shown in Fig. B.

On the opposite wall of the shop, DeLaughter has built a similar filing system for small parts—resistors, capacitors, and hardware. Instead of using partitioned shelves, he keeps parts in the widely available, plastic-drawer cabinets (Fig. D) made for that purpose, and stacks them side-by-side. However, the point here is not the container, but the indexing.

Every horizontal row of drawers is visualized as a section, and is identified by a letter accordingly. On the other hand, each vertical column of drawers is numbered. Thus any individual drawer can be identified by the letter-number combination that appears on its card. Separate sections within each drawer, set apart by the conventional metal dividers, are also numbered.

The parts index is similar to that used for tubes. Capacitors and resistors (Fig. E) are listed according to type, value, working voltage, and other pertinent characteristics. Suppose a technician needs a 100,000-ohm, ½-watt, carbon resistor. The "file" number listed on the index is "C4-4." The drawer is section (row) C, column 4. The resistor is in the fourth compartment (Fig. F) of that drawer.

The system has saved the five bench men at *Ray & DeLaughter* hours of valuable time that could not be gained in any other way. —30—

F

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF ELECTRONICS WORLD published Monthly at Chicago, Illinois for October 1, 1960.

1. The names and addresses of the publisher, managing editor, and business managers are: Publisher, Ziff-Davis Publishing Company, 434 So. Wabash Ave., Chi. 1, Ill.; Editor, William Stocklin, 1 Park Ave., New York 16, N.Y.; Business manager, Matthew T. Birmingham, Jr., 1 Park Ave., New York 16, N.Y.

2. The owner is: Ziff-Davis Publishing Company, 434 So. Wabash Ave., Chi. 1, Ill.; Estate of William B. Ziff, 1 Park Ave., New York 16, N.Y.; A. M. Ziff, 1 Park Ave., New York 16, N.Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

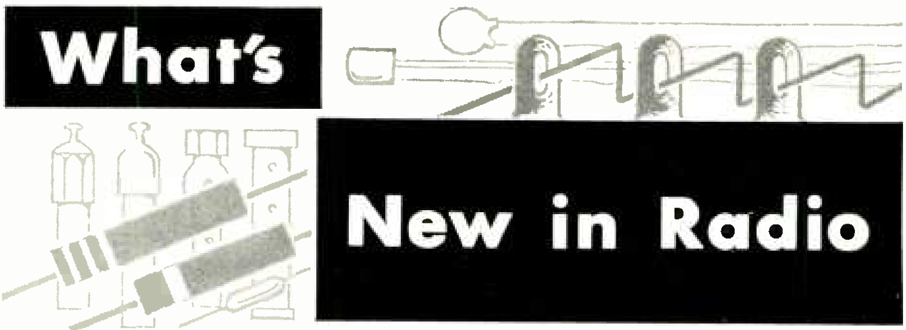
5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 248,280.

MATTHEW T. BIRMINGHAM, JR., business manager.

Sworn to and subscribed before me this 6th day of October, 1960.

(SEAL) WILLIAM PROEHMER, Notary Public.
(My commission expires March 30, 1962)

What's New in Radio



THERMO WIRE STRIPPER

Ungar Electric Tools, 4101 Redwood Ave., Los Angeles 66, Calif. has announced what it terms a revolutionary

thermo wire stripper. The new tool strips wire insulation while soldering without changing tools. It consists of a clip that slips on the barrel of existing *Ungar* soldering tips or heating units, severs all rubber and plastic insulation from 8- to 24-gauge wire, and will not cut, nick, or score the strands.

The complete stripping cycle takes less than five seconds and requires no additional equipment. For more information, write direct to the manufacturer.

COMPONENT SUBSTITUTOR

Mercury Electronics Corp., 77 Searing Ave., Mineola, N. Y. has introduced its Model 500 component substitutor which is said to do the work of three or four ordinary substitution devices.

The new instrument provides 44 different substitution values. Operating capabilities include: 20 values of resistance from 33 ohms to 10 megohms; 10 values of capacitance from .0001 μf. to .5 μf.; 10 values of electrolytics from 4 μf. to 330 μf.; power rectifiers up to 55 ma.; crystal diodes; power resistance continuously variable up to 5000 ohms; and bias voltages (either polarity) continuously variable up to 15 volts.

TUBE LISTS FOR CADDIES

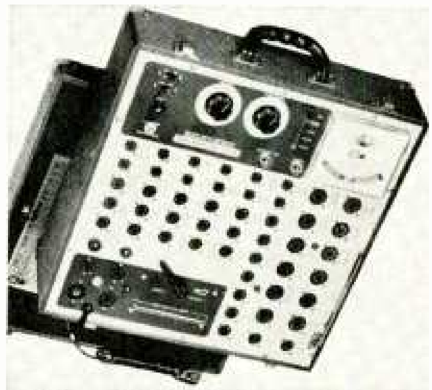
General Electric Co.'s Receiving Tube Department, Owensboro, Ky. has introduced inventory lists of tubes for stocking service cases available through *G-E* tube distributors. Individual lists cover recommended inventories for three cases. These are ETR-1478 which holds 162 tubes; the ETR-1477 which holds 228 tubes; and the ETR-2071 which carries 365 tubes.

In offering the lists with the caddies, the company hopes to help "add to the serviceman's experience in using his service case . . .and time . . . most effectively."

B&K TUBE TESTER

B&K Manufacturing Co., 1801 W. Belle Plaine, Chicago 13, Ill. has announced the availability of its new Model 685 professional-type dynamic mutual-conductance tube tester.

An automatic "Dyna-Quik" type, the Model 685 features the speed of multiple socket testing for existing tube



types plus the flexibility of punch-card testing for new tube types.

Said to be obsolescence proof, the new instrument incorporates many advanced features. Bulletin No. AP16, available from the manufacturer, contains further information on this equipment.

PACKAGED CIRCUITS

Centralab, division of *Globe-Union, Inc.*, 900 E. Keefe Ave., Milwaukee 1, Wis. has announced that a group of 31 new packaged electronic circuits is now available to the replacement market.

Among the new PEC's are three vertical integrators, two tone controls, one video and three audio coupling networks as well as a phase comparator network, a flip-flop network, two yoke balancing networks, and other specialized circuits. The new units have been given part numbers from PC-371 through PC-404.

TRANSISTORIZED DEPTH FINDER

Paco Electronics Co., Inc., division of *Precision Apparatus Co., Inc.*, 70-31 84th St., Glendale 27, Long Island, N. Y. has introduced a completely transistorized marine depth finder in kit or

wired form. Designated as Model DF-90, the new device may be operated from a boat's own power source or from low-cost batteries.

It features an oversize reading scale, calibrated in one-foot intervals, and has a range up 120 feet. The circuit uses five transistors and a barium-titanate transducer. Made of aluminum, the DF-90 weighs nine pounds.

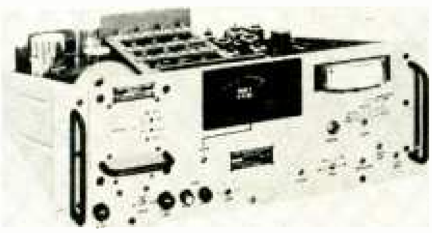
HICKOK METER

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio has introduced a new meter featuring an acrylic plastic front. Designated as Model 86H, the new instrument is said to provide clear reading as well as a distinctive modern appearance. The acrylic plastic is also claimed to be rugged and non-fading, allowing maximum light.

The meter, available in all common milliammeter, ammeter, and voltmeter ranges with an accuracy of 1 per-cent full-scale, also features the company's "taut band suspension," said to eliminate friction in the meter movement.

SSB RECEIVER

Hallicrafters Co., 4401 W. 5th Ave., Chicago 24, Ill. has announced its model SX-116 receiver, a crystal-controlled, single-sideband communications set for the high-frequency spectrum. According to the manufacturer, the new equip-



ment makes available for the first time the full advantage of SSB operation for commercial and military applications in stationary, vehicular, airborne, or shipboard systems.

For full details, write to the manufacturer.

TELEPHONE AMPLIFIER

Radio Merchandise Sales, Inc., 2016 Bronxdale Ave., Bronx 62, N. Y. has announced its new "Ampli-Phone," a device that enables telephone users to talk into, and hear from, a telephone without holding it in the hand.

"Ampli-Phone" consists of an amplifier and a separate 4-inch loudspeaker, both housed in high-impact styrene cabinets. It includes a volume control and indicator lights. A parabolic front picks up all voices within a room and directs them into the telephone receiver mouthpiece, making it possible to speak at a distance from the phone. The speaker enables several persons to hear at once from the same telephone.

MOBILE RADIO SET

Aeronautical Electronics, Inc., P.O. Box 6527, Raleigh, North Carolina has introduced a 15-watt u.h.f. FM mobile radio set. Called the "Slimline," the new set is less than five inches high and will fit under the dash in any car or truck, including the new domestic compacts or foreign types.

All operating controls are located on the front panel. The sets have provision for a maximum of three transmit and receive channels, and have built-in provision for plug-in installation of "Unicall," a selective call system which permits sharing of crowded frequencies without interference.

The "Slimline" package includes the radio set, mounting hardware, con-

trolled reluctance microphone, roof-top antenna, 12 feet of coaxial cable with fitting attached, and power cable.

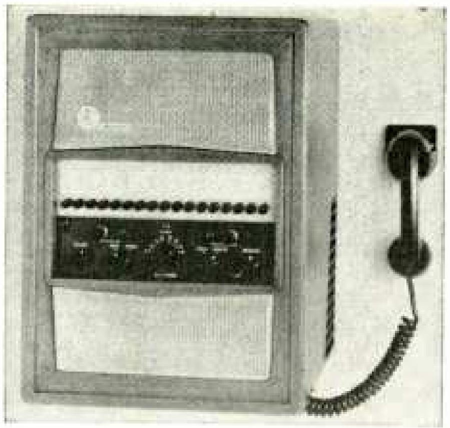
SNAP GROMMETS

G. G. Budwig, 3400 Bayside Walk, San Diego 8, California has developed a new type of grommet which is suitable for a variety of electronic applications.

The new units are two-piece, snap-together plastic items which the company claims are easier to install and stay in place better than conventional grommets. In addition, the company states that the plastic grommets have excellent dielectric characteristics and are impervious to oils and most chemicals. They are fabricated of polyethylene.

MARINE RADIOTELEPHONE

Pearce-Simpson, Inc., 2295 N. W. 14 St., Miami 35, Fla. has introduced its "Imperial 150B Radiotelephone," claimed to provide top performance in compact size. Included is a 150-watt transmitter with local or remote control of 16 pre-tuned channels plus broadcast. Frequency range is 2 to 22 kc., permitting operation on Great Lakes or high seas frequency as well as on normal marine channels. The receiver features an audio squelch and noise limiter.

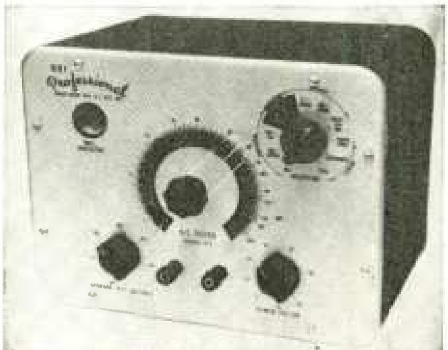


The Imperial 150B comes as a single unit for 12- and 32-volt systems, or with an auxiliary converter for 110-volt a.c. operation.

NRI TESTER

National Radio Institute, 3939 Wisconsin Ave., Washington 16 D. C. has announced availability of its professional Model 311 resistor-capacitor tester. This instrument uses a lab-type bridge circuit for measurement of resistance, capacity, leakage, power factor, opens and shorts.

The Model 311 is available in kit or wired form. For further information, write to the organization, requesting circular SD151.



REFERENCE BATTERY

Mallory Battery Co., division of *P. R. Mallory & Co., Inc.*, Indianapolis 6, Ind. has introduced a voltage reference mercury battery.

Said to be the first commercially available low-impedance multi-voltage reference source, the new device may be used for instrument calibration; for speed, temperature, and voltage measurements; thermistor bridges; bias circuits; pH testing; and supplying stable d.c. output for measuring, telemetering, and control systems.

The battery provides eight outputs from 0 to 10.80 volts in 1.35-volt increments. Accuracy is listed as ±1/2 percent of stated open-circuit voltage.

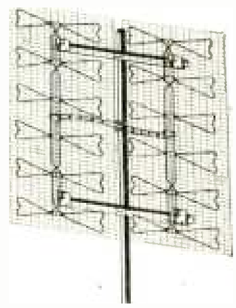
NEW WESTON INSTRUMENTS

Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J. has announced a new low-cost a.c. panel meter. Designated as Model 1724, the meter employs a moving-iron-vane mechanism and is available as voltmeter, ammeter, and milliammeter. Full-scale value accuracy is stated as ±2 per-cent.

The manufacturer also has announced improved new models in its 301 panel instrument series, featuring a larger useful dial area, improved readability, and modernized glare-free cases. The 301 line is available in d.c., r.f., and a.c. rectifier types, as well as moving-iron a.c. types.

U.H.F. ANTENNAS

JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N.Y. announces that it is now in production on three u.h.f. antennas designed especially for translator areas with reception problems.



The new series features a specially designed cardioid dipole for improved broad-band response on channels 70 to 83. The three new models are: TR604, a 4-bay for primary u.h.f. translator locations; TR606, 6-bay for near-fringe areas; and TR612, 12-bay for fringe and far-fringe sites.

Each model includes rigid, heavy-gauge, galvanized, welded-wire rod construction; oversized precision-formed cardioid dipole made of corrosion-proof solid aluminum rod; full-wave horizontal and vertical spacing of bays for higher stacking gain; and solid bus bar multi-stage phasing transformers which maintain constant 300-ohm impedance over u.h.f. translator spectrum.

A bulletin is available on request to the manufacturer. —30—

Answer to Puzzle Appearing on Page 121

E	R	G	■	A	C	O	R	N	■	L	A	G
I	E	R	■	F	L	A	R	E	■	A	G	E
A	V	I	A	T	O	R	■	U	P	P	E	R
■	■	D	I	S	C	■	E	T	A	S	■	■
S	I	D	E	■	K	E	R	R	C	E	L	L
T	R	I	E	S	■	K	N	O	T	■	I	E
A	M	P	■	P	R	E	E	N	■	A	N	A
G	A	■	P	E	A	S	■	■	■	N	E	D
E	S	C	H	A	R	■	■	■	I	T	S	■
■	■	L	I	K	E	■	G	A	T	E	■	■
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R	A	M	■	R	A	D	A	R	■	N	O	W
I	M	P	■	S	T	E	M	S	■	A	W	L

CALENDAR of EVENTS

JANUARY 8-12
Symposium on *Thermoelectric Energy Conversion*. Sponsored by Joint Technical Society Department of Defense including AIEE, IRE, American Rocket Society, American Nuclear Society, etc. Statler-Hilton Hotel, Dallas, Texas. Dr. G. K. Teal, Texas Instruments Inc., Dallas, Tex. is representing IRE on the committee.

JANUARY 9-11
Seventh National Symposium on *Reliability and Quality Control*. Sponsored by IRE, AIEE, ASQC, and EIA. Bellevue-Stratford Hotel, Philadelphia. Further details and program information from the IRE at 1 East 79th St., New York 21.

JANUARY 17-19
Winter Instrument-Automation Conference and Exhibit. Sponsored by Instrument Society of America. Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo. Details available from Wm. H. Kushnick, executive director ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

FEBRUARY 1-3
1961 Winter Convention on *Military Electronics*. Sponsored by IRE. Biltmore Hotel, Los Angeles, Calif. Exhibits and technical sessions. Details from Arthur N. Curtiss, IRE Business Office, 1435 S. La Cienega Blvd., Los Angeles 35, California.

FEBRUARY 1-4
Second Annual Convention. Sponsored by the Electronic Representatives Association (ERA). Ambassador Hotel, Los Angeles, California. Business sessions and social program. Complete entertainment program for ladies. Contact ERA headquarters, 600 S. Michigan Ave., Chicago 5, Illinois for program details.

FEBRUARY 10-14
Washington High Fidelity Music Show. To be produced independently by Music Productions, Inc., the organization of M. Robert Rogers and Margot Phillips. Shoreham Hotel, Washington, D. C. Producers will forward details on reserving space.

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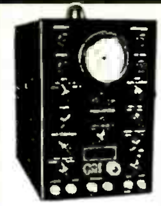
INVITATION TO AUTHORS

Just as a reminder, the Editors of ELECTRONICS WORLD are always interested in obtaining outstanding manuscripts, for publication in this magazine, covering the fields of audio and high-fidelity and radio-TV-industrial servicing. Articles in manuscript form may be submitted for immediate decision or projected articles can be outlined in a letter in which case the writer will be advised promptly as to the suitability of the topic. We can also use short "filler" items outlining worthwhile shortcuts that have made your servicing chores easier. This magazine pays for articles on acceptance. Send all manuscripts or your letters of suggestion to the Editor, ELECTRONICS WORLD, One Park Avenue, New York City 16, New York.

TS-100AP 'SCOPE

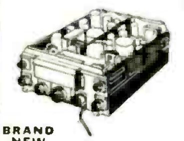


(WORTH $750)
OUR LOW PRICE **$29.50**

Can be used with linear sweep or general purpose test scope. Cables included. Also used with circular sweep as precision range calibrator. Self-contained in metal case 8" x 12½" x 16" deep. For 110 V 50 to 1200 cycles AC. Excellent used, like new, with all tubes including crystals and C.R. Tube.
BRAND NEW $59.50

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC



BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc. fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 400 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. SPECIAL! **$19.50**
PE-101C Dynamotor, 12/24V input $7.95
UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last **$29.50**

LORAN R-65/APN-9 RECEIVER & INDICATOR

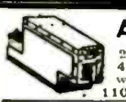
Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used. Value $1200.00. Our Price **$79.50**
Used, less tubes, crystal and visor, but with 3BP1 C.R. tube $29.50
12 Volt Inverter Power Supply for above. BRAND NEW $32.50
28 Volt Inverter Power Supply, exc. cond. $49.50
Shock Mount for above $2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

LORAN APN-4

FINE QUALITY NAVIGATIONAL EQUIPMENT

Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes. Exc. used **$49.50**
Receiver-Indicator as above, BRAND NEW **$88.50**
12V Inverter Power Supply, BRAND NEW $32.50
28V Inverter Power Supply, exc. cond. $49.50
Shock Mount for above $2.95
We carry a complete line of spare parts for above.

ARC-5/R28 RECEIVER



2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. BRAND NEW **$24.45**
110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW **$21.50**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW **$9.95**

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes **$16.95**
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal **$12.45**
MODULATOR for above, new with tubes $5.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC.	$12.95	$14.95
BC-454	Receiver 3-6 Mc.	10.45	12.45
BC-455	Receiver 6-9 Mc.	11.50	13.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions **$7.95**
Factory wired, tested, ready to operate $11.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW **$8.95**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal **$13.95**
T19 TRANSMITTER 3-4mc complete with all tubes and crystal. Exc. used **$9.95**
BC 696 TRANSMITTER 3-4 mc complete with all tubes and crystal. Exc. used **$9.95**
BC-456 Modulator .... USED 3.45 NEW 5.95
ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. BRAND NEW. 3⅜" x 1-13/16" x 2⅜". Uses Standard Electrolyte .... Only $2.95

2 VOLT BATTERY "PACKAGE"

1—2V, 20 Amp. Hr. Willard Storage Battery, Model #20-2, 3" x 4" x 5½" high $2.79
1—2V, 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW! Combination Price **$5.45**

ARC-3 RECEIVER!

Complete with All Tubes Exc. Used **$16.95**
Like NEW $21.50
Used $14.95

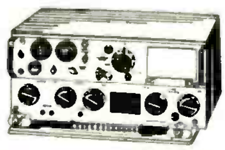
Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only **$16.95**
Like new condition $22.50

AN/ART-13 100-WATT XMTR

11 CHANNELS
200-1500 Kc
2 to 18.1 Mc



$48.50

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter. AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%, class "B." A Real "HOT" Ham buy at our low price! Orig. cost $1800. Exc. Used **$48.50**
0-16 Low Freq. Osc. Coil for ART-13 .... 7.95
24V Dynamotor for ART-13 .... 11.95
Same as above less meter 39.50
We carry a complete line of spare parts for above.

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify $8.95

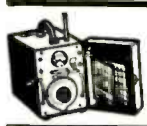
BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 watts. Complete with speaker, tubes. Used **$10.95**
Less tubes, used $5.95

NAVY AIRCRAFT RADIO RECEIVER

ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning. AVC. CW. Illuminated dial. Complete with tubes and dynamotor. BRAND NEW $34.50
Like New $26.50
Power Supply 110 V. AC. Wired $8.50

BC-906 FREQ. METER—SPECIAL

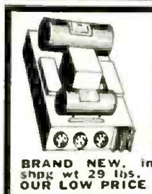


Cavity type, 145 to 235 Mc. BRAND NEW, complete with antenna. Manual included.
OUR LOW PRICE **$10.88**

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$27.50**

DYNAMOTOR ASSEMBLY



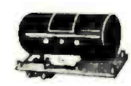
Very fine unit, made by Collins Radio. Consists of TWO Dynamotors mounted on filter base.

	INPUT	OUTPUT
Dynamotor #1	12VDC @ 3.8A	220VDC @ 100 Ma.
Dynamotor #2	12VDC @ 9.9A	400VDC @ 180 Ma.

BRAND NEW, in original packing, shpg wt 29 lbs.
OUR LOW PRICE **$7.95**

MOBILE-MARINE DYNAMOTOR

Model DM35



Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs.
OUR LOW PRICE, BRAND NEW **$8.95**

OTHER DYNAMOTOR VALUES:

Type	Input	Output	Excellent Used	BRAND NEW
DM-25	12V 2.2A	250V .050A		$4.50
DA-1A	28V 1.6A	230V .100A		3.25
DM-28	28V	224V .07A	2.75	4.75
DM-32A	28V 1.1A	250V .05A	2.45	4.45
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.50
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	8.95	14.95
PE-86	28V 1.25A	250V .050A	2.75	3.85

BD-77 DYNAMOTOR Input 14V @ 39A. Output 1000V @ .350A with starting solenoid, Filter Box and Mounting Base .... Like New $14.95

SCHEMATIC DIAGRAMS For any equipment on this page, each **65c**

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.

Telephone: CO 7-4605
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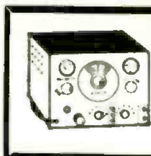
75-77 Leonard St., New York 13, N. Y.

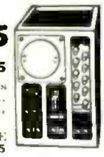
TS-16/APN TEST SET



For aligning and calibration of radio altimeters. May be used to check calibration of count or circuits and modulator sweep freq. and bandwidth of transmitter. Audio-oscillator range: 340 to 7250 cycles. 13/14 V.DC input. Complete with tubes, connecting cables, instruction summary, BRAND NEW ... **$9.95**

BC-603 FM RECEIVER

20 TO 27.9 MC.



Excellent Used **$14.95**
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10-channel, pushbutton or continuous tuning. Complete with speaker, squelch, and ten tubes: 3-6AC7, 1-6J5, 2-12SG7, 1-6H6, 1-6V6, 2-6SL7.
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Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $9.25
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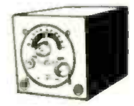
BC1206-C BEACON RECEIVER



195 to 420 Kc. made by Setchel - Carlson. Works on 24-28 volts DC. 135 Kc. IF. Complete with 5 tubes. Size 4" x 4" x 6". Wt. 4 lbs. BRAND NEW **$9.99**
Brand New, less tubes ... $5.95
USED, with tubes 5.95
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SCR-522 Transmitter-Receiver, complete with all 18 tubes, top rack and metal case.
COMBINATION. Exc. Used **$29.50**

MICROPHONES

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TS-9	Handset		3.88
TS-11	Handset		3.95
TS-13	Handset		4.25
RS-38	Navy Type		4.75

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BRAND NEW **$22.50**

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Removed from Brand New Gov't Equipment

RECEIVING					
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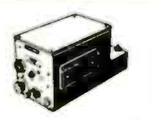
6AK5	.40	6H6	.55	814	2.25
6C4	.25	6SL7	.85	815	2.15
6AL5	.38	12A6	.45	826	.44
6AC7	.55	SPECIAL PURP.		1625	.29
6J6	.32	2C39	3.50	4X-150	5.95
6V6	.65	3E29	4.25	6072	2.50
				1P25A	7.95

BC-605 INTERPHONE AMPLIFIER BRAND NEW .... Each $4.95

234-258 MC RECEIVER

AN/ARR-2



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Complete with tubes **$8.88**

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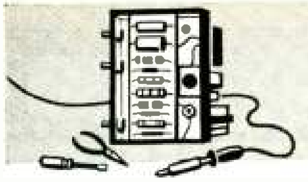

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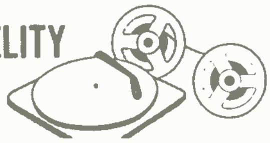

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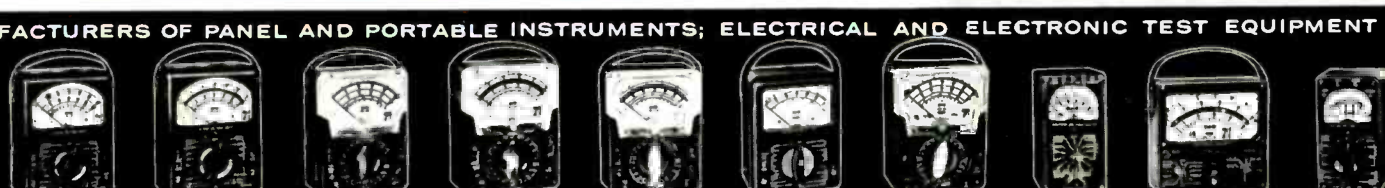

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