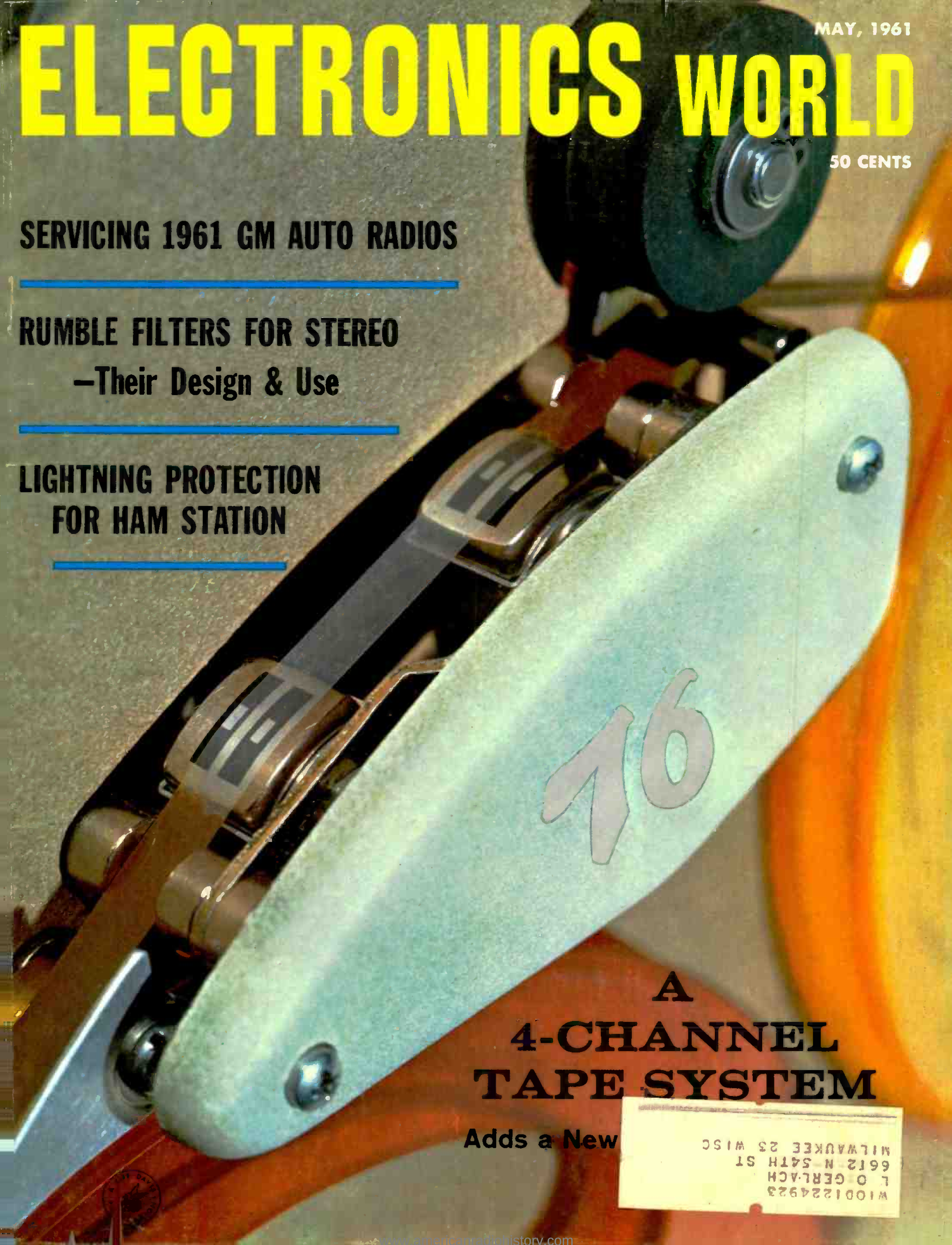
MAY, 1961

ELECTRONICS WORLD

50 CENTS



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Adds a New

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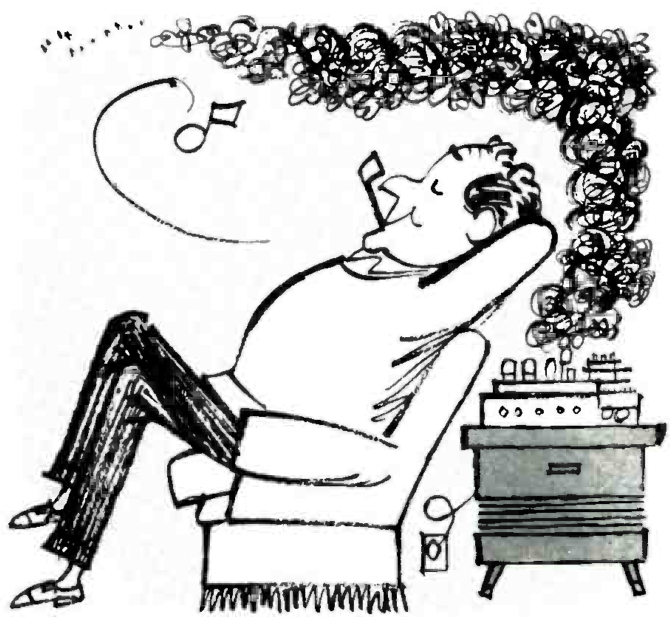
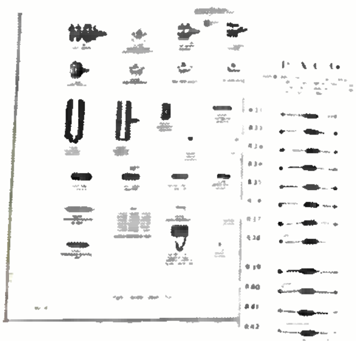
If drug manufacturers made the mistakes in labeling you find in some kits, the world would be a quieter, lonelier place. You know a selenium rectifier when you see one, and if this is a selenium rectifier, you're Thomas Alva Edison.

Let's see. On Page 5 it says; "See diagram Page 12." On Page 12 it says; "See instructions Page 5." Well, if you hold Page 5 open with your tongue, and Page 12 open with your left ear, that still leaves you three fingers on your left hand free for soldering and also...

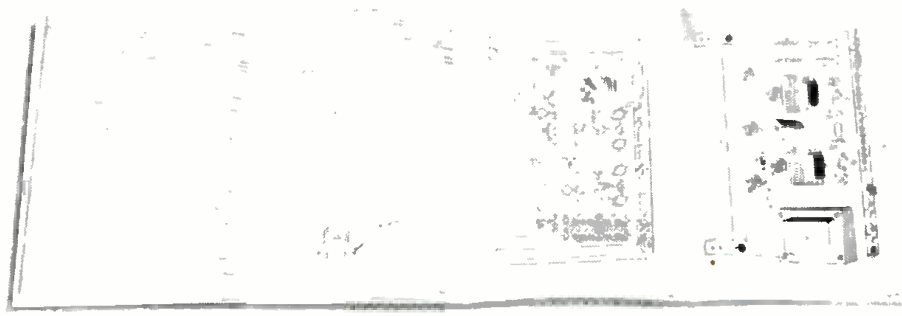


Don't look now, but while Heifetz fiddles, your amplifier burns. When the smoke clears, you'll probably find that the 100 microfarad electrolytic was shorted because it had not been pre-tested. All work and no play, makes Jack a very mad boy!

UNLESS THE KIT YOU BUILD IS A PACO



No mistaken identity or endless searching. Parts are clearly pictured and labeled; resistors are neatly mounted and identified!



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ELECTROLYTIC TEST: indicates in-circuit electrolytic capacity from 2 mfd to 400 mfd in two ranges; condenser is automatically proved non-shorted and not open if Capacity Reading can be obtained.

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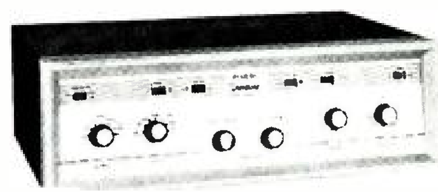

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By **W. A. STOCKLIN**
Editor

Four-Channel Tape & Reader-Service Coupon

IN KEEPING with the ELECTRONICS WORLD tradition of bringing to the attention of our readers new and exciting ideas of unusual interest, we are publishing in this issue an outstanding article on a provocative subject—"Four-Channel Stereo Adds Depth to Tapes." This is not an ordinary 4-track method of recording and playback but involves four separate channels to be played back simultaneously, with different information on each of the channels.

In a way, it seems odd that the tape industry has not gone to at least a 3-channel system. In looking back just a few years, the tape industry was doing quite well up to the advent of the stereo disc. Shortly thereafter the industry, led mainly by a group interested in prerecorded tapes, panicked and all of their thoughts were directed toward setting up a competitive system with disc. They went to 2-channel, 4-track to cut the cost of raw tape in half. They also tried to go to the 3.75-ips speed, again to cut the cost of tape, and much thought was given to the cartridge principle in the hopes of producing a changer mechanism that would simplify the use of tape equipment for the average consumer.

To try to compete with disc in the same arena is a fallacy. The tape industry has much more to offer. With tape, recordings may be made in the home; and this is something that cannot be done easily and conveniently with the disc. Tape can offer additional channels over and above the two channels now used for stereo in the home. Tape can provide a quality of reproduction that exceeds the present disc. These are the advantages and they should be promoted.

The tape machine will probably never become a mass consumer item. Once the industry acknowledges this fact they can direct their efforts to providing something different—over and above what the disc offers—and not worry too much about competitive cost. There is a great market fulfilling the needs of those individuals who are interested in the best—irrespective of cost.

The tape industry could have gone over to 3 channels without any difficulty. Most original tape masters in the libraries of record companies today are on three-channel tape and these could readily be made available in that form without undue trouble or delay.

Since the prerecorded tape industry has not made an added channel available, this gives us a very good opportunity to call to the attention of our readers some of the things that can be done with a tape machine. We have had articles commenting on 3-channel tape and there is no doubt that we will have more articles in future issues on the same subject. For this month, though, the 4-channel tape system that was developed by *Nortronics* goes one step farther and this system should provide our readers with many hours of exciting entertainment. In normal 2-channel operation you use a left and right speaker. In our 4-channel system, we have added two other speakers—both in the center—one near the listener and the other some distance away. With this method, an entirely new dimension in sound is obtained. Don't miss this feature starting on page 29 of this issue.

Reader-Service Coupon

A new monthly feature, starting with this issue, is a reader-service coupon which appears on page 130. We have always been aware of the fact that many of our readers, because of their interest in electronics—both vocationally and avocationally—have need for much more information from manufacturers on new products and new literature, over and above what we can publish in our regular departments. The tremendous cost of processing such requests has been a great deterrent to offering such a service in the past.

However, in view of the many requests we are now receiving from our readers for more information, and after re-evaluation, we feel that the importance of this service to our readers outweighs any inconvenience and cost on our part.

Starting with this issue, then, any of our readers who wants more details on any of the new products and literature listed in our "New Products" section can simply circle the appropriate number on the coupon and return it to us for processing. We concede that it was inconvenient for readers to have to write to individual companies from whom further information was desired. Now, however, any number of items can be circled and, in one operation, the card mailed to us and we will follow through for you. We have even extended this service to include all of the advertisers in our publication. If more information is desired on any of the products advertised in this issue, simply circle the corresponding numbers in the same coupon. We will do the rest. —30—

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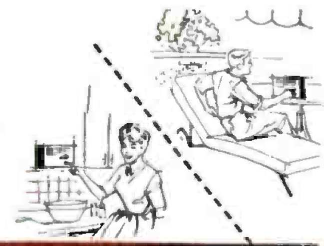

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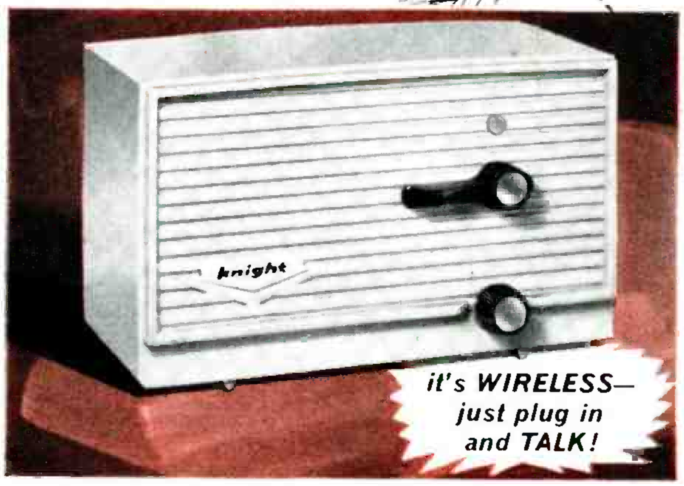

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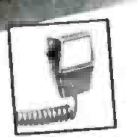

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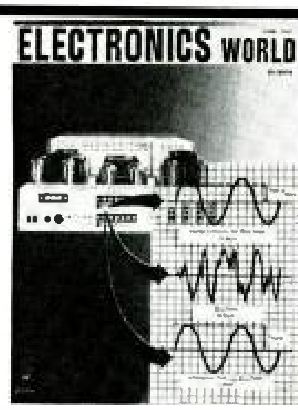

COMING NEXT MONTH

INDUSTRIAL COUNTING TECHNIQUES
Electronic devices that take counts and control machinery are helping to standardize production and cut retail costs. Here's how they work.

MUSIC-POWER MEASUREMENTS
The techniques for making music-power measurements are discussed in depth by a well-known audio engineer who points out the pitfalls of "short-cut" methods.

COMBATING FM MULTIPATH DISTORTION
As more FM stations go on the air, this type of interference will increase. Here are details on a minor circuit modification that will cure the trouble.

RADIATION HAZARDS
Means for measuring radiation effects are becoming more important with space travel not too far away. Details on existing detecting equipment and an outline of future requirements are covered.

ANALYZING SOLUTIONS ELECTRICALLY
The polarograph has so many advantages in chemical analysis that it is coming into widespread use in many and varied industries. How such equipment works and how it is serviced is covered in this article.

ACCURATE TRANSISTORIZED TACHOMETER
This highly accurate instrument with good temperature stability can be home-built for about $17.00. Sports car enthusiasts, auto service technicians, and the enlightened car owner will want this unit.

MINIATURE HI-FI AMPLIFIER
In this unique circuit, the output tubes serve as their own phase inverter. This low-power unit can be used "as is" or as a second amplifier in a stereo setup.

OUTBOARD VU METER
Construction details on a high-impedance, low-impedance meter circuit with input sensitivity that is down to about 50 µv.

1961 AUTO RADIOS: FORD CARS
Second in the current series of service data for the auto radio technician. Sets used in all the Ford models are covered.

GLOW LAMP PULSE GENERATOR
This novel neon-lamp circuit produces multiple pulses synchronized to the line frequency.

IMPROVING RECEIVER SENSITIVITY
Many older and less expensive communications receivers can be given a "shot in the arm" by following the "noise-alignment" techniques described by the author.

All these and many more interesting and informative articles will be yours in the June issue of ELECTRONICS WORLD . . . on sale

May 16th

LETTER SYMBOL QUIZ

By **JOE TERRA**

Most one-letter symbols used in the terminology of electronics stand for the first letter of the word which they are used to represent, for example, f for frequency or R for resistance and so on. The list of one-letter symbols given in Column A are not abbreviations in the sense illustrated above. Can you match them with their definitions given in Column B?

COLUMN A		COLUMN B	
1.	Y	A.	Current
2.	X	B.	High-voltage power plate supply
3.	G	C.	One thousand
4.	I	D.	Admittance
5.	Z	E.	Electric flux density
6.	L	F.	Inductive reactance
7.	X_L	G.	Reactance
8.	H	H.	Inductance
9.	B	I.	Voltage
10.	E	J.	Wattage
11.	D	K.	Conductance
12.	K	L.	Cathode
13.	L	M.	Impedance
14.	M	N.	Coil or transformer winding
15.	P	O.	Magnetic field intensity.

(*Answer on page* 125)

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses—commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to quality for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelephone license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally *required* to complete the course and get your license is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand—choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

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
Don Fenimore, 1305 Ray Street, Dexter, Mo.	1st	12
Jim E. Miller, 8433 12th, S.W., Seattle 6, Wash.	1st	12
Robert R. Constance, 222 Sander St., Pineville, La.	1st	12
Michael J. Flaherty, 5 Wakefield Dr., Trenton, N.J.	1st	12
J. R. Pierce, Jr., Rt. 5, Kingsport, Tenn.	1st	12
Pias B. Jernigan, Rt. 2, Benson, N.C.	1st	12
Gordon Fritsch, Box 122, Edwall, Wash.	1st	12
Bert G. Erickson, P.O. Box 119, Arcadia, Fla	1st	12
William F. Bratton, Jr., 435 Etna St., Russell, Ky.	1st	12
Richard P. Neal, 2 Carleton Place, Alexandria Va.	1st	12

Resident Classes Offered at Four Locations

To better serve our many students throughout the nation, Grantham School of Electronics maintains four separate schools—located in Hollywood, Seattle, Kansas City, and Washington, D.C.—all offering the same resident courses in F.C.C. license preparation. (Correspondence courses are conducted from Hollywood.)

For further details concerning F.C.C. licenses and our training, send for our FREE booklet, "Careers in Electronics". Clip the coupon below and mail it to the School nearest you.

Get your First Class Commercial F.C.C. License Quickly by training at

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Hollywood 27, Calif.	Seattle 4, Wash.	Kansas City 9, Mo.	Washington 6, D.C.
(Phone: HO 7-7727)	(Phone: MA 2-7227)	(Phone: JE 1-6320)	(Phone: ST 3-3614)

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Address ____________________

City ____________________ State ______

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☐ Hollywood classes, ☐ Kansas City classes, ☐ Washington classes

16E

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T-W ANTENNA and AUTOMATIC TENN-A-LINER

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And where a rotator is required, team the T-W with a Channel Master Automatic Tenn-A-Liner . . . the only rotator that aims the antenna within one degree of precise transmitter location. The ruggedness and dependability of the Automatic Tenn-A-Liner have been proved by hundreds of thousands of trouble-free installations.

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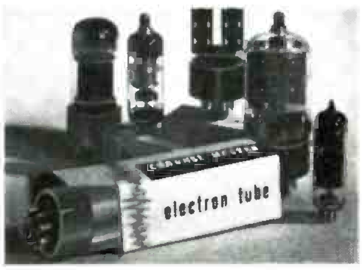

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ELLENVILLE, N. Y.

Within the Industry

DONALD H. HARTMANN has been appointed to the newly created position of executive vice-president of *Heath Company.*

He joins the firm from *Moto-Mower, Inc.* where he was vice-president and general manager. Prior to that, he served one year as assistant to the president of *Dura Corporation.* He has also been associated with *General Motors, Kaiser-Fraser Corporation,* and *Packard Motor Car Company.*

Mr. Hartmann received a degree in engineering from Wayne State University in Detroit and was a U.S. Navy pilot in World War II.

* * *

INTERNATIONAL RESISTANCE CO. has entered the semiconductor field with the purchase of controlling interest in **NORTH AMERICAN ELECTRONICS, INC.** of Lynn, Mass., which will continue operations as an independent entity . . . Stockholders of **CGS LABORATORIES, INC.** have voted to change the name of the organization to **TRAK ELECTRONICS COMPANY, INC.** . . . **ITT** has acquired **JENNINGS RADIO MANUFACTURING CORPORATION,** San Jose, California manufacturer of high-power vacuum capacitors and switches . . . **SEG ELECTRONICS CO., INC.** has acquired all of the outstanding stock of **SOLAR ELECTRONICS CORPORATION,** manufacturer of amateur radio equipment, which will be operated as a wholly owned subsidiary. Production facilities will be moved to 12 Hinsdale Street, Brooklyn . . . **ITT LABORATORIES** has been joined to **ITT FEDERAL DIVISION** to form a single operating unit which will be known as **ITT FEDERAL LABORATORIES.**

* * *

GERALD RANDOLPH has been appointed director of engineering at *Knight Electronics Corp.*, the wholly owned kit manufacturing subsidiary of *Allied Radio Corporation.*

In his new position, Mr. Randolph will supervise the engineering of new products for the "Knight-Kit" line, which now consists of more than sixty kits for the audio, service, industrial, amateur, and hobbyist markets.

He joins the firm after serving as chief engineer of *Wallson Associates* and as senior engineer at *ITT Laboratories.* He holds patents on two electronic circuits and has patents pending on five others in the fields of communications, instrumentation, and control.

* * *

AL WEINGAST, director of purchasing at *Precision Apparatus Co.*, has been elected president of P.A.'s Inc. (Purchasing Agents of the Radio-Television and Electronics Industry).

Serving with Mr. Weingast are: Milton Brody, *Mohawk Business Machines Corp.*, vice-president; Louis Lucci, *Republic Electronic Industries,* recording secretary; B. J. Trimboli, *Telechrome Mfg. Co.*, corresponding secretary; and A. Schneiderman, *Olympic Radio & Television,* treasurer.

Elected to the board of directors were Bernard Loew, *Adams Labs;* Paul Reneau, *Magnetic Amplifiers;* Abe Weissman, *Marken Machine;* Sam Wolfson and Arnold Sutta, *Emerson Radio & Phonograph.*

The Association's mailing address is P.O. Box 62, Rosedale 22, N.Y.

* * *

JOHN SPITZER has been appointed manager of advertising and sales promotion for the semiconductor division of *Sylvania Electric Products Inc.*

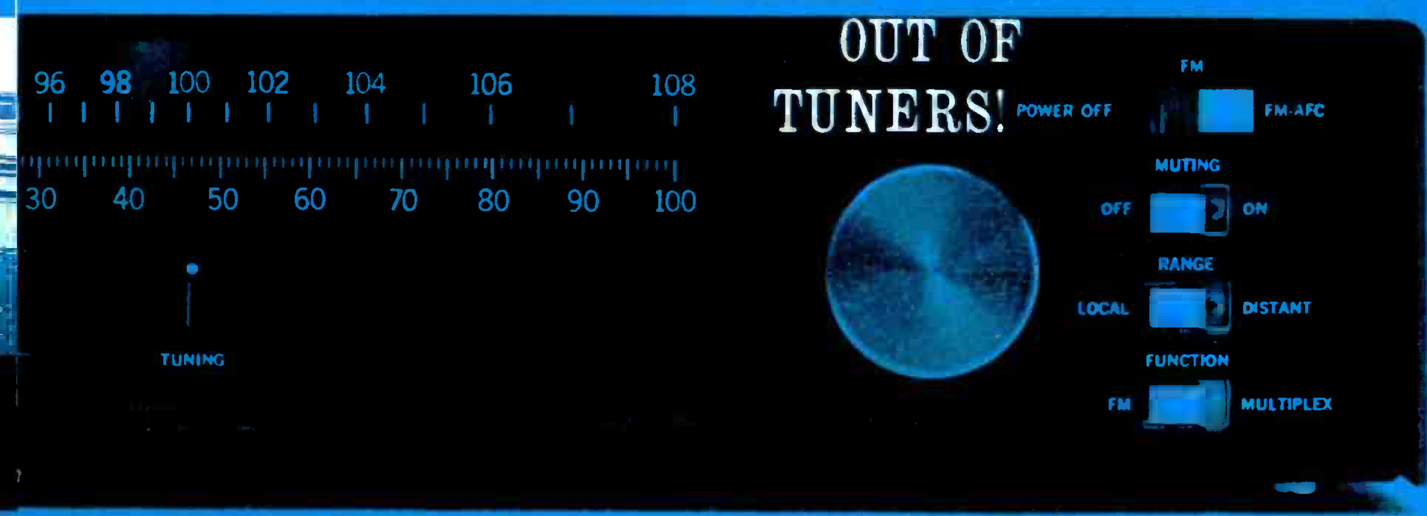
He joined the firm in August 1960 as advertising supervisor for the semiconductor division. Before that, he was with the *Univac Division* of *Sperry Rand Corporation.* A native of New York City, Mr. Spitzer attended Emory University in Emory, Ga. where he received his B.A. in Economics.

He will make his headquarters in Woburn, Mass.

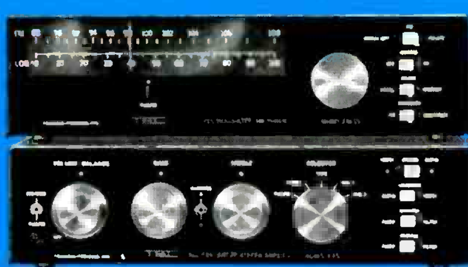
* * *

CLEVELAND INSTITUTE OF ELECTRONICS has moved to new and enlarged quarters at 1776 East 17th St. in Cleveland, Ohio . . . **JERROLD ELECTRONICS CORPORATION** has dedicated its newly expanded laboratory in Huntingdon Valley, Pa. The new facility now provides approximately 20,000 square feet of laboratory and research space . . . **DIEBEL DIE & MANUFACTURING COMPANY** has moved its operations to its newly completed, 35,000-square-foot plant in Morton Grove, Ill. . . . **ULTRASONIC SYSTEMS INC.** has moved into new quarters at 2255 Carmelina Ave., West Los Angeles, Calif. . . . **PACOTRONICS, INC.** has added 20,000 square feet of production space to accommodate its increasing line of hi-fi, test equipment, ham, and marine gear . . . **AUDIO DEVICES, INC.** has broken ground for a new two-story, 20,000-square-foot building in Stamford, Conn. The new

TEC'S TAKEN TUBES OUT OF TUNERS!



Long awaited . . . finally here . . . high fidelity's first all-transistor FM tuner is, quite naturally, from Transis-Tronics. The **TEC FM-15** is the most efficient tuner on the market today. Double conversion provides far superior image rejection, significantly reducing interference from unwanted signals. And because of its all-transistor circuitry, the **FM-15** has no heat, no hum, no microphonics and exceptionally low power requirements. **HEAR THE FM-15 WITH ITS PERFECT COMPANION, THE S-15 ALL-TRANSISTOR STEREO AMPLIFIER.** Here is a combination which truly obsoletes all others. Hearing is believing. In the meantime . . . write Transis-Tronics for complete specifications on both units. TEC



TRANSIS-TRONICS, INC., 1601 W. OLYMPIC BLVD., SANTA MONICA, CALIFORNIA

TRANSISTOR ENGINEERED COMPONENTS

plant will provide added laboratory and pilot production facilities for the firm's line of magnetic tapes . . . **WESTINGHOUSE ELECTRIC CORPORATION** has completed a new facility for its semiconductor department at Youngwood, Pa. . . . **PHILCO CORPORATION** has moved into its new research center at Union Meeting and Jolly Roads, Blue Bell, Pa. . . . **WARD LEONARD ELECTRIC CO.** of Mount Vernon, N.Y. has opened a new plant at Hagerstown, Md. for the manufacture of molded metal-film precision resistors . . . The Electronics Division of **CHANCE VOUGHT CORPORATION** has begun operations at its new, ultra-modern plant near Arlington, Texas.

* * *

JOHN A. MAYBERRY has been promoted to the post of merchandising manager, distributor sales, at *CBS Electronics*. He was formerly the merchandising manager for dealer products.

Prior to joining the firm in 1959, Mr. Mayberry was district sales manager for *Sylvania*. He has appeared before numerous dealer and distributor groups as a speaker and is well known throughout the industry.

He is a native of Duluth, Minnesota and received his degree from Northwestern University's School of Commerce.

* * *

IRE has elected six persons to serve on its Board of Directors during 1961 for one-year terms.

Succeeding the late W.R.G. Baker, Stuart L. Bailey, president of *Jansky & Bailey, Inc.*, was elected treasurer. Haraden Pratt, engineering consultant, and Ferdinand Hamburger, Jr., professor and chairman of the Department of Electrical Engineering at Johns Hopkins University, were re-elected to the offices of secretary and editor respectively. All three officers also serve as directors.

Alfred N. Goldsmith, consulting engineer, and Patrick E. Haggerty, president of *Texas Instruments, Inc.* were re-elected directors while Daniel E. Noble, vice-president and director in charge of communications at *Motorola Inc.* was elected to the directorate.

* * *

HAL DENNIS is the new national sales manager for *United Audio Products* . . . The consumer products division of *Motorola Inc.* has named **PAT A. CALOBRISI** to the post of product planning manager . . . **O. D. PERRY** has been elected president of *Triad Transformer Corporation*, a division of *Litton Industries* . . . **WILSON R. SMITH** has been named plant manager, semiconductors, for *CBS Electronics* . . . *Tru-Ohm Products* has appointed **M. GAIUS WIKE** to the post of distributor sales manager . . . The electron tube division of *RCA* has announced the appointment of **L. S. THEES** to the new post of division vice-president, general sales. He was for-

(*Continued on page 88*)

A PROPHECY

For men and women with a sincere desire to succeed

"In the years that have passed since my days on the faculty of RCA Institutes, I have become even more firmly convinced that the individual who continues his education . . . particularly his technical education . . . is the individual who profits both as a thinking man and as a working man. Science and industry will reward you for your talents and energy. Out of your efforts may come inventions, new products, processes and services. There is everything good yet to be accomplished in our lives and in our work. What man has done, man can do better."

David Sarnoff

Chairman of the Board,
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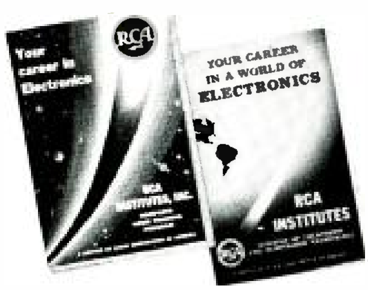
RESIDENT SCHOOLS *in*

Los Angeles and New York City train you for any field of Electronics you may choose!

No Previous Technical Training Required For Admission. RCA Institutes Resident Schools in Los Angeles and New York City offer training that will prepare you to work in rewarding positions on research and production projects in fields such as automation, communications, technical writing, television, computers, and other industrial and advanced electronics applications. Even if you did not complete high school, RCA will prepare you for such training with courses specially designed to provide the basic math and physics required for a career in electronics.

Free Placement Service. RCA Institutes graduates are now employed in important jobs at military installations such as Cape Canaveral, with important companies such as IBM, Bell Telephone Labs, General Electric, RCA, and in radio and TV stations all over the country. Many other graduates have opened their own businesses. A recent New York Resident School class had 92.06% of the graduates who used the Free Placement Service accepted by important electronics companies... *and had their jobs waiting for them on the day they graduated!*

Coeducational Day and Evening Courses. Day and Evening Courses are available at Resident Schools in New York City and Los Angeles. You can prepare for your career in electronics while continuing your normal full-time or part-time employment. Regular classes start four times each year.



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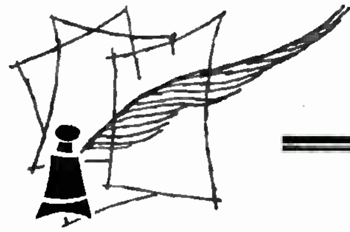


from our Readers

HI-FI FM STANDARDS

To the Editors:

In your January issue the *Paco* tuner was discussed. The article said that the FM portion had been tested according to IHFM standards.

It may be a wonderful thing to know that the tuner you are buying has had to pass all these rigid requirements. But will all tuners be alike if the manufacturer states that he has complied with the IHFM standards? Formerly a fellow could tell something about tuner sensitivity when the quieting figures were given. But when you give a usable sensitivity of 5 μv., how does a guy like me know what goes on?

I don't see where the IHFM has made it one bit easier for me to pick out a tuner because I have to depend on what a dealer tells me. Where can I get that yardstick I need to go by?

KENNETH T. ROCHE
Sheboygan, Wis.

We would like to emphasize that the IHFM does not set "rigid requirements" but it does instead set standard methods of taking measurements. The term "usable sensitivity" has a definite meaning and a measurement of this specification indicates the least value of signal "which will produce a 30-db rise in indicated output with standard test modulation as compared with the indicated output with standard test modulation measured through a 400-cps null filter."

If all manufacturers follow these standards, this does not mean that all tuners will be alike, but simply that they will all have their specs measured exactly the same way. Hence, the consumer will be able to make an intelligent comparison of figures.—Editors.

* * *

V.H.F. DEMONSTRATION OSCILLATOR

To the Editors:

As a communications engineer concerned with radio interference, I feel that poor judgment was used in publishing the article on a demonstration oscillator in the January 1961 issue of ELECTRONICS WORLD.

The operation of such a device could result in serious interference to commercial and military communications, not to mention many neighborhood television sets.

DONALD J. BROWN
Dover, New Jersey

It was certainly not our intention that the demonstration unit be operated for more than a brief time during classroom demonstrations. What is more, the power output of the device described is extremely low. This, coupled with the fact that no antenna was connected to the device and the fact that the small open line would radiate very little signal, led us to the conclusion that the unit would not produce harmful interference.

We are quite aware of the interference problem, and as a matter of fact, we have run many articles on this very subject. But, we feel that classroom training for future workers in our field is important too.—Editors.

* * *

FUSES AND FUSEHOLDERS

To the Editors:

Mr. Lebens, our vice-president in charge of engineering, has just read your article on "Fuses and Fuseholders" in the February issue. He remarked to me that you had done quite a fine job on this article and, in fact, had given him an idea that he thought we could incorporate in our own literature. That is the idea you illustrate in Fig. 1 showing a "keep-alive" resistor.

If at any time you are out in our vicinity and would like to drop in and see how "Buss" fuses and fuseholder are made, we would be glad to give you a personally conducted tour through our factory. The ordinary layman has no idea of the amount of engineering and production know-how that it takes to make fuses and fuseholders of the quality standards that we have always tried to maintain.

H. VONP. THOMAS
Merchandising Manager
Bussman Mfg. Div.
St. Louis, Mo.

We're glad that the article was helpful and we appreciate the invitation.—Editors.

* * *

COMMERCIAL KILLER

To the Editors:

I have subscribed to ELECTRONICS WORLD for many years and have read and profited by many fine articles. The February issue, for example, has more than its share of useful articles. But, in this issue I noticed a reference to an upcoming article in the March issue for a "commercial silencer." This type of article I object to.

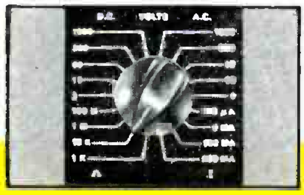
Commercials on TV and radio are the lifeblood of most of us in the electronics industry. If most TV sets had commercial killers attached to them, most TV stations would go out of business, and we would have no need for technical magazines. I hope you will turn down any future articles or advertising on so-called "commercial killers."

WILLIAM M. SLUSSER
Idaho Falls, Idaho

Viewers usually do not want to

First real VOM advance in 20 years

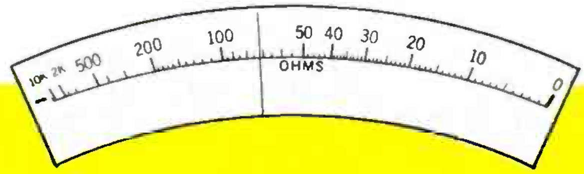
SET IT!



SEE IT!

READ IT!

DIRECTLY—ACCURATELY
WITHOUT MULTIPLYING



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AUTOMATIC VOLT-OHM-MILLIAMMETER

- Individual Full-Size Scale for Each Range
- Range Switch Automatically Sets Correct Scale
- Only One Scale Visible at Any Time
- No Multiplying . . . No False Readings
- Meter Protected Against Extreme Overload
- Mirrored-Scale for Precise Readings

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EASIEST—FASTEST—ERROR-FREE READINGS

Once you set the range switch properly, *it is impossible to read the wrong scale.* Readings are easiest, fastest of all—so easy the meter "practically reads itself." Eliminates reading difficulties, errors, and calculations.

All scales, including the ohms scale, are *direct reading.* You do not have to multiply. Saves time and trouble. Gives you the right answer immediately. Ohms-adjust control includes switch that automatically shorts out test leads for "zero" set.

Every scale in the V O Matic 360 is the same full size . . . *and only one scale is visible at any one time,* automatically. Supplemental ranges are also provided on separate external overlay meter scales.

This new-type automatic VOM is another innovation by B&K that gives you features you've always wanted. Outdates all others.

Net, $59.95

Includes convenient stand to hold "360" for correct viewing in 4 positions.

Ranges: DC Volts — 0 - 3, 15, 60, 300, 1000, 6000 (20,000 Ω/v)
AC Volts — 0 - 3, 15, 60, 300, 1000, 6000 (5,000 Ω/v)
AF (Output)— 0 - 3, 15, 60, 300 volts
DC Current — 0 - 100 μa, 5 ma, 100 ma, 500 ma, 10 amps
Resistance — 0 - 1000 ohms (3 Ω center)
0 - 10,000 ohms (50 Ω center)
0 - 1 megohm (4 k Ω center)
0 - 100 megohms (150 k Ω center)

Supplemental Ranges: 18 separate external overlay meter scales for:
DC Volts— 0 - 250 mv   **Capacitance**—100 mmfd to 4 mfd
Audio Power Output—up to 56 watts   **DB** (decibels)
Peak-to-Peak AC (sine) Volts— 0 - 170, 850

Polarity Reversing Switch and Automatic Ohms-Adjust Control
Frequency Response AC: 5 - 500,000 cps
Burn-Out Proof Meter: Protected against overload and burn-out
Complete with 1½-volt and 9-volt batteries and test leads

Ask Your B&K Distributor for Demonstration or Write for Catalog AP17-N

B&K

B & K MANUFACTURING CO.
1801 W. BELLE PLAINE AVE • CHICAGO 13, ILL.
Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

silence interesting and informative commercials that are tastefully and intelligently prepared. However, each viewer should have the right to turn off what he finds annoying and objectionable. After all, TV sets do have "on-off" switches.—Editors.

* * *

RESISTANCE SUBSTITUTOR

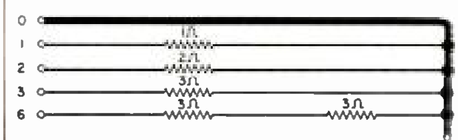
To the Editors:

For the past few years I have been using a device very similar to "The Resistance Substitutor" described in your February 1961 issue. However, my substitution board uses only 25 resistors and covers a range of 1 to 100,000 ohms, which makes it much more versatile than yours.

Using resistors of 1, 2, 3, and 6 ohms, any value between 1 and 9 ohms can be had by connecting to one of them or by connecting two of them in series. Since 6-ohm resistors are not generally available, I used two 3-ohm resistors in series for the 6 ohms needed.

For higher decade units, get resistors 10 times as large. This system can be expanded to as many decade units as needed by using larger resistors. I used 1-watt, 5% resistors and find they work well. Only in power supplies must I use care in connecting this into a circuit.

My unit is constructed on a piece of tempered Masonite and has 5 decade



units and 25 resistors mounted on it. I used a piece of welding rod as a bus for each of these decades. I bent it into an "L" shape and bolted both ends to the Masonite. I soldered the leads from one end of the resistors to this bus and fastened the other ends to solder lugs fastened under bolts to the Masonite. Mounting of the resistors followed exactly the schematic arrangement shown. Short clip leads are used to interconnect the various resistors and decades. The entire assembly can be built for about 6 dollars and it is well worth it.

DAVID S. DODSON
Manhattan, Kansas

Thanks to Reader Dodson for passing his circuit along to us.—Editors.

* * *

CROSSED-UP CROSSWORD

To the Editors:

A review of high-school physics will show that a dyne is not a unit of energy as you implied in your crossword in the March issue. A dyne is a unit of force. Furthermore, all energy, no matter what form, can be measured in any energy unit. Your reference to kinetic energy was therefore misleading.

THEODORE WADE, JR.
Dependable Scientific Laboratories
Bennet, Nebraska

Reader Wade is right. Our definition should have been "a unit of force."—Editors.

—30—

FREE

tells how

To Get An FCC Commercial License

Completion of the Master Course (both Sections) will prepare you for a First Class Commercial Radio Telephone License with a Radar Endorsement. Should you fail to pass the FCC examination for this license after successfully completing the Master Course, you will receive a full refund of all tuition payments. This guarantee is valid for the entire period of your enrollment agreement.

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"License and $25 raise due to Cleveland Institute Training"

"I sat for and passed the FCC exam for my second class license. This meant a promotion to Senior Radio Technician with the Wyoming Highway Department, a $25 a month raise and a District of my own for all maintenance on the State's two-way communication system. I wish to sincerely thank you and the school for the wonderful radio knowledge you have passed on to me. I highly recommend the school to all acquaintances who might possibly be interested in radio. I am truly convinced I could never have passed the FCC exam without your wonderful help and consideration for anyone wishing to help themselves."

CHARLES C. ROBERSON
Cheyenne, Wyoming

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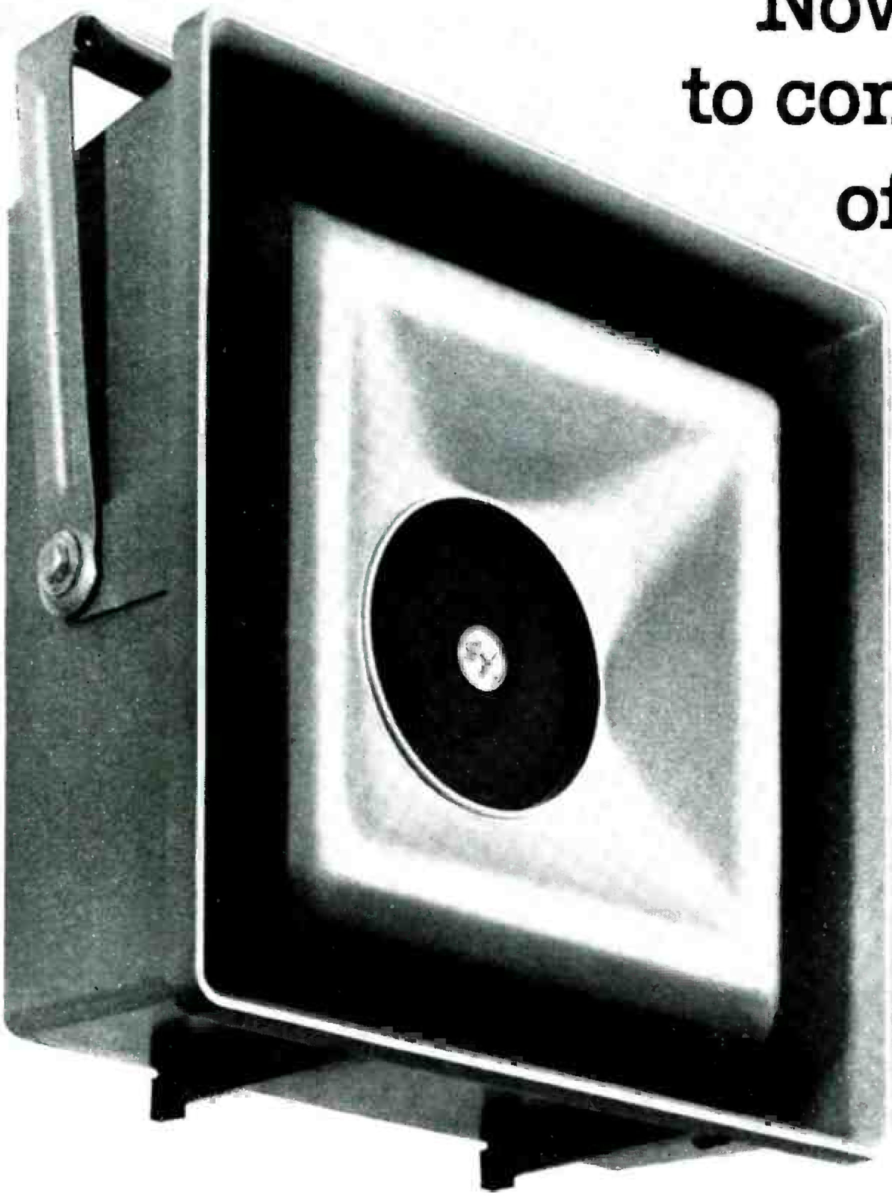

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Spot News

By ELECTRONICS WORLD'S WASHINGTON CORRESPONDENT

SOLID-STATE AIRBORNE ATOMIC CLOCK DEVELOPED—A 6½-pound airborne atomic clock, combining the latest techniques in solid-state design and so accurate that its maximum error would not exceed one second in 1271 years, has been developed for the Air Force. The device, technically referred to as an Airborne Atomic Frequency Standard, has been designed for missiles and aircraft and is expected to become operational next year. It will replace the numerous crystal oscillators, used as frequency or time standards, now required to calibrate airborne communications, navigation, guidance, fire control, computers, and timing devices. First of its kind, the unit has been so simplified that only an "on-off" switch is required to operate it. No calibration is needed—the unit acts as its own primary standard.

HIGH-INTENSITY ELECTRONIC FLASH NOW AVAILABLE FOR MISSILE RESEARCH—An electronic flash, which lights up with the intensity of 10 press-camera flashbulbs, maintains the light evenly at peak brilliance, and suddenly shuts off without an afterglow, has been developed for Navy missile research. Developed by three scientists at the Naval Ordnance Laboratory in Silver Spring, Maryland, the flash provides illumination for a high-speed camera which takes 82 equally exposed pictures of a missile model undergoing re-entry airflow tests which last but a fraction of a second. The flash unit is a gaseous discharge tube coupled with an artificial transmission line made up of a number of charged capacitors. When the capacitors are discharged, alternating current races back and forth through the line, keeping the tube's arc burning evenly for 3/1000th of a second. The light then abruptly ceases to shine without any afterglow, avoiding double-exposure with the high-speed camera.

CLOSED-CIRCUIT TV WEATHER BRIEFINGS AT IDLEWILD—The Weather Bureau has installed a closed-circuit television system at the New York International Airport to provide weather briefings for overseas flights. The televised briefing consists of a series of weather charts, accompanied by a taped commentary of a government forecaster. The charts depict the anticipated wind and weather conditions at levels from the surface to approximately 45,000 feet covering the major international routes. The briefings are changed every six hours and can be modified more often as conditions make this necessary.

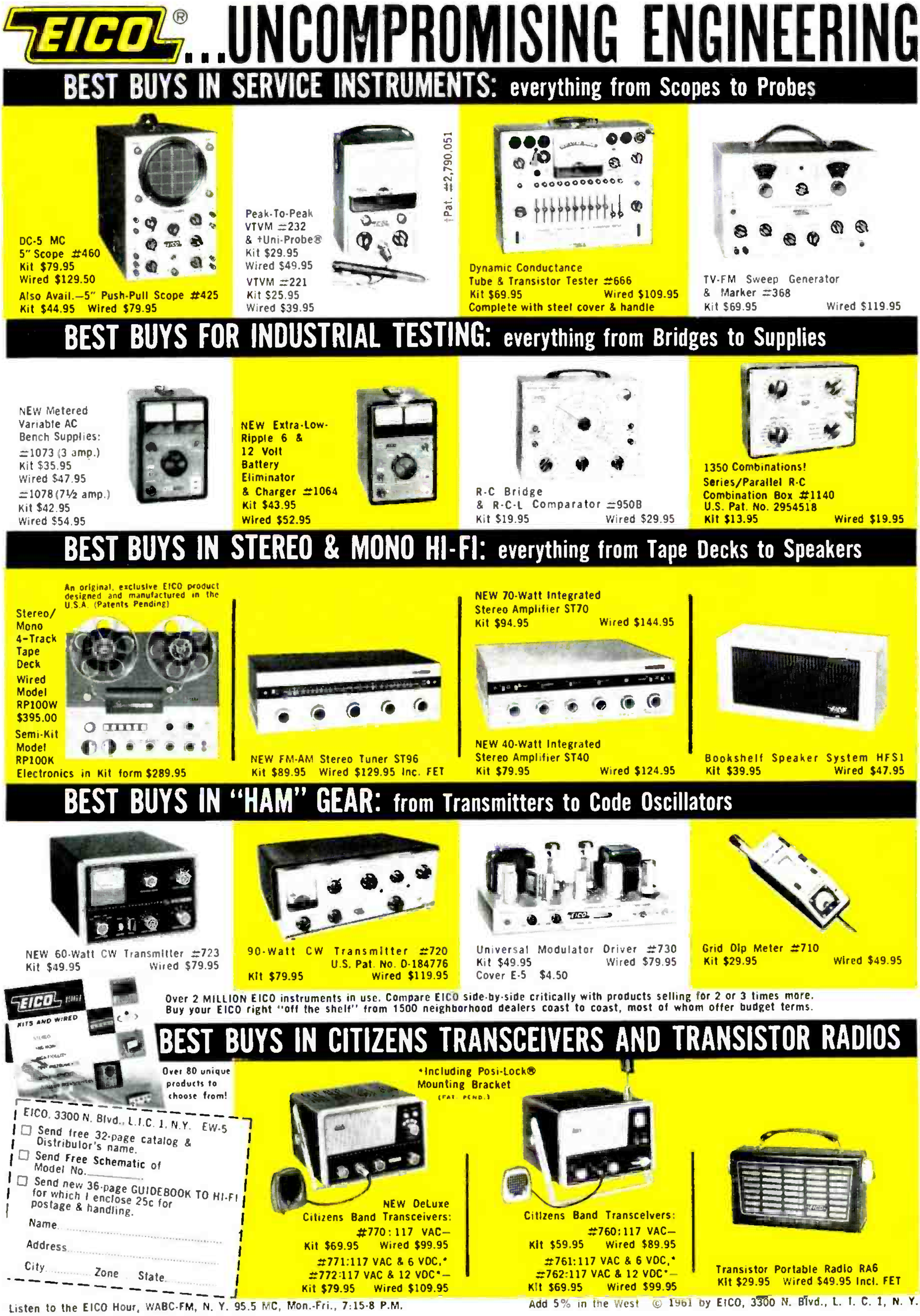
FIRST FAA TESTS OF 3-D RADAR SUCCESSFUL—Tests of an air-height surveillance radar (AHSR), a 3-D model, being developed for the Federal Aviation Agency to provide altitude information in the control of air traffic, have been successful and show definite promise of preventing mid-air collisions. Operating from a 100-ton, 165-foot high antenna erected at the Bureau's Research and Development Center near Atlantic City, N.J., the radar has given altitude information accurate to within 500 feet at a distance of 20 miles.

TIME-SIGNAL ACCURACY INCREASED TO ONE PART IN TEN BILLION—A new time-signal standard that can be held constant to one part in ten billion has been announced by the Department of Defense. This degree of accuracy is ten times better than that furnished for any other physical unit of measurement such as the meter or the gram. A perfect watch set to match this constancy would lose less than 1/100th of a second in three years. In operation, time signals are transmitted continuously on 18 kc. from station NBA in the Canal Zone and the frequency of the carrier wave is compared at Washington to the Naval Observatory's cesium atomic clocks. Stabilization is achieved at NBA by using very precise quartz-crystal oscillators.

SPECIAL ANTENNA DESIGNED TO WARN PILOTS OF COLLISION COURSE—The FAA's research and development group has launched a series of flight tests on a unique lens antenna which it is hoped will eliminate mid-air collisions. The antenna, employing a Luneberg lens for both directional and omni-directional scanning, can be mounted under a plane's fuselage to afford maximum coverage in all directions.

GENERAL GRANT NOW COMMANDER OF AIR FORCE COMMUNICATIONS—Major General Harold W. Grant has been named to command the Air Force Communications Service upon its activation at Scott Air Force Base, Illinois on July 1st. In this post, General Grant will direct the total-aero-space communications complex, a global network, which includes point-to-point and air-to-ground contact.

-30-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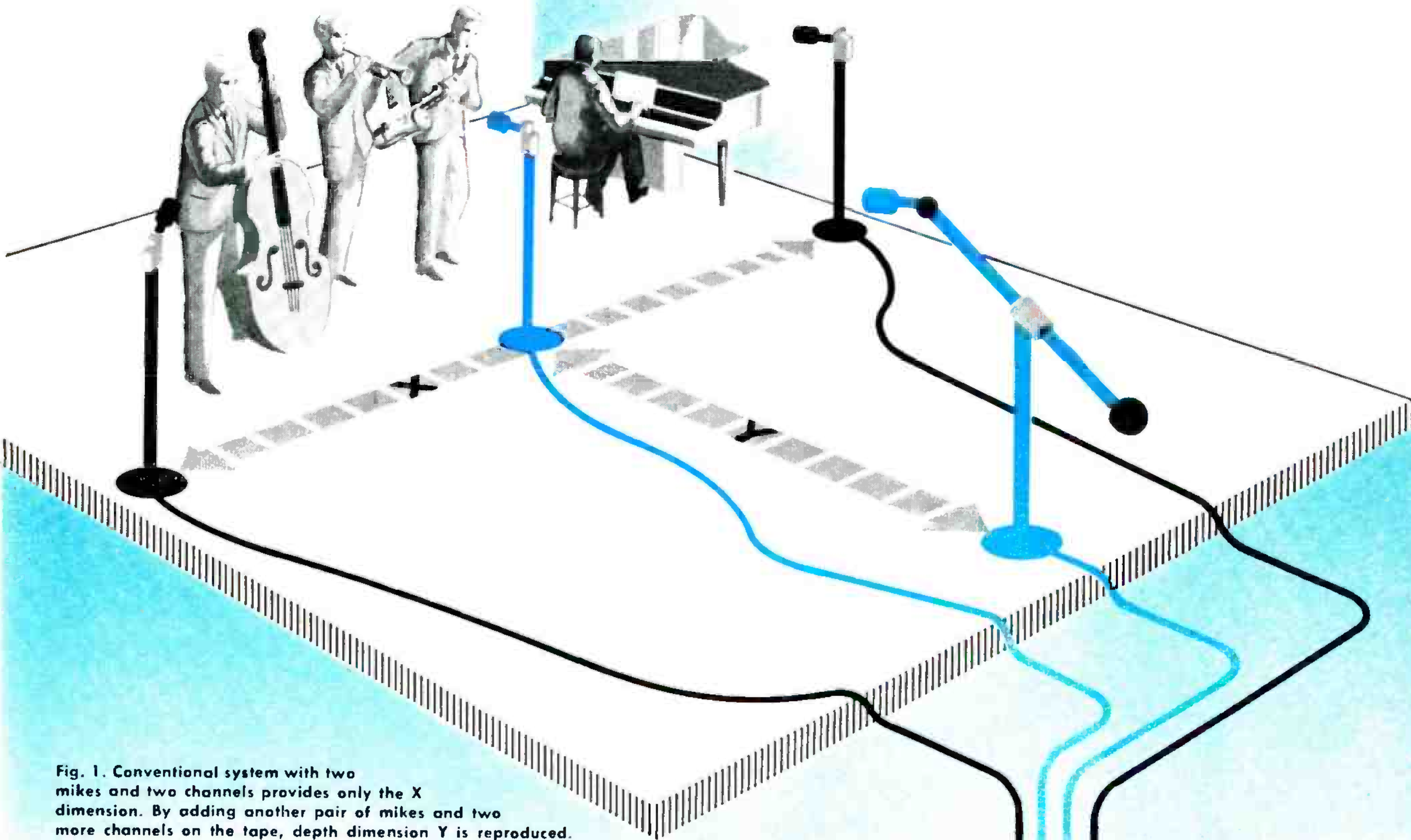
FOUR-CHANNEL STEREO ADDS DEPTH TO TAPES

By **JOHN W. HOGAN,** Chief Engineer, The Nortronics Co., Inc.

How to set up a tape system that provides a new dimension in sound. Construction of transistorized preamps included.



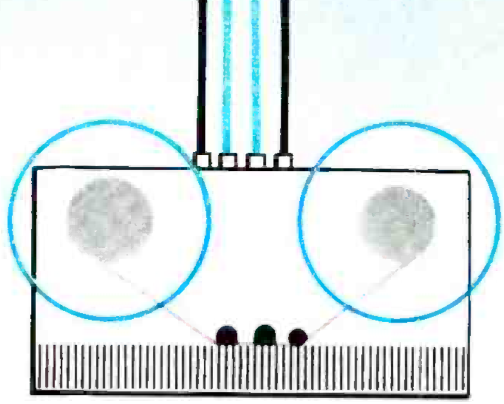


Fig. 1. Conventional system with two mikes and two channels provides only the X dimension. By adding another pair of mikes and two more channels on the tape, depth dimension Y is reproduced.

COVER STORY

MOST of us have had the experience of seeing and listening to musicians perform at close range. Even though personal tastes may vary greatly, the added factor of being physically near the orchestra or performers will generally enhance listening enjoyment. In addition, a live performance has a "depth" to it which contributes to our enjoyment. To duplicate this "closeness" and "depth" in recordings is practically impossible with our present stereo system.

There is no question that the owner of a monophonic tape recorder will have a new world of sound realism open up to him if he converts to two-channel stereo. But the user of a stereo recorder is sure to find even more realism if he tries the four-channel system to be described.

Conventional stereo, or what this author prefers to call "single dimension (*X-X*) stereo," is shown in Fig. 1. With this approach, the depth of the orchestra or performing group is reduced to that recreated by only the two channels. When listening to a recording of this type, the act of turning up the volume does not appear to bring the listener closer to the performers, it merely makes them louder.

Fig. 1 also shows the addition of a *Y-Y* dimension which will provide the necessary depth perspective. It should be noted here that most master recordings are made on three-channel magnetic recording equipment. However, the most artistic blending and mixing of multiple-channel master recordings will be of little avail in producing the complete illusion of depth if only two-channel, single-dimension tapes are to be the end result of the mixing.

HEAD TYPE	BIAS Current	BIAS 100-ohm reading	RECORD Current	RECORD 100-ohm reading	COMMENTS
TLB-4	1 ma.	.1 v.	.05 ma.	.005 v.	Transistorized Record & Playback
TLB-4R	.6 ma.	.06 v.	.03 ma.	.003 v.	Transistorized Record Only
TLB-2	.3 ma.	.03 v.	.025 ma.	.0025 v.	Vacuum-Tube Record & Playback
TLB-7R	.5 ma.	.05 v.	.04 ma.	.004 v.	Vacuum-Tube Record Only

Table 1. Record-head data for Nortronics heads. If other heads are used, consult manufacturer's data for current requirements. Note that the record-current level for each head type is for 0 vu or standard reference level at 1 kc at a tape speed of 7.5 ips.

The current quarter-track system that makes use of two tracks in one direction and two tracks in the reverse direction provides the basic tool for an easy means of producing four-channel, single-direction *two-dimensional stereo*. It requires an additional quarter-track head and an additional stereo amplifier compared to conventional stereo. A block diagram of the playback arrangement is shown in Fig. 3.

A four-channel, professionally recorded demonstration tape, entitled "Spatial Sound," is now available. This tape will permit the sound hobbyist to play tape stereo in two dimensions with the above modifications in existing tape equipment. The tracks are so arranged that the conventional *X-X* dimension will play through the standard 1 and 3 tracks of a conventional tape recorder. The additional dual-track stereo head and amplifiers will permit the audiophile to bring out tracks 2 and 4 and begin a new and pleasantly appealing listening experience with all the realism and depth of the live performance.

This article will describe how to adapt existing tape-recorder equipment for both playback and recording of four-channel sound. The audiophile can purchase the necessary components for both recording and playback functions or, if technical "know-how" exists, he can construct them.

During the early days of two-channel tape stereo, a dimension of 1.25 inches was used to separate two staggered monophonic half-track heads which, in turn, were aligned with the bottom and top tracks. Because many units are still in the field with bracket spacing for this system, it was decided to specify the four-channel "Spatial Sound" system with the heads spaced 1.25 inch between gap lines, as shown in Fig. 3.

The heads must be aligned in azimuth and in height (at right angles to the direction of tape travel) so that tracks 1 and 3 (Head 1) and 2 and 4 (Head 2) are in coincidence with the standards of four-track usage. This can usually be done by adjusting the height position of Head 1 until the top line of the core on track 1 coincides with the top of the tape and Head 2 until the bottom line of the core on track 4 coincides with the bottom of the tape.

Transistorized Playback Amplifiers

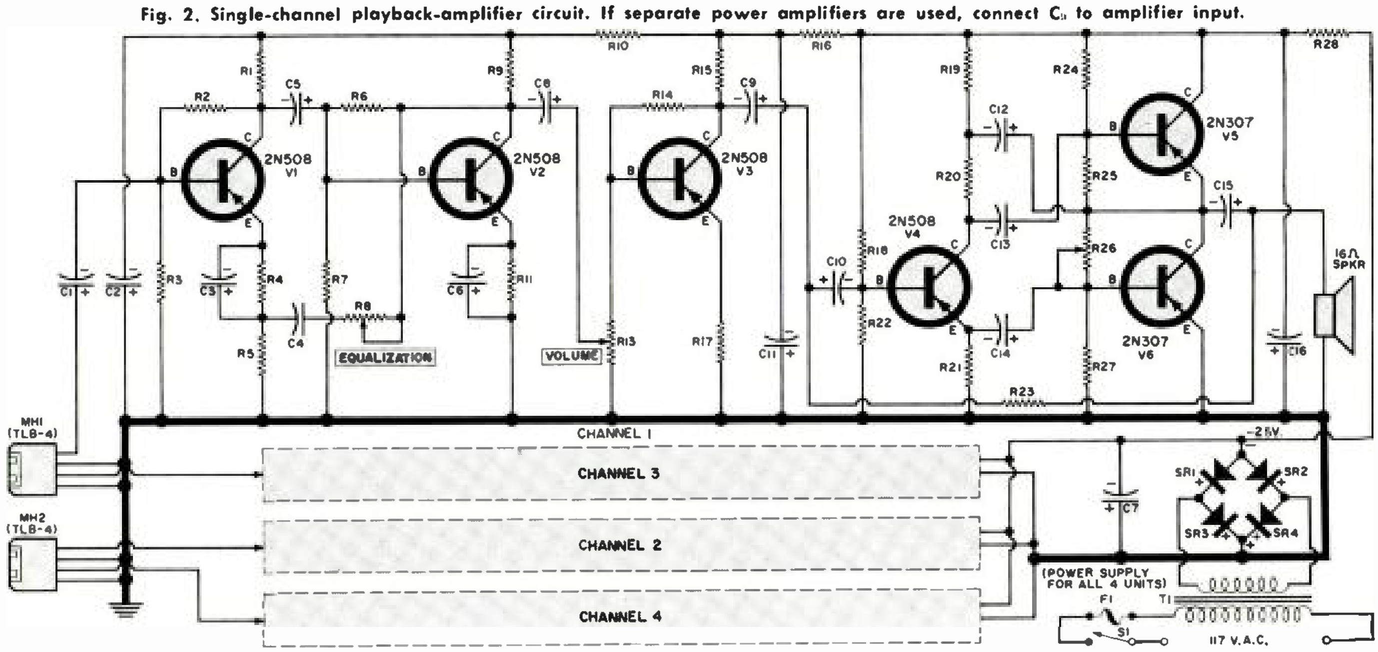
A transistorized playback amplifier is shown in the schematic of Fig. 2. Four of these amplifiers are required for a complete four-channel playback system. The individual amplifiers do not have output or interstage transformers to deteriorate frequency performance. Each one is capable of supplying approximately 3 watts of audio power, at low distortion, to a 16-ohm speaker network. Transistors V_1, V_2, V_3, and V_4 are Type 2N508 units with an h_{fe} of 100 or above.

There are several equivalent *p-n-p* units that would be satisfactory, but it might be necessary to make minor adjustments in the values of R_2, R_6, R_{11}, and R_{18}—even among the Type 2N508 transistors.

Construction of the transistorized playback amplifiers should follow one of two construction techniques. The first would be to construct all four amplifiers on one chassis. The other method would be to construct each amplifier on an individual chassis. There are advantages to each method and the builder should determine which will be more satisfactory for his individual cabinet considerations, mounting space, etc.

No matter which way the amplifiers are constructed, normal good practice, such as putting the consecutive amplifier stages in a line, should be followed. Lead length and component dress is not overly critical, but care should be taken

Fig. 2. Single-channel playback-amplifier circuit. If separate power amplifiers are used, connect C_{11} to amplifier input.



R_1, R_9—10,000 ohm, ½ w. res.
R_2—150,000 ohm, ½ w. res.
R_3, R_7—47,000 ohm, ½ w. res.
R_4, R_{11}, R_{15}—1000 ohm, ½ w. res.
R_5—10 ohm, ½ w. res.
R_6—470,000 ohm, ½ w. res.
R_8—1000 ohm audio taper pot
R_{10}, R_{21}—2200 ohm, ½ w. res.
R_{13}—5000 ohm audio taper pot
R_{12}—39,000 ohm, ½ w. res.
R_{14}—3300 ohm, ½ w. res.
R_{16}—470 ohm, ½ w. res.
R_{17}—22 ohm, ½ w. res.
R_{18}—82,000 ohm, ½ w. res.
R_{19}—330 ohm, ½ w. res.
R_{20}, R_{24}—100 ohm, ½ w. res.
R_{22}—3900 ohm, ½ w. res.
R_{23}—15,000 ohm, ½ w. res.
R_{25}, R_{26}—220 ohm, ½ w. res.
R_{28}—25,000 ohm linear taper pot
R_{27}—4.7 ohm, ½ w. res.
C_1, C_6, C_9, C_{10}—25 µf., 15 v. elec. capacitor
C_2, C_{11}, C_{12}, C_{13}, C_{15}—100 µf., 25 v. elec. capacitor
C_3—1000µf., 3 v. elec. capacitor
C_4—.47 µf., 25 v. capacitor
C_5—10 µf., 25 v. elec. capacitor
C_8—100 µf., 3 v. elec. capacitor
C_7, C_{16}—1000 µf., 25 v. elec. capacitor
C_{14}—2000 µf., 15 v. elec. capacitor
MH_1, MH_2—Magnetic tape head (Nortronics TLB-4 or equiv.)
SR_1, SR_2, SR_3, SR_4—1N253 silicon diode
F_1—1 amp fuse
S_1—S.p.s.t. switch
T_1—Power trans. 24 v. @ 2 amps (Stancor RT-202)
V_1, V_2, V_3, V_4—2N508 transistor (G-E)
V_5, V_6—2N307 transistor (RCA)
Note: The tape heads are available direct from The Nortronics Co., Inc., 1015 S. Sixth St., Minneapolis 4, Minn. at $21.60 each.

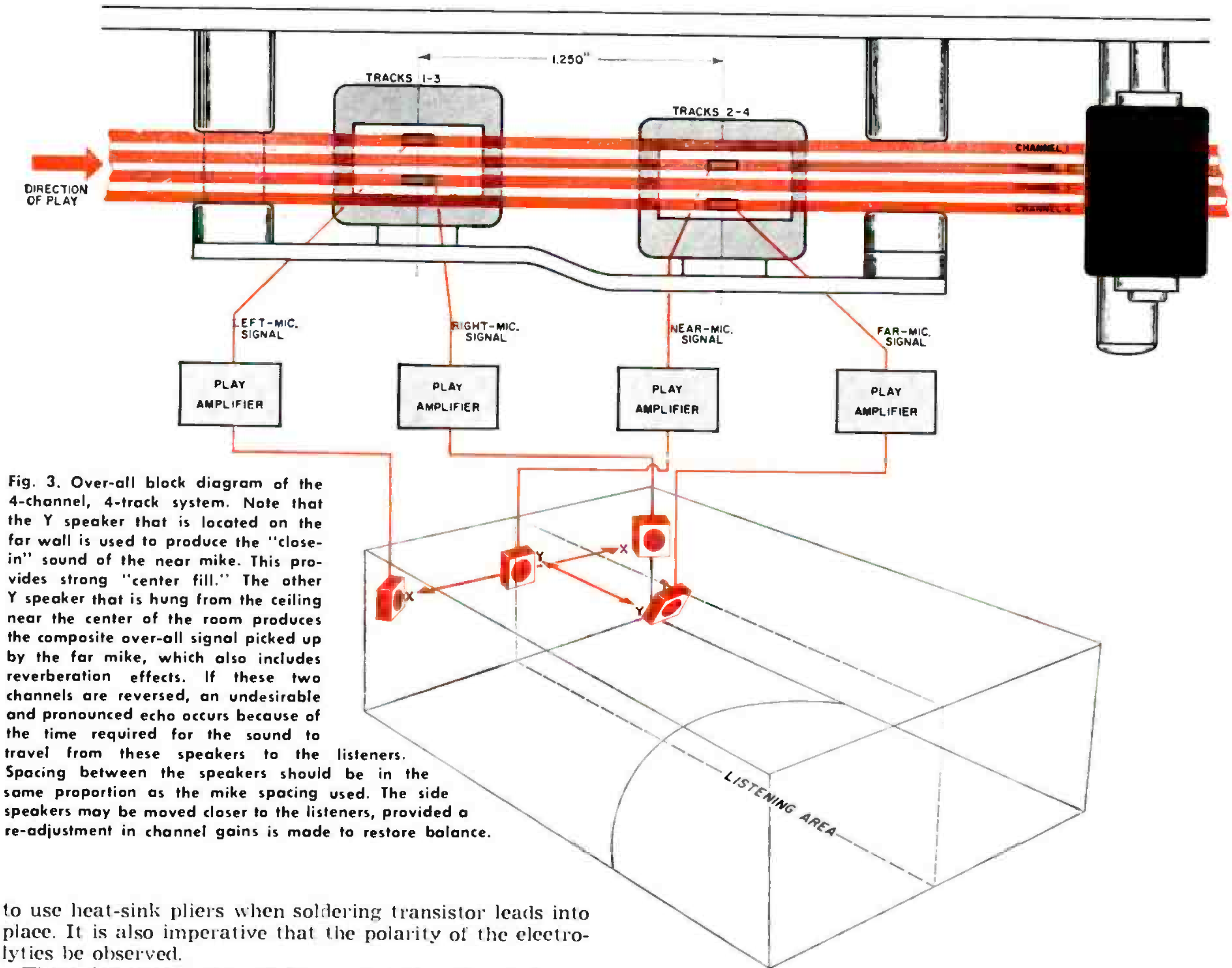


Fig. 3. Over-all block diagram of the 4-channel, 4-track system. Note that the Y speaker that is located on the far wall is used to produce the "close-in" sound of the near mike. This provides strong "center fill." The other Y speaker that is hung from the ceiling near the center of the room produces the composite over-all signal picked up by the far mike, which also includes reverberation effects. If these two channels are reversed, an undesirable and pronounced echo occurs because of the time required for the sound to travel from these speakers to the listeners. Spacing between the speakers should be in the same proportion as the mike spacing used. The side speakers may be moved closer to the listeners, provided a re-adjustment in channel gains is made to restore balance.

to use heat-sink pliers when soldering transistor leads into place. It is also imperative that the polarity of the electrolytics be observed.

The voltage ratings on the capacitors have been chosen to insure a reasonable safety factor providing the power-supply voltage does not go much over 25 volts. It is necessary to have transistors V_5 and V_6 mounted on a suitable heat sink.

Control R_{26} is used to provide a bias balance on the output transistors for maximum power output and low distortion. This adjustment can be easily done if an oscilloscope is available to monitor the output voltage across the speaker while adjusting the control.

Volume control R_{13} is a simple current divider to provide conventional audio-taper control. Equalization control R_8 is used in a feedback path to permit adjustment of any unbalance which may accompany loudspeaker losses and other minor irregularities in the system.

Transistorized Record Amplifiers

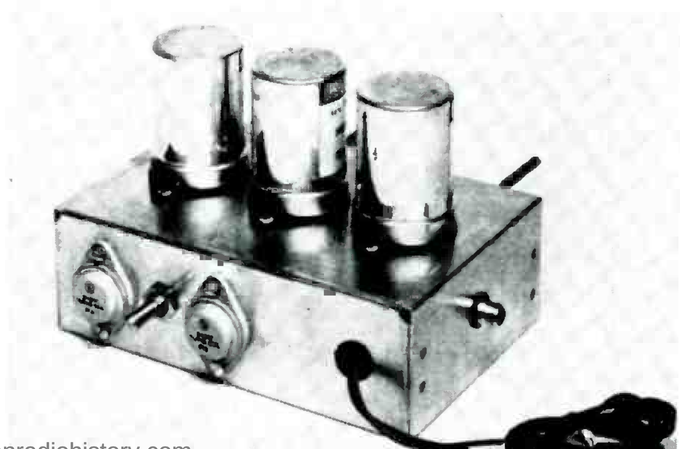
Fig. 4 is the schematic of the transistorized record amplifier. Four such amplifiers comprise the complete recording system. The individual amplifiers are capable of providing unusually high-quality recordings. Inclusion of an input transformer permits a balanced hum-rejection system that provides a true measure of broadcast-quality performance.

It is recommended that all of the four-channel transistor recording amplifiers be built on a single chassis. This will prevent an excessive number of inter-chassis wiring connections and reduce the possibility of unwanted hum and noise pickup. Transistor V_1 operates as a straight signal amplifier and provides a suitable input impedance match to the transformer. V_2 is operated as an emitter-follower; this provides a sufficiently high input impedance to permit the use of simple, conventional voltage-dividing gain controls for both microphone and high-level mixing. Transistor V_3 provides a driver amplifier for the main equalizing networks, consisting of resistors R_{17}, R_{18}, R_{19}, and R_{20} and capacitors C_8, C_9, C_{10}, and C_{11}. This network provides the appropriate response to compensate for minor amplifier losses in the low and high end of the audio-frequency band, as well as the necessary NAB-type record curve for 7.5 ips.

The audio record driver is V_4. This stage is connected into a parallel trap C_{12}-L_1, to reduce the 80-kc. bias signal to a minimum value on the collector of V_4 which, in turn, reduces potential intermodulation distortion with the added record current in the head. It is highly recommended that the builder use a high-"Q" inductance such as a *J. W. Miller* Type 6306 component. As in the case of the playback amplifier construction, it is recommended that normal good practice, such as short lead dress and good soldered connections with appropriate use of heat-sink techniques, be used when soldering a transistor lead.

The use of a single bias oscillator to provide bias injection to all four amplifiers eliminates the necessity for elaborate

Single transistorized playback amplifier built from Fig. 2. Note the heat-sink mounting of the two power transistors.



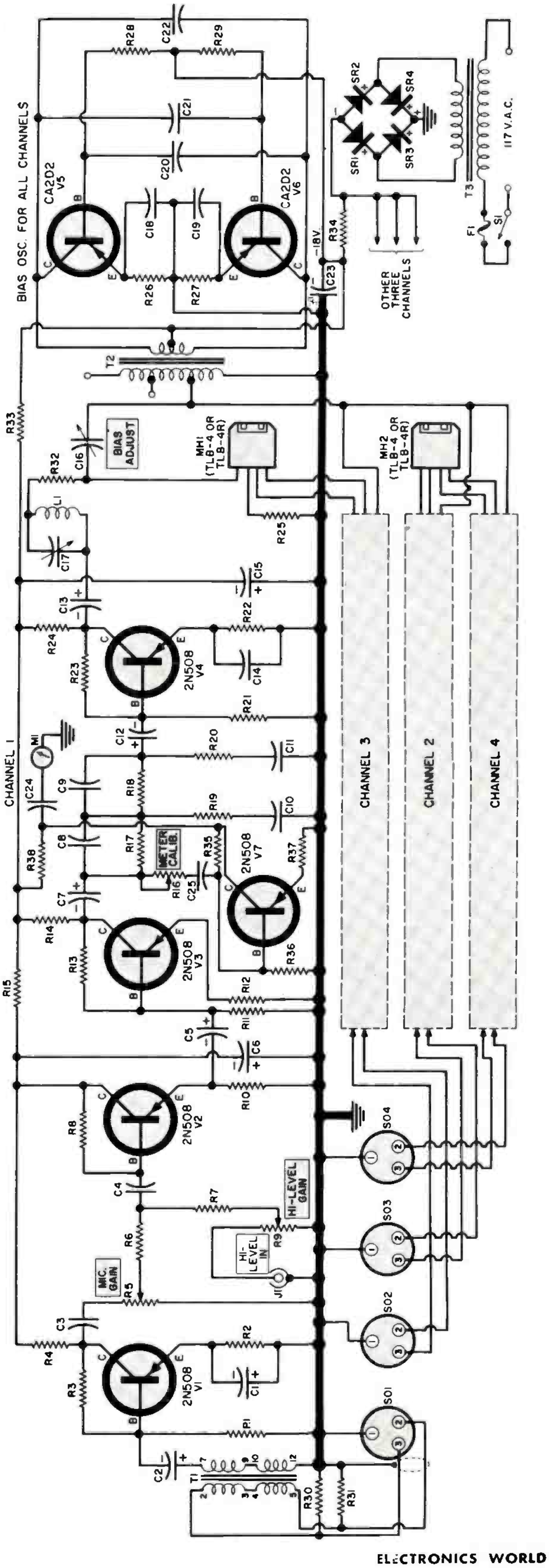


Fig. 4. Diagram of one of four identical record-amplifier channels. The oscillator and rectifiers are common to all channels.

R_1—68,000 ohm, ½ w. res.
R_2, R_{31}—1000 ohm, ½ w. res.
R_3—120,000 ohm, ½ w. res.
R_4, R_{10}, R_{14}, R_{24}, R_{32}, R_{38}—10,000 ohm, ½ w. res.
R_5, R_9—100,000 ohm audio taper pot
R_6, R_7—100,000 ohm, ½ w. res.
R_8, R_{13}, R_{23}—470,000 ohm, ½ w. res.
R_{11}, R_{21}, R_{36}—47,000 ohm, ½ w. res.
R_{12}, R_{22}, R_{37}—220 ohm, ½ w. res.
R_{16}—5000 ohm linear taper pot
R_{17}—12,000 ohm, ½ w. res.
R_{18}—6800 ohm, ½ w. res.
R_{19}—4700 ohm, ½ w. res.
R_{20}—2200 ohm, ½ w. res.
R_{15}—330,000 ohm, ½ w. res.
R_{25}—100 ohm, ½ w. res.
R_{26}, R_{27}—10 ohm, ½ w. res.
R_{28}, R_{29}, R_{30}, R_{33}—22,000 ohm, ½ w. res.
R_{35}—470 ohm, ½ w. res.
R_{34}—Value chosen to give −18 volts (10 watts)
C_1—1000 µf., 3 v. elec. capacitor
C_2, C_7—10 µf., 10 v. elec. capacitor
C_3, C_4, C_{24}, C_{25}—1 µf., 25 v. capacitor
C_5—25 µf., 10 v. elec. capacitor
C_6, C_{13}—100 µf., 25 v. elec. capacitor
C_8—.0022 µf., 25 v. capacitor
C_9—.0047 µf., 25 v. capacitor
C_{10}, C_{18}, C_{19}—1 µf., 3 v. capacitor
C_{11}—2.2 µf., 3 v. capacitor
C_{12}, C_{15}—25 µf., 25 v. elec. capacitor
C_{14}—.05 µf., 10 v. capacitor
C_{16}, C_{17}—40-500 µµf. padder
C_{20}, C_{21}—.01 µf., 25 v. capacitor
C_{22}—.033 µf., 100 v. capacitor
C_{23}—500 µf., 25 v. elec. capacitor
L_1—10 mhy. r.f. choke (J. W. Miller z6306)
T_1—Mic. matching trans. (UTC A-20 or equiv.)
T_2—Osc. trans. (Nortronics T60T2)
T_3—Power trans. 24 v. @ 2 amps (Stancor RT-202)
MH_1, MH_2—Magnetic head (Nortronics TLB-4, TLB-4R or equiv.)
SR_1, SR_2, SR_3, SR_4—1N2069 silicon diode
F_1—1 amp fuse
S_1—S.p.s.t. switch
M_1—VU meter
SO_1, SO_2, SO_3, SO_4—Mic. socket
J_1—Phono jack
V_1, V_2, V_3, V_4, V_7—2N508 transistor (General Electric)
V_5, V_6—CA2D2 transistor (Minneapolis-Honeywell, see text)

Note: The tape heads and oscillator transformer (T_2) are available direct from The Nortronics Co., Inc., 1015 S. Sixth St., Minneapolis 4, Minn. at $21.60 (each) and $4.50 respectively.

synchronizing networks to avoid secondary whistles from beat frequencies which would result if four separate oscillators were used. The oscillator makes use of two transistors such as the *Minneapolis-Honeywell* CA2D2 (V_5 and V_6) or any other good quality power transistors of the type used in power amplifiers or in switching applications. It is recommended that an effort be made to choose two transistors as closely matched as possible in leakage and gain. This oscillator can be tuned between 60 and 100 kc. by changing the value of capacitor C_{22}. It is recommended, however, that the constructor compromise on a frequency between 70 and 80 kc.

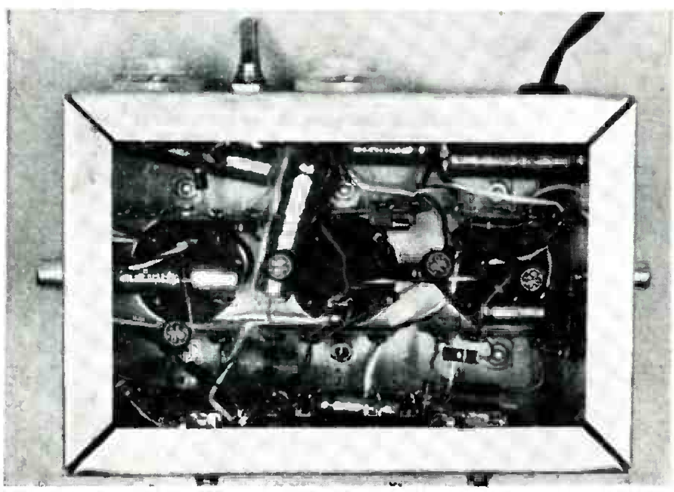
System Adjustment

The *Nortronics* Model TLB-4 magnetic head is a combination low-impedance head that will handle both recording and playback in transistor circuits. For the hobbyist with a limited budget, two of these units properly mounted will provide the entire head complement. If vacuum-tube circuits are used instead of these transistor versions, then high-impedance Model TLB-2 heads may be used for both record and playback. If the builder wants to use separate record and playback sets, Model TLB-4R should be used with the transistorized record circuits. With vacuum-tube record circuits, use the TLB-7R heads.

The 100-ohm resistors from the record head to ground are used to measure head current from the bias oscillator and the audio driver. Table 1 gives typical values to be used for

(*Continued on page* 74)

Under-chassis view of playback amplifier built from Fig. 2.



The Service Technician and "Do-It-Yourself" Repair

By ALLAN F. KINCKINER

The non-professional dabbler can make trouble for himself and you—and he can also do a good job of disguising the clues to his "handiwork."

PROFESSIONAL service technicians may shake their heads all they please over some of the results, but little can be done to prevent the amateur from attempting his own electronic repairs. The "do-it-yourself" trend, evident in all fields, shows no signs of playing out soon.

In electronics, the DIY practitioner may be an experimenter with a certain amount of ability and a fair chance of success, or a hobbyist who has simply put together a kit or two, perhaps quite successfully. Whatever his background, he often fails in his attempt and is mystified as to the reason. At this point, he has no choice but to go to the professional. If he comes to you, no matter how much you may frown upon his attitude, you will probably be inclined to take on the job. Electronic service is your livelihood and you are not looking for excuses to turn away business. If you do, your competitor may not. The real problem is that this type of work involves special difficulties.

You may be afraid that the set has been so badly butchered by inept work that much unnecessary trouble has been added, and that salvage is impossible or highly difficult. As to butchering, this is not always so. You might be better off, in some respects, if it were. Obviously abused parts or circuits can be helpful clues. On the contrary, tampering may have been masked by the scrupulous soldering and lead dress of the conscientious culprit. This only makes things harder.

Professional technicians called on to service amplifiers, tuners, radios, and other equipment assembled from kits by hobbyists are often impressed with the neat soldering and wiring they find. As much as they are capable of doing, these constructors do "by the book." However assembly work is one thing and fault analysis another. The builder can have far more trouble finding a defect in a piece of equipment than he had in putting it together properly. When he moves on to some other equipment, like his TV set, the trouble will multiply.

Very often he will find the defective part. This is not always difficult. A burned-out component can be spotted with the eye, using no instruments or logic, and without any idea as to how or why it got that way. A replacement is purchased and installed as neatly as one could wish. You just can't tell that anything was done. This is often how the trouble starts.

The DIY amateur may know how to put the replacement in, but he doesn't necessarily know how to select it. Sometimes he is exclusively responsible for his mistake: he will give one or two specifications for the component when he is buying, but be unaware of the importance of a voltage rating, current rating, tolerance, or some other factor. Sometimes the counterman who waits on him shares responsibility. After all, the latter is primarily a salesman interested in turning over merchandise. If he does not have an exact or satisfactory replacement, he may sell a "nearly correct" part. A professional may not alway use an exact replacement himself—but he is in a better position to reject an unsatisfactory or marginal one.

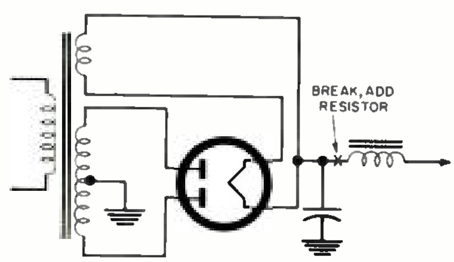
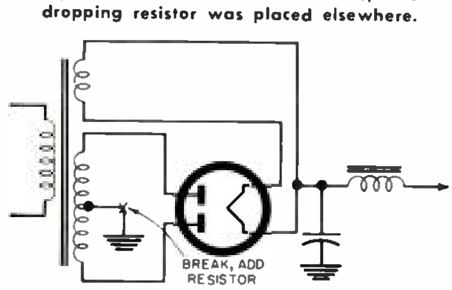


Fig. 1. A dropping resistor compensated for an incorrect transformer replacement.

Fig. 2. In another similar case, the dropping resistor was placed elsewhere.



The "nearly correct" replacement is the clue to many a tough dog created by the equipment owner. This point is worth remembering. Sometimes the replacement is marginal. It doesn't create any trouble until some time later. When it acts up and the professional is called in, the part has aged enough so that it looks as though it "belongs." It doesn't give itself away. The service technician would do well to appraise his customer, in addition to the defective equipment, for clues concerning DIY efforts. Some actual cases will illustrate the type of problem that may be encountered and what to look for.

A customer brought in his TV set with the complaint that "something was burning," but never mentioned that he had at one time made repairs on it himself. Perhaps he didn't think this fact was important; perhaps it could not have been wrung out of him by any means short of torture. However, there was one useful clue: we knew him to be an audiophile who had built several kits.

The receiver, an *AMC* with a 20-inch CRT, had a badly burned width coil. A correct replacement was installed, but we noticed that it ran too hot. Since the raster was being overscanned without some provision for width reduction, a yoke-sleeve type of width control was temporarily installed—but we decided to make additional checks.

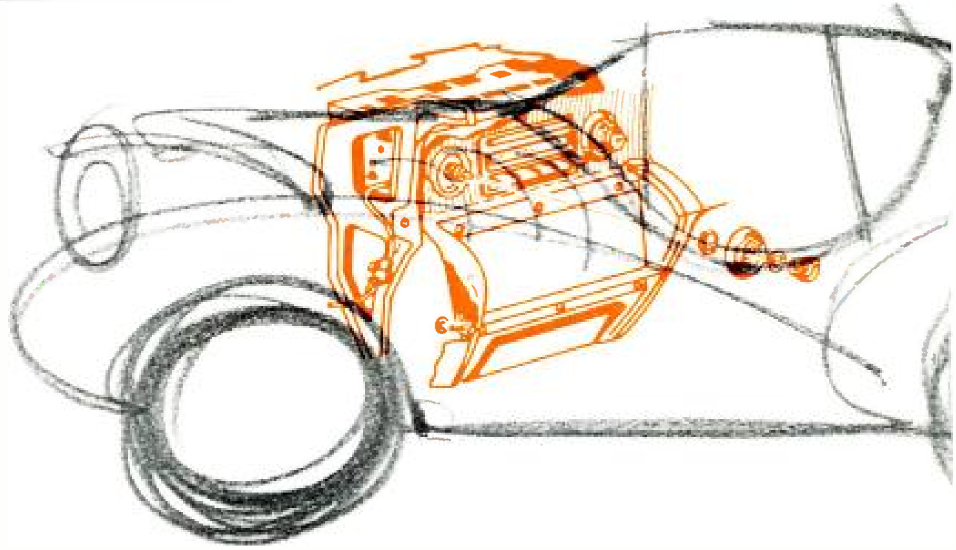
Troubleshooting soon showed that "B+" voltage throughout the set was about 40 volts too high—an invitation to widespread component breakdown. This was traced to the power transformer. It was fairly close to the specifications for this receiver in most respects, except that the "nearly correct" step-up ratio of the high-voltage secondary was too high. Installation and wiring were so neat that it took close scrutiny to re-

(*Continued on page 96*)

AUTO RADIOS FOR 1961

By **MAX ALTH**

Servicing the 1961 GM line of car receivers installed in Buick, Cadillac, Chevrolet, Pontiac & Oldsmobile autos using Delco sets as original equipment.



DELCO RADIO makes the line of "Original Factory Equipment" for *General Motors* automobiles and trucks. From the customer's point of view there are three general groups of AM receivers: manual, manual with push-buttons, and the "Wonder Bar" model which has a signal-seeking system in addition to the push-buttons and manual controls. Electronically the '61 *Delco Radio* sets are quite similar. The basic circuit consists of four tubes and a single power transistor in the output (Fig. 1). The "Wonder Bar" models have an additional tube; a 12AL8 which is used for the signal-seeking circuit, while the 12DS7 detector-audio tube used in the basic circuit is replaced by a 12DV8 in the signal-seeking models. The *Buick* "Sonomatic," Model 980134, varies in that the 12EK6 i.f. tube used with the other sets is replaced by a *Delco* DS22 transistor. All the sets are hybrids using the car's battery for plate voltage as well as heater voltage. They all use a negative ground, mechanical push-buttons, slug tuning, and the signal-seeker is actuated by a solenoid and spring arrangement. The spring alone does the actual pulling.

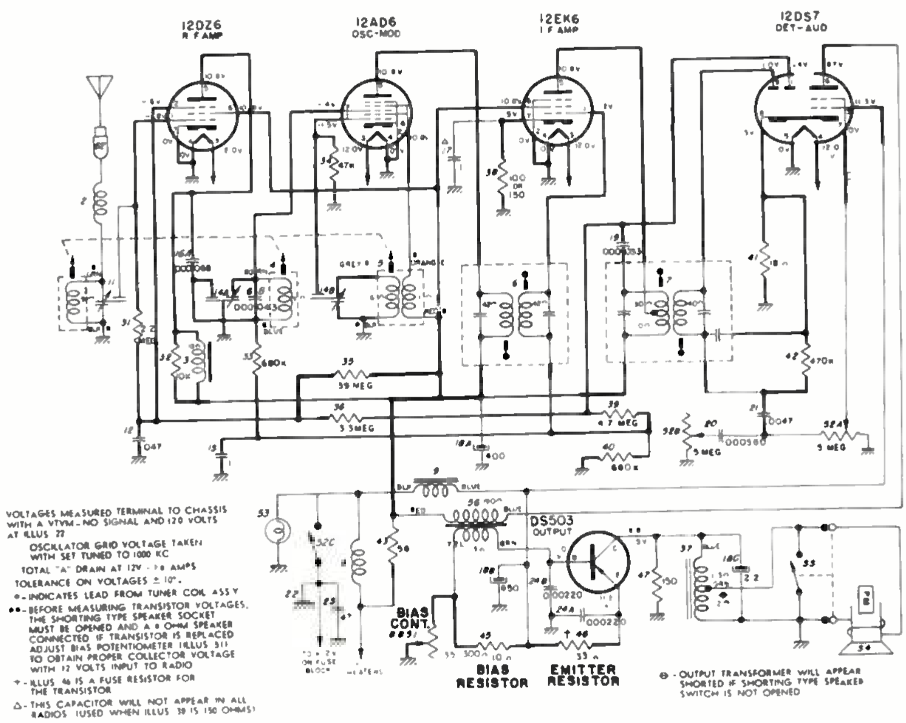
Re-installation this year is no better nor worse than last year. While the sets are perhaps a bit smaller, the space behind the dashboard is tighter. This of course means that a great deal more care must be exercised in preventing shorts when pushing the dashboard wires aside.

Removing the Receiver

The *Chevy* receiver is easier to remove if you follow instructions and remove the glove compartment first. The antenna trimmer on this car is where such trimmers should be: accessible from the dash. All you need do is remove the knobs on the right-hand control shaft. See Fig. 2. The antenna trimmer on the rest of the models, including the *Corvair*, is to be found on the side or the rear of the receivers.

Cadillac warrants special mention. If you succeed in removing this set in less than an hour the first time around you are in a class with Houdini. Here are the steps to be followed. See Fig. 3. Remove the upper instrument panel cover by removing the five screws found along the rear edge of the panel and pulling the panel towards the rear. Disconnect the harness; then disconnect the clock and the dash light from the harness. Remove the instrument panel bezel and the three screws holding the radio mounting panel to the heater bezel. Remove the ¼" bolt from the front right of the radio. Use a spanner wrench or long-nose pliers to loosen the nuts on the control shafts after the control knobs have been removed. Re-

Fig. 1. Chevrolet Model 988413. Heavy lines in schematic indicate printed circuit.



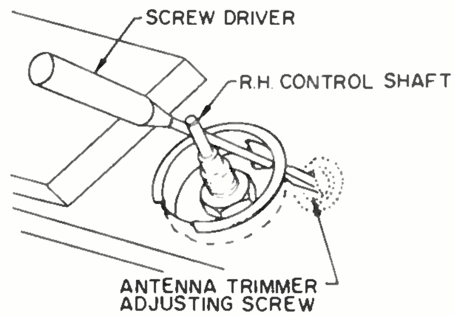
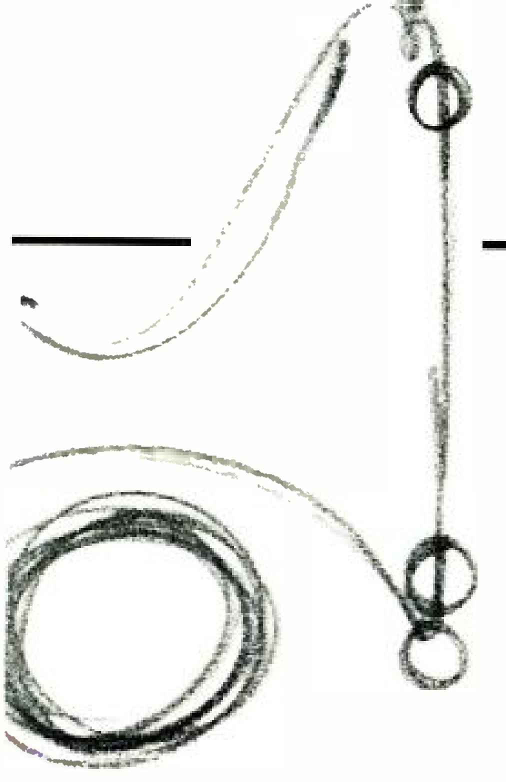


Fig. 2. Antenna trimmer is easily reached.



move the ¼" bolt from the rear of the set. Remove the dial light from the top cover of the radio (grey wire). Pull the radio up dial first, and set it on the panel. Unplug the multiple speaker plug and the rear speaker connector. Disconnect power and antenna leads.

The *Corvair* requires that the heater control assembly be removed before the receiver is removed for Models 988460 and 988468.

The *Buick* requires that the two screws holding the bottom of the radio be removed, and that the four screws holding the corners of the trim plate be taken out. Then the radio and the plate are pulled forward together.

The removal and the re-installation of the radios in other cars in the *GM* line is more or less standard.

Service Problems

Manual control will not actuate dial indicator nor affect the tuning. The receiver works fine, and the push-buttons will tune the stations in. The fault may be caused by a loose and slipping clutch. The set has to be "pulled." If this has occurred on a "Wonder Bar" receiver make certain that you do not permit the clutch to rotate while tightening it, otherwise the alignment between the seeking solenoid and the switches will have to be re-set. See Fig. 4.

Manual control is stiff and difficult to turn. Push-buttons are also stiff. This may be caused by wax coming out of a capacitor and falling on the tuning slugs. The unit will have to be disassembled and cleaned. Forcing the control may rip the coil right out of its grommet.

Ignition noise on re-installation. The set was quiet originally, but now it picks up considerable ignition noise. First try moving the dashboard wires away from the heat sink and transistor. In some instances noise will ride in on the dashboard wires and enter the set *via* coupling to the transistor and heat sink. If this is not the trouble, check for the usual causes of ignition noise: cracked plugs, loose ground connections on the existing bypass capacitors, loose antenna ground. Next try the antenna trimmer. This should peak rather sharply when it is tightened almost all the way down. If the antenna trimmer will not peak, there is a good chance that one of the r.f. tubes is shorted or otherwise defective. These sets have a lot of gain and will operate fairly satisfactorily without an r.f. stage in strong signal areas.

Popping noise when any of the lights or electrical equipment in the car are turned on or off. The noise may come and go with the weather and temperature. In most cases the noise is due to an intermittently defective filter capacitor. Tapping the can while the set is operating will often identify a bad capacitor. The entire can should be replaced.

The receiver is noisy, current drain may be erratic or excessive. Check for solder splatter across the edges of the spark plate and the chassis. Check for a cold solder joint at or around the "on-off" switch. Note, do not remove the spark plate as it is a very effective bypass for r.f. noise entering the set.

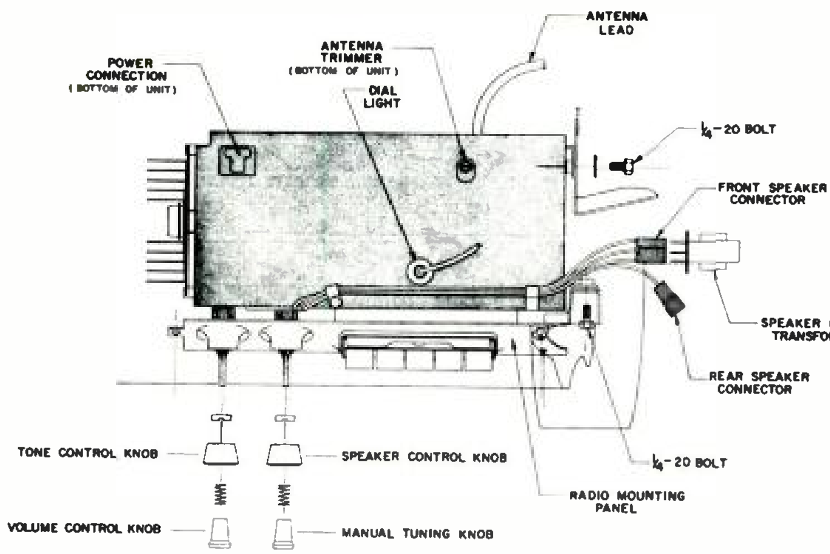
Drifts off station after warm up. This may be caused by a defective temperature-compensating capacitor in the oscillator circuit. To check, you need to bring the set up to its operating temperature. This can be done by covering the set while it is on the bench and operating it at 16 volts. If the radio drifts off station replace the compensating capacitor. This may be found on the printed circuit board, or beneath the metal plate that covers the dual trimmers, or built into the dual trimmers used with the compact push-button sets.

Receiver is intermittent, weak, and possibly noisy. The i.f. transformers appear to be the worst offenders. In some instances poor solder joints at the can terminals are to blame. In other instances too much solder heat at these terminals causes the plastic transformer base to deform and so loosen the contact on the internal printed capacitors. When replacing these transformers in a "Wonder Bar" receiver always use an exact replacement for the detector stage; otherwise the signal-seeker may not work properly.

Audio output very low. The tone is slightly distorted. Check the speaker plug to make certain that it is all the way in. These sets have a shorting switch on the output transformer. If the speaker plug is not all the way in, the output winding and speaker are

(*Continued on page* 105)

Fig. 3. View of the Cadillac receiver from above. Note location of the ¼" bolts.



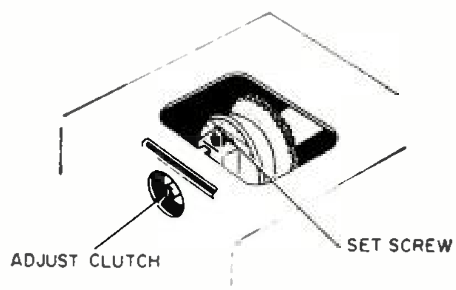
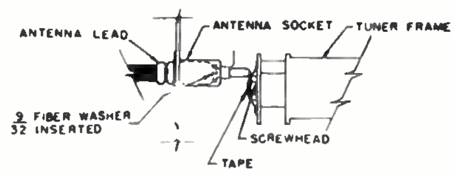


Fig. 4. When the clutch must be adjusted take care to keep the set screw vertical.

Fig. 5. Place a fiber washer on the plug and tape on the frame to prevent shorts.



LIGHTNING

Protection for the Ham Station

By **HOWARD S. PYLE, W7OE**

Some simple suggestions for the radio amateur who wants to play safe against the danger of lightning.

WE frequently read "safety tips" in connection with ham operation but, in most cases, these have to do with "man-made" electricity. Far too little attention has been given to the greater potentials of natural electrical discharges which we know as "lightning." Yet lightning is probably the most lethal of electrical discharges known to man. True, deaths from lightning do not approximate those caused by man-made electrical devices but it is a fact that lightning causes more deaths in an average year than either tornadoes or hurricanes. According to the National Bureau of Vital Statistics, an average of 230 persons per year lost their lives due to lightning in the ten-year period, 1946-1955!

Man-made electricity is relatively safe *if* proper safety precautions are observed. Lightning is entirely unpredictable and the safety measures against this hazard are woefully meager. Nevertheless, there are some steps which we can take to lessen the probability of lightning causing death or damage in connection with our ham equipment.

The National Board of Fire Underwriters has set up certain specific requirements for lightning protective devices in connection with overhead power lines and has likewise promulgated a number of rules governing radio installations of any class—including amateur. Disregard of these as well as of local ordinances could adversely affect your fire insurance coverage!

What is Lightning?

What is lightning? Briefly, it is a tremendous electric spark between areas where positive and negative electrical charges accumulate. When it is realized that an arbitrary figure given man-made electricity places a value of 20,000 volts as the potential required for a spark to jump *one inch* between needle points, it can readily be seen what a gigantic voltage it takes to cause a spark to jump from a cloud to earth—a distance of many *thousands of feet*.

Lightning discharges take place between two clouds, within a swelling cumulus cloud, or between a cloud and the earth. Accompanying thunder, which can seldom be heard more than about fifteen miles from the lightning stroke, can be disregarded from the angle of safety precaution. Thunder is merely a very rapid expansion of the air in the path of a lightning stroke and can be likened somewhat to the effect caused when a jet plane breaks the sound barrier. In itself it is ominous and annoying and may rattle a few dishes on the shelf, but it is relatively harmless.

When a great enough intensity has been built up between opposite polarities in the cloud layer, or between a cloud and earth, a lightning discharge will occur. This may be within the cloud itself, to an adjacent cloud, or to the earth—whichever offers the greatest potential difference. It has been reliably estimated that lightning strikes somewhere on the earth on an average of some *100 times per second!* In the United States, Weather Bureau records indicate that over a period of years central Florida has had the greatest number of thunderstorm days per year: an average of 100. Along the Gulf Coast, from Texas to Florida, from 40 to 90 thunderstorms are the annual average.

West Central United States shows from 40 to 70 such days each year with other portions of the country proportionately less. The West Coast of the United States ranks the lowest with an average of 10 days per year; the Rocky Mountain area, 20 to 30. All of these thunderstorms are not of major proportions—many are an almost imperceptible flash accompanied by nearly inaudible rumbles of distant thunder. Nevertheless, lightning, particularly that which is seeking a discharge path to the earth, does most peculiar things. Ordinarily, lightning will seek the highest object in its area, even though such an object provides relatively poor conductivity—a tall tree, for instance. A tall smokestack in the same area will usually offer a far better conducting path to earth but, in its unpredictability, lightning has frequently been known to ignore the chimney and choose the tree!

In earlier days and to a somewhat lesser extent in recent times, houses and barns were "protected" by an installation of heavy copper lightning rods and ground wire, connected to earth. Some scientists have advanced the belief that were lightning to make a direct hit on the rods, they would melt and the building would probably shatter and burn. The effectiveness of the lightning rod seems to lie, in their opinion, in providing a "static drain" so that lesser charges than those generated by a lightning bolt could be "bled off" and make the area around the rods and buildings thus protected, less conductive thereby diverting the direct lightning stroke to an object of greater conductivity. These beliefs still lack complete confirmation, however.

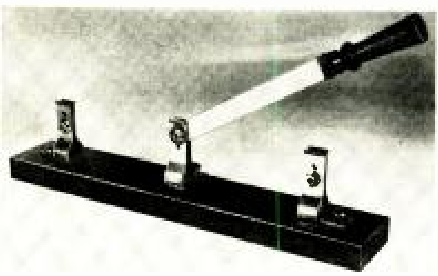
Antenna Protection

With this sketchy explanation of what little is really known about lightning would you, as a radio ham with a fair understanding of electricity, want to take chances with such a lethal force of nature? Would you pick up a bomb or hand grenade of which you were doubtful? Yet many hams do just that by inviting lightning to visit their antenna installations. With a tall, insu-

lated-base vertical radiator or with a horizontal wire antenna, either of which is often the highest structure in the neighborhood, aren't such hams asking for it?

Most vertical antennas require insulation from ground; some are of the grounded type which make relatively satisfactory static drains. Those which are *not* grounded, however, should be fitted with some sort of air-gap lightning arrester to provide a short path through the air for a lightning stroke to follow (if it will) in the event of a strike. Such gaps can take a variety of forms: two are shown in the accompanying diagram. They are adaptable to either single- or two-wire feeder systems. As electrical charges build up in the surrounding atmosphere, very frequently small sparks can be seen to jump the air gap on such arresters. They are then serving as static drains and may help in avoiding a direct stroke when the lightning has built up to a point of complete discharge.

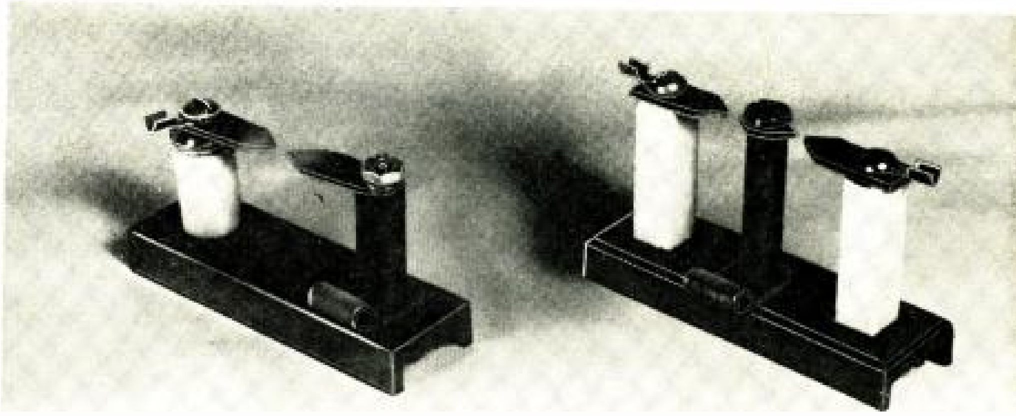
Conventional horizontal-wire antennas are subject to the same treatment. On very low-powered rigs, such as the 75-watt input Novice limit, some of the ordinary receiving-type lightning arresters will prove satisfactory. Many, however, are so adjusted that transmitted r.f. is bypassed to ground each time the key is pressed, thus destroying



A 60-amp. lightning ground switch for single-wire lines. For two-wire lines a double-pole, double-throw switch should be utilized.

the radiating quality of the antenna system. The type of lightning arrester containing neon or similar gas through which atmospheric discharges will readily pass should be avoided for transmission purposes. They are suitable for use with receivers but, again, transmitted energy of even the Novice low-power limit, will break down the gas and bypass the radiated signal to ground. It is far better to use something like the air gaps illustrated and be *sure* of protection without shorting your output.

Coaxial cable, used as a transmission line, presents no particular problem insofar as lightning protection is concerned. It is often buried in the ground which, in itself, is pretty adequate lightning protection. Ordinarily, in a workmanlike installation, the braided shield of the coax is grounded both at the transmitter and at the antenna end. Little can be added if such is the case other than to caution against *soldering* a ground connection to the shielded braid. It is OK if the cable is "pig-tailed" but where a ground connection is attempted *without* separating the



Two types of lightning arresters described in text. The one at the left is for single-wire lines, the other one is for two-wire open lines. The mounting base should be Transite, asbestos material, or a similar rigid fireproof substance.

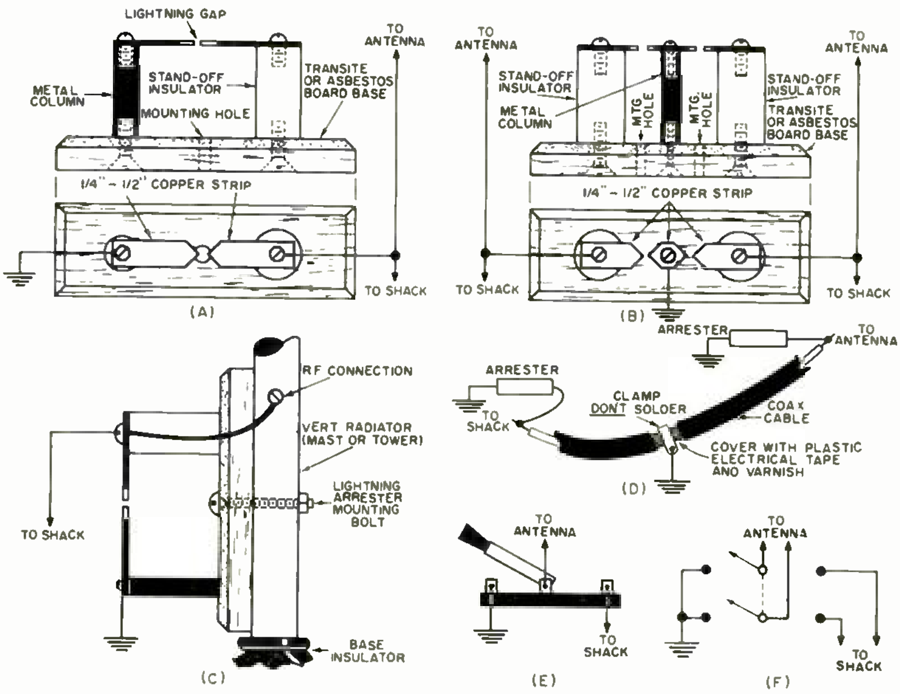
braid from the inner conductor insulation, *don't* solder it. Use a clamp, as shown in the diagram. *Cold* solder or liquid aluminum may be used over the clamp but to hot solder it would destroy the insulation of the inner conductor. Such a ground connection should be covered with a good grade of plastic electrical tape and two or three coats of good varnish applied over the entire connection, to prevent corrosion.

Lightning grounds should be as heavy as possible. The ground wire size should be large—at least #10 and preferably #8 or #6. While driven ground rods will serve for ground contact, several of them should be provided—all bonded together. Better yet, bury as large a sheet of metal, preferably copper although galvanized iron will serve, at a depth of not less than three feet and an area of six square feet or more.

An ordinary single- or double-pole, double-throw knife switch of at least 60-ampere capacity can serve as a ground switch on the outer wall of the building. This has the disadvantage, however, of making it incumbent on the operator to throw it to the ground position during thunderstorms and when the equipment is not in operation, if he remembers to do so! The gaps illustrated in the diagram are more desirable from this standpoint as they are "automatic" although they are not continually connected to ground but depend on atmospheric electricity to seek ground through them. The gaps on such protective devices should be set as close as possible without permitting flashover when the transmitter is keyed on its highest input power. Ordinarily the gap should not exceed 3/16" but can be much closer with low-powered transmitters.

Play safe! Have respect for lightning which *may* encourage it to have a small measure of respect for you. Although there are limits to the protective measures effective against lightning, it behooves you to take whatever precautions *are* available. —30—

(A) Construction of lightning arrester for single-wire and (B) two-wire open lines. (C) Installation of arrester at bottom of vertical radiator and (D) in conjunction with coax cable. (E) Connection of s.p.d.t. and (F) d.p.d.t. grounding switches.



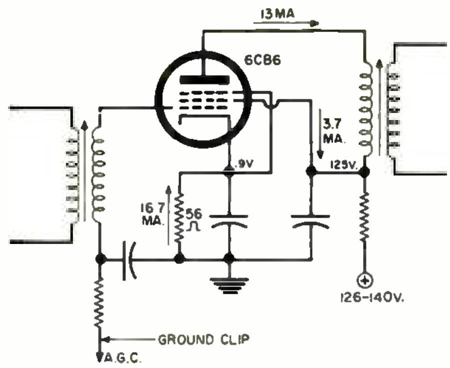


Fig. 1. The cathode voltage reading is a clue to operation of an i.f. amplifier.

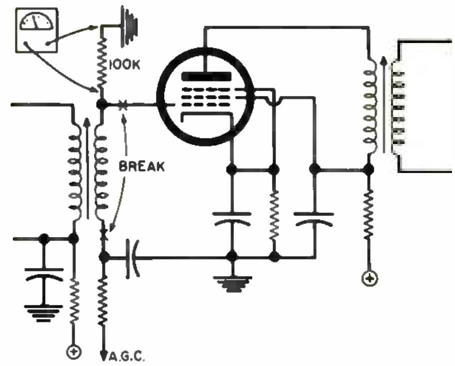


Fig. 2. A meter check for leakage between windings of an i.f. transformer.

SPEED-CHECKING I.F. SYSTEMS

By DARWELL H. WEBSTER

You can get a picture of operation in TV and radio i.f. stages without elaborate tests.

WITH THE exception of occasional tube failure, the i.f. system of a radio or TV receiver rarely presents a serious servicing problem. However, many older sets can be made to perform much better if a little attention is devoted to this part of the circuit. There are also cases where a breakdown elsewhere in the receiver will be reflected as apparent misalignment or malfunction of the i.f. section. For such reasons, a method of quickly checking out this part of the set is desirable. The following steps can be used.

The first check, assuming the heater circuit is functioning properly, should be of the voltages present in each stage. During these tests, connect an alligator-clip lead between the a.g.c. (or a.v.c.) line of the i.f. strip and circuit "B−." With the a.g.c. line short-circuited, the circuit voltage readings can be used to determine the relative condition of the tube, the resistors, and the possible presence of leaky bypass capacitors in each stage. As an example, according to reference tube manuals, a 6CB6 with a 56-ohm cathode-bias resistor and 125 volts "B+," the usual conditions of use, should have plate and screen-grid currents of approximately 13 and 3.7 ma. respectively (Fig. 1), making a total cathode current of approximately 16.7 ma. The voltage drop across the cathode-bias resistor should therefore be approximately .9 volt.

If this voltage is lower by more than 15 to 20 per-cent, the plate and screen-grid voltages should be checked. If these voltages are normal, disconnect one end of the cathode bypass capacitor, if one is present. A normal voltage after disconnecting this capacitor would indicate that the latter is leaking. The tube may have low emission and should be replaced if the other tests fail to raise the cathode voltage to normal. (Note: These tests are made with the receiver *not* tuned to a station.)

In the event the cathode voltage should read high, check the plate, screen-grid, control-grid voltages. Normal voltages at these points (*e.g.*, control grid = 0 volt, plate and screen grid = 110-140 volts) indicates that the cathode-bias resistor should be checked, for it may have increased in value. If not, try replacing the tube.

A slightly positive voltage on the control-grid would indicate that the tube may have an internal leakage between elements. Should the positive voltage still be present on the control grid after tube replacement, check the coupling capacitor which is sometimes between i.f. stages, for it may be leaking. In radios and some television receivers, a slightly positive grid voltage may be caused by leakage between the primary and secondary of the i.f. transformer. Disconnect the two secondary leads of the transformer, connect a 100,000-ohm resistor between one of these leads or points to circuit "B−" and measure for a voltage across the resistor. The presence of a voltage here (Fig. 2) would confirm leakage in the transformer.

Should *all* the voltages at a given i.f. amplifier check low, it will be an indication that the "B+" line may be low, the plate decoupling resistor has increased in value, or the plate decoupling capacitor is leaking.

Problems with Series "B+"

In some i.f. circuits, two consecutive stages may be in a series "B+" arrangement (as shown in Fig. 3), that is, the tubes may be in series across the "B+" line (approximately 260 volts, in this case) so that about 130 volts is normally dropped across each stage.

If the tube (V_2) in the upper half of the stacked or series arrangement should have poor emission, its effective resistance would be increased and the voltage drop across this stage would therefore also increase. This, in turn, would leave less voltage available for the tube in the lower half of the series "B+" divider, V_1, and the latter could not function properly. In such a configuration, therefore, voltages in the upper-half tube should be checked first.

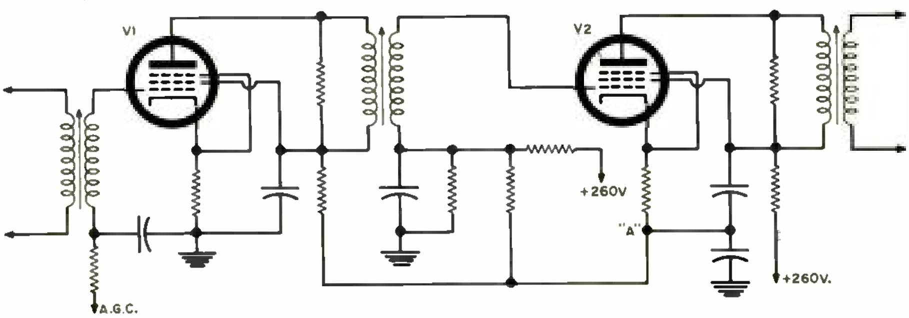
However, before taking voltage readings in this stage, V_2, note that this circuit "sees" point *A* as its "B−" point. Measurements should therefore be made with the meter's ground clip connected to *A*. Using this as the reference point reduces confusion in evaluating readings.

For example, suppose that the first check, at the tube's cathode, is to be made, and that the normal drop across the cathode resistor is .9 volt. If the stage is operating properly, a cathode reading referred to point *A* will be exactly .9 volt. If this reading were taken with reference to the receiver's normal "B−" point however, a normal reading might be 130.9 volts with point *A* actually being 130 volts above "B−." Such readings would be difficult to interpret.

In-Circuit Bypass Checks

It normally would be highly unprofitable to disconnect and check, individually, all the i.f. bypass capacitors for

Fig. 3. Consecutive i.f. stages may have a "stacked" or series "B+" arrangement.



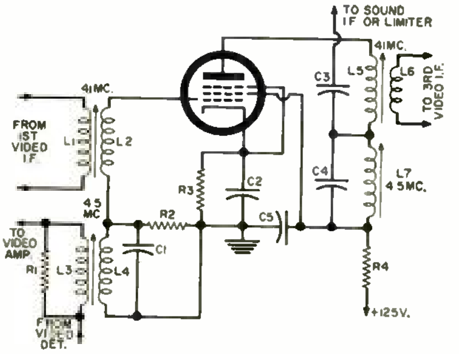


Fig. 4. TV reflex circuit serves as separate video and audio i.f. stages.

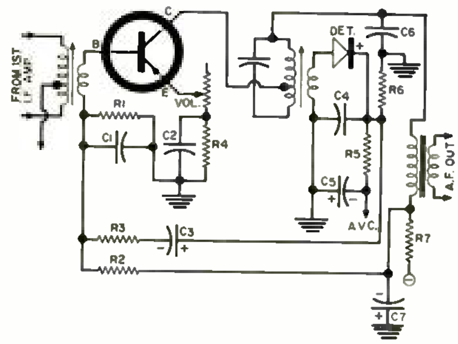


Fig. 5. The reflex circuit, as used in a transistorized portable radio, separately amplifies i.f. and a.f. signals.

opens. Besides, the best test for any component is in the circuit where it is used. A fast test for locating possible open bypass capacitors requires only an AM signal generator, an oscilloscope, and a scope demodulator probe. A relatively large modulated signal at the center of the frequency band for the i.f. section under test is applied to the grid of the first i.f. amplifier stage. The oscilloscope demodulator probe is then used to determine the relative signal present across each bypass capacitor. There will normally be a small indication on the oscilloscope even with good capacitors, for the probe will tend to pick up some signal from nearby coils and signal leads. However, when an open bypass capacitor is located, there will be a relatively large indication on the oscilloscope. This test should first be performed on a good receiver, observing the normal amplitude of the signal across a good bypass capacitor, and then disconnecting the component and mentally recording the change in amplitude of the signal at that point in the circuit. This should be done wherever bypassing is used, whether in plate, screen, or cathode circuits.

Reflex Circuits

In Fig. 4 we see the type reflex i.f. circuit used in some television receivers, and in Fig. 5 a transistor version used in some portable radios. In these circuits, the bypass capacitors are much more critical than in a regular i.f. stage. We will briefly discuss why this is so before presenting servicing procedures.

In the vacuum-tube reflex circuit (Fig. 4), the tube first amplifies the video i.f. signal, as does any other video i.f. amplifier. The signal is later demodulated in the video-detector circuit and the 4.5-mc. sound i.f. signal is transformer-coupled (L_3 and L_4) back to the grid of this same tube, where it is amplified and fed to the limiter or sound detector. From this it can be seen that the tube is functioning as a video i.f. amplifier (41 mc.) and a sound i.f. amplifier (4.5 mc.) at the same time.

At the video i.f., capacitors C_1, C_4, and C_5 provide bypass action, resulting in the equivalent circuit shown in Fig. 6. At the sound i.f., L_2 and L_5 offer little opposition to the signal and the equivalent circuit shown in Fig. 7 becomes effective. Note that while C_1 and C_4 act as bypass capacitors for the video i.f. signals, they are part of the 4.5-mc. resonant circuits for the sound i.f. signals.

Should C_1 open, both sound and video would be weak, with the sound being more affected than the video. With C_1 open, the video i.f. signals would see a high-impedance grid circuit. This would result in less gain. The sound i.f. signal, after being brought back from the video detector, would not be feeding its usual resonant tank circuit, and the amplification of the 4.5-mc. signal would be much less than normal. Similar conditions would exist if C_4 were to open.

C_5, when open, will reduce the over-all gain of both signals as a result of the degenerative effect of R_4, and the symptoms will also be similar to those occurring when C_1 or C_4 is open. C_1 and C_4 can be checked for open by performing the test for open bypass capacitors, with the signal generator set to the center of the video i.f. amplifier's band. C_5 can likewise be tested for open, at either the video i.f. or at the 4.5-mc. sound i.f.

In the transistor reflex amplifier (Fig. 5), C_1 and C_6 act as i.f. bypass capacitors, while C_7 acts as the audio bypass. Should C_1 or C_6 open, the gain of the stage at the intermediate frequency will decrease while the audio gain will remain essentially unchanged. Therefore, C_1 and C_6 should be checked for open at the i.f. and C_7 at the audio frequency. This can be done rapidly by feeding in a modulated i.f. signal and observing the probe-detected signal across C_1 and C_6 on the scope *with one end of C_3 disconnected* to prevent the audio from the receiver's detector from being present across C_1 and C_6 and possibly giving false indications. If C_1 and C_6 are thus found to be functioning properly, reconnect C_3 and, with a direct scope probe, check for audio across C_7. The presence of an audio signal here indicates that C_7 is either open or has lost capacitance.

Other Hints

The final check, of course, is the i.f. section alignment. The procedure for this alignment will not be outlined here, as the best method for each model is normally given in the servicing data for that receiver.

To help in spotting receivers with possible i.f. or tuner weaknesses, it has been found beneficial to make a small chart indicating the approximate a.g.c. voltage to be expected in a receiver with various circuit combinations on various channels. (Example: cascode r.f. amp, 3 i.f. stages, keyed a.g.c.—Ch. 8 = 2 volts, Ch. 13 = 3 volts.) With such a chart, the technician can quickly determine whether the i.f. section of a TV receiver is up to par by measuring a.g.c. voltage on two channels. A similar technique, using two or more broadcast stations, can be used on radios.

The i.f. section of a radio or TV receiver is much more critical than many technicians believe. Slight changes in alignment, resistance values, or voltages, or the presence of leaky or open bypass capacitors, can mean the difference between an old "worn-out" receiver and one which compares favorably with a new unit. Therefore, a few minutes of corrective effort may increase the value of a used receiver which is being reconditioned for resale or increase your customer's confidence in his service technician's ability. –30–

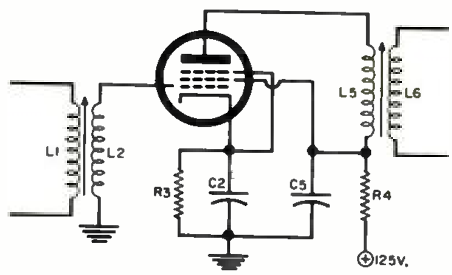
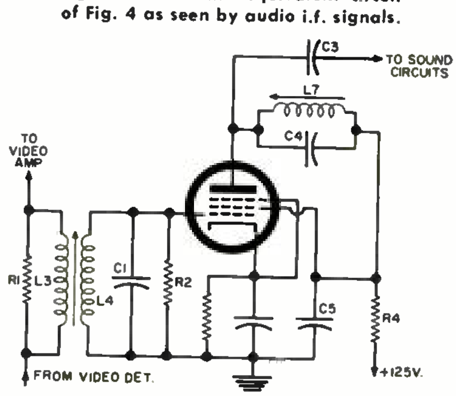
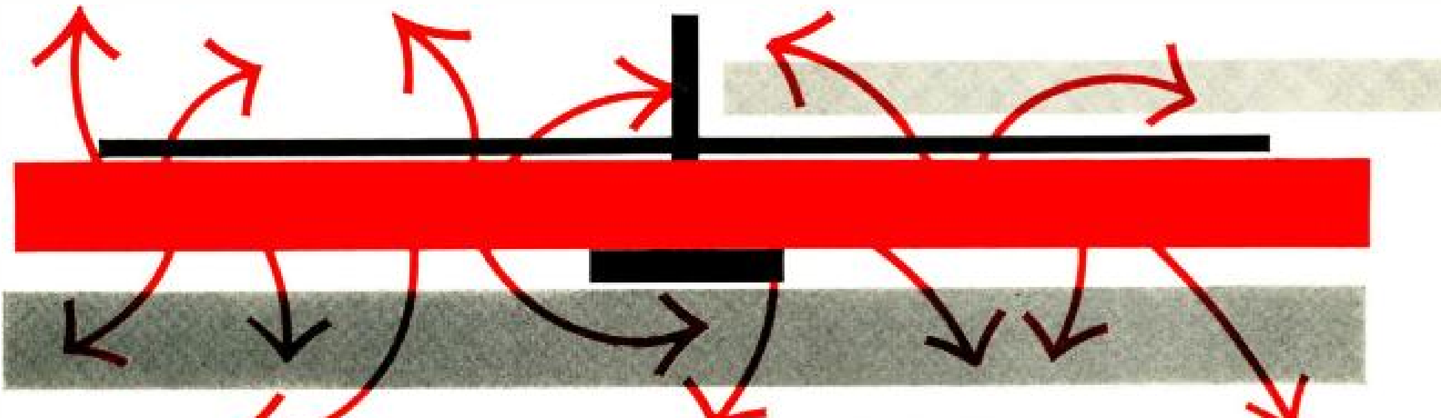


Fig. 6. This equivalent diagram shows how the circuit of Fig. 4 looks to video intermediate-frequency signals.

Fig. 7. This is the equivalent circuit of Fig. 4 as seen by audio i.f. signals.



Rumble Filters For Stereo



THEIR DESIGN & USE

By ROBERT W. TIMMERMAN

How to build a practical high-pass filter circuit employing a 40-cps cut-off in order to reduce rumble.

LOW-FREQUENCY noise or "rumble" has been a recurring problem in disc sound recording and reproduction. If we define rumble as undesired sound or noise at frequencies below about 120 cycles-per-second, it is obvious that the problem was non-existent in the early days of recording, that is, before about 1930. Until the widespread use of vinyl disc pressings in the late 1940's, *high*-frequency record surface noise (hiss) was much more annoying than the low-frequency disturbances which must have been increasingly present with the improvements in loudspeakers and amplifiers that were taking place. For a time rumble, introduced largely by mechanical defects in the turntable drive, became sufficiently noticeable to focus attention on the need for improved turntables and changers. The improvements were forthcoming and the magnitude of rumble disturbances dropped to the point where they were all but forgotten until the recent more general use of really good low-frequency speakers.

Stereo disc recording, with groove modulation in any direction rather than the former single plane, as well as somewhat lower recording levels, has reopened the question of turntable construction. It is probable that all except the latest equipment was designed to minimize only lateral rumble, as the principal requirement of lateral, monophonic recording. Thus the seriousness of low-frequency noise in relation to other technical factors tends to change with time as developments and improvements occur in individual components. We now have a condition of technical advance, probably temporary, that encourages attempts to reduce rumble at the point of reproduction, by some means short of scrapping our expensive turntables. The present discussion is restricted to consideration of electrical filters to achieve this result.

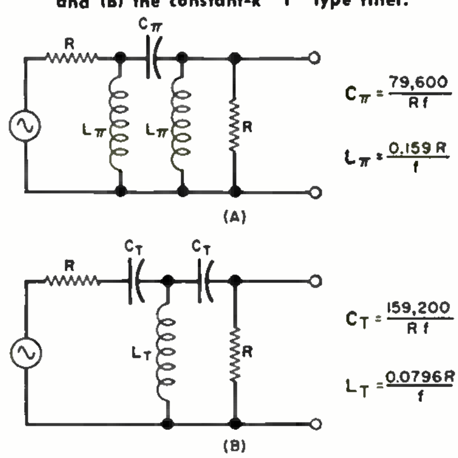
The effectiveness of selective filters in improving the signal-to-noise ratio depends entirely on the nature of the signal and the noise. If either is in the form of constant single, or relatively few, frequencies, separation may be readily obtained. Unfortunately, neither of these cases fits a wide-range sound system, where the desired signal may be anything within audibility, and the noise may be a thump, bump, throb, or at worst, roar, different in each system and changing with time in a given system. Suppression of all output below a fixed, preselected frequency has become generally accepted as the optimum compromise for improving signal quality at the low end of the spectrum. Benefits from this high-pass filtration are contingent upon the assumptions that the undesired noise is concentrated within the eliminated band and that the desired signal becomes progressively less valuable as frequency decreases.

The first assumption is more-or-less valid and can be supported by measurements. The value of signal in this region is highly subjective, since a person may be willing to tolerate a continuous background noise in order that the cannon blasts (or 32-foot organ tones) on one record of his collection will sound forth unattenuated, while another person may prefer a quieter background, knowing that 99.9% of the music is coming through. The dilemma is sharpened when one recalls that a large portion of the money he has paid for a sound system is for its ability to reproduce those deep, low-pitched sounds below about 100 cps.

Certain reasonably specific advantages can be cited for high-pass filters in an audio system. Subsonic frequencies, such as those which could be introduced by eccentric records or idler wheels, irregular disc surfaces, or FM tuner transients would not, in themselves, affect the audible result, but if they should be fed to the amplifier in major magnitude, the electrical overload can adversely affect not only the power stage, but can drive other stages unnecessarily into non-linear response regions.

From the observations thus far we conclude that a high-pass filter can be a desirable part of an audio playback system. The selection of cut-off frequency remains to be made. As the first step toward that decision, let us investigate some of the possible interfering frequencies.

Fig. 1. (A) Constant-k "Pi" type filter, and (B) the constant-k "T" type filter.



Interfering Signals

The a.c. power line 60-cycle hum is a common offender, which might be dismissed as something that is just not present in a good system in the first place. Granted that 60-cycle interference is usually low in level, we certainly welcome any further reduction of it. We must note here that nothing can be done against the harmonics of line frequency, which sometimes are as troublesome as the fundamental. A typical record changer or moderate-quality single-play turntable employs a shaded-pole induction motor operating at around 1550 rpm, or 26 revolutions-per-second. Slight rotor unbalance or an eccentric drive pulley can introduce a nice tone at this fundamental frequency. It is also true that the torque of a single-phase induction motor varies at twice the line frequency. A hysteresis motor or a three-phase power drive would eliminate the last named variable, but they are more drastic measures than we contemplate here.

Pickup-arm resonance is a property which does nothing of itself, but is always there, ready to be excited by passing signals. The resonant frequency of present pickup systems is usually in the 10-20 cps range.

A turntable drive which employs an idler pulley (typically 1½ to 2 inches in diameter) is subject to the effects of irregularities in that element, which turns at 3 to 4 rps. As the ultimate in potential cyclical disturbances, we mention record groove eccentricity, 0.56 cps at 33⅓ rpm.

The significance of these sources of rumble is analyzed as follows: Frequencies below the pickup arm resonance may be disregarded as unlikely to cause

f (cps)	20	40	80
R = 1500Ω			
L (hy.)	5.96	2.98	1.49
C (µf.)	5.31	2.65	1.33
R = 1800Ω			
L (hy.)	7.16	3.58	1.79
C (µf.)	4.41	2.21	1.11
R = 2200Ω			
L (hy.)	8.76	4.38	2.19
C (µf.)	3.62	1.81	0.91

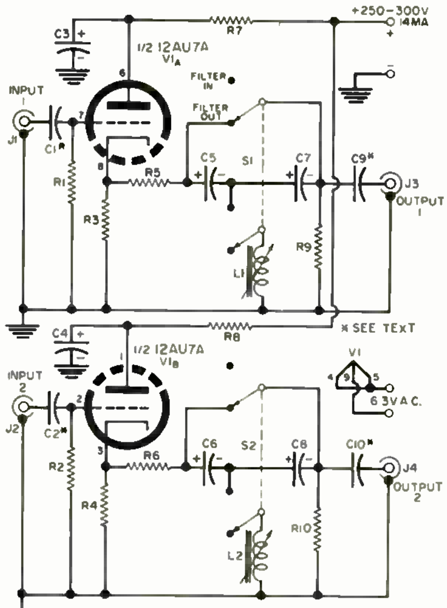
Table 1. Circuit constants for "T" filter.

trouble, since the stylus compliance and arm mass provide mechanical filtering action (good!). Thus about 15 cps is the lowest electrical cut-off of interest at the present state of the art.

To suppress a 26-cps motor vibration would require a filter cut-off not lower than about 40 cps. Published data[1] indicates that a lower limit of 40 cps will satisfy a critical listener to "very loud" symphonic music under home conditions. The data on which that conclusion was based was gathered some time ago, and perhaps present critical listeners are harder to satisfy, but if we accept 40 cps as the optimum compromise, a fairly easy decision has been reached. Unfortunately this does not touch 60-cycle hum, but the author's observations are that most so-called 60-cycle hum is rich in harmonics and elimination of the fundamental would make practically no audible difference. In the following section, 40 cycles will be used for the filter design example, although the reader may select his own frequency if tests of other cut-offs may be desired.

Filter Design

Principles of electric filters are covered in standard texts,[2] and will not be dwelt upon here. After studying the characteristics of several types, the writer concluded that the constant-*k*, *LC* filter offers the most for the least, considering sharpness of cut-off, complexity of construction, and ready availability of parts. There are two configurations of this basic filter type, generally called the "Pi" and "T" types, after the appearances of their circuit diagrams.



R_1,R_2—470,000 ohm, ½ w. res.
R_3,R_4—1000 ohm, ½ w. res.
R_5,R_6—1200 ohm, ½ w. res. ±5%
R_7,R_8—10,000 ohm, ½ w. res.
R_9, R_{10}—1500 ohm, ½ w. res. ±5%
C_1,C_2,C_9,C_{10}—.1 µf., 200 v. capacitor (see text)
C_3,C_4—10 µf., 450 v. elec. capacitor
C_5,C_6,C_7,C_8—2.7 µf., 50 v. elec. capacitor
S_1,S_2—D.p.d.t. switch
L_1,L_2—3 hy. filter choke (UTC VIC-15, see text)
J_1,J_2,J_3,J_4—Phono jack
V_1—12AU7A tube

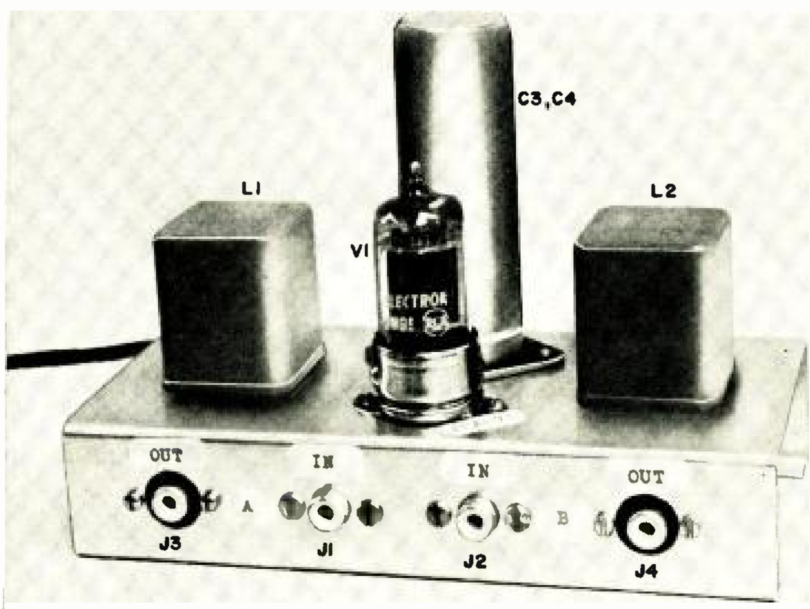
Fig. 2. Stereo rumble-filter circuit.

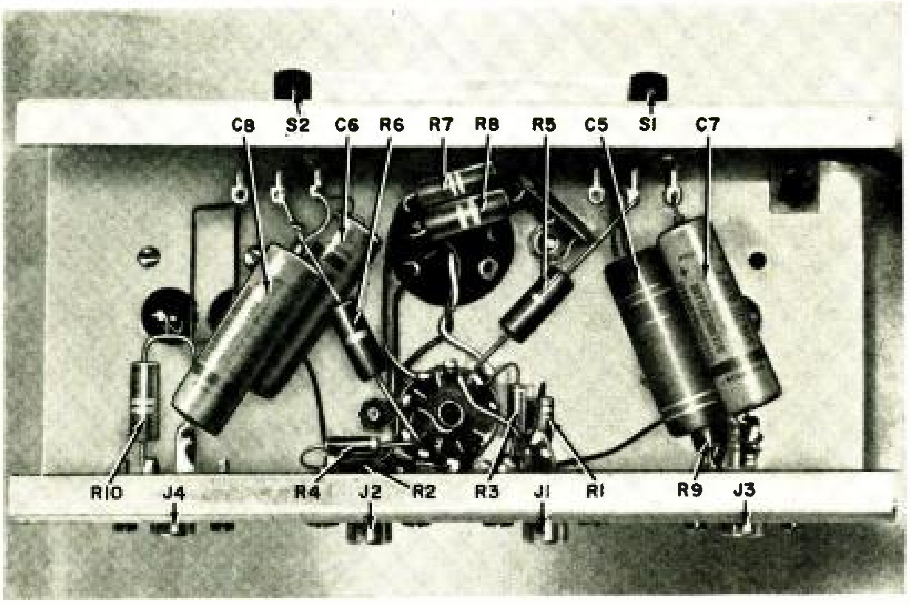
Elementary diagrams of the two types are shown in Fig. 1, together with the mathematical formulas interrelating the respective *L*, *C*, and *R* values. Overall characteristics of the two types are electrically identical. For the reader who may be interested in the basis for the formulas, they are developed in a lucid manner by Sheffield.[3] In Fig. 1, *R* is in ohms, *C* in microfarads, *L* in henrys, and *f* in cycles-per-second. Note that for any specific value of *f*, the value of only one of the three circuit constants may be independently set.

Selection of the configuration and practical constants is based primarily on economics. In general, costs rise with increasing *L*, increasing *C*, and decreasing *R*. The influence of *R* in this way is indirect, as related to the signal source impedance. Since low-impedance electronic circuits impose penalties in construction and operating costs, one should set *R* at a readily obtained value. A standard triode cathode-follower can be designed to have an output impedance of about 300 ohms, hence we shall design a filter to go with such a circuit. To minimize the effects of circuit loading, *R* should be at least five times the source impedance, or 1500 ohms here. A parts catalogue quickly reveals the fact that high-quality inductors are more expensive than comparable capacitors. This leads to choice of the "T"-type filter, as it requires one inductor compared to the "Pi" type's two. For a "T" filter to match $R = 1500$ ohms at $f = 40$ cps, the formulas in Fig. 1B show that *L* and *C* must be 3.0 henrys and 2.7 microfarads respectively. The effects of variations in *R* and *f* are shown in Table 1, where *L* and *C* values are given for a range of characteristic impedances and cut-off frequencies.

Sharpness of cut-off is determined by quality of the components used, hence a brief survey of that subject is desirable. Resistors are no problem at the frequencies and signal levels involved here, and ordinary composition units are satisfactory. The best available (*i.e.*, highest "*Q*") inductors are none too good for this particular service. A high-permeability toroid-core unit should be selected if funds are available. An added advantage of toroidal construction is the negligible hum pickup from external fields. Other, less costly, inductors can be used with fairly good results, as noted below. Capacitors are relatively uncritical as to quality. The writer has tried a variety of junk-box capacitors in these circuits, and all appear to work well, including good-grade electrolytics. To

The home-made stereo rumble filter built by author. Note the two tunable chokes.





Under-chassis view. The output and input coupling capacitors, C_1, C_2, C_9, and C_{10}, are not incorporated in the unit itself as they are found in associated amplifiers.

secure optimum performance, the *R*, *L*, or *C* of each component should be as close as possible to its calculated value; practically, 5% tolerance is close enough. When designing a filter, the controlling component will logically be the one which is already on hand, is least readily changed, or which is available only in wide-tolerance values. That unit would be measured, then the required values for the associated parts would be calculated and procured to match.

The design and construction of a practical filter unit will be described. This is a stereo rumble filter using moderately priced parts.

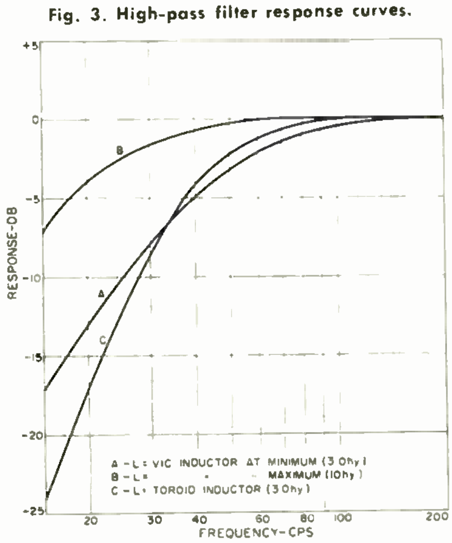
Stereo Rumble Filter

Photographs of the completed stereo filter unit are shown and the circuit diagram is given in Fig. 2. The filter sections are built around *UTC* inductors of the VIC series. The "*Q*" of these units is lower than for toroids, but so is the price. Midget, low-voltage electrolytic capacitors are used. A random lot of four nominal 2-μf. units were measured and found to be 2.7 μf., ±5%, thus they were just right for the 40-cps example developed in an earlier paragraph. The inductors (*UTC* VIC-15) are variable from about 3 to 10 henrys, and therefore are adjusted to minimum inductance for the present filter. This range of inductance adjustment was selected in anticipation that easy tuning to lower cut-off frequencies might be possible, although probably at a sacrifice in cut-off sharpness resulting from the mismatch of values under that condition.

The two triode sections of a 12AU7A tube are used as cathode-followers, each designed for an output impedance of about 300 ohms. The 300-ohm output in series with a 1200-ohm resistor results in the required 1500-ohm source for feeding the filter section. The filter is loaded by a 1500-ohm resistor. Provision is made to switch the filter in or out of service by means of a double-pole, double-throw switch in each channel. To disable the filter, the capacitors are shorted and the inductor is disconnected, leaving a purely resistive voltage divider with the same output as the passband of the filter. In the author's unit simple slide switches are used, ganged by means of a metal bar connecting the two slide buttons. Of course, a rotary or a lever-action switch is usable, or the switching feature may be omitted entirely.

The effects of the filter and cathode-follower here result in an over-all insertion loss of about 9 db, corresponding to 0.35 voltage gain. If the amplifier with which the filter is to be used has insufficient reserve gain to make up for this loss, another voltage amplifier stage will have to be added, or the amplifier otherwise modified. The filter should be inserted as near to the input of the amplifier as possible, preferably just after the input function selector switch, where signal level is around one volt. A point just before the power amplifier is probably more convenient in many systems, and that should be satisfactory.

Fig. 3. High-pass filter response curves.



Response curves for each channel of the stereo filter are shown in Fig. 3. Curve A is with the VIC-15 inductor adjusted to the calculated value of 3.0 henrys. Although the nominal cut-off frequency is 40 cps, the actual cut-off (arbitrarily defined as the –3 db point) is 52 cps, and the curve straightens out to a slope of 9 db per octave below about 30 cps. Curve B shows the effect of adjusting the VIC-15 to its maximum inductance, changing nothing else in the circuit. The cut-off has shifted down to 23 cps and the shape of the curve has not suffered seriously as far down as it was examined (15 cps). Thus we have a useful adjustment that permits reasonably easy selection of the optimum cut-off frequency for a given installation.

To determine the effect of higher "*Q*" inductance, a 3.0-henry toroid coil was temporarily substituted in one channel of the Fig. 2 circuit. The resulting response is plotted as Curve C in Fig. 3. Using the toroid coil, the roll-off begins at a lower frequency, but reaches a steeper slope of 16 db per octave, resulting in greater attenuation below 34 cps than is achieved with the VIC coil. Further substitution of oil-filled capacitors for the electrolytic units gave a response indistinguishable from Curve C.

The curves in Fig. 3 were measured with flat response from the preceding amplifier stage to the cathode-follower, and flat response to the stage following the filter. Some additional high-pass filter action can be obtained by proper choice of *R* and *C* values in the respective coupling circuits. For example, replacement of the 0.1-μf. capacitor at the input with 0.02 μf. will result in additional attenuation of about 3 db at 15 cps without noticeably affecting the response above 50 cps. The output coupling capacitors may be similarly chosen.

Output coupling capacitors are shown in the circuit diagram of Fig. 2 to call attention to the fact that isolation from the following grid must be provided. It is preferable, however, that these capacitors be located close to the input of the following stage, particularly if the line is more than a few inches long. By this arrangement the advantages of the low filter output impedance are retained.

In conclusion, the writer has found that the practical performance of the circuit described here justifies its use. Rumble for a certain old turntable is audibly reduced with the cut-off set at 40 cps, although there is practically no difference in the sound of normal orchestral music. Surprisingly good sound is obtained even with an 80-cps cut-off. This last statement may seem to border on heresy, but the reader is invited to try it for himself.

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2. *Terman, F. E.: "Radio Engineers' Handbook," Section 3.*
3. *Sheffield, B.: "Filter Design Simplified," Audio Engineering, March, May 1951.*
4. *Markow, E. W.: Audio Engineering, November 1952, p. 27.*

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A D.C. VOLTAGE CALIBRATOR

An easily built standard uses a low-cost cell to provide 9 precise, well-distributed voltages.

By G. H. MORGAN

HOW OFTEN have you wondered about the accuracy of the readings you are taking with your v.t.v.m. or v.o.m.? Good secondary standards suitable for checking the calibration of test instruments are not generally available to the service technician and are usually too expensive to buy.

Certain batteries, however, have properties which make it possible to use them as d.c. voltage standards for precision that is much greater than that needed by service shops. Furthermore, it is the d.c. voltage calibration of a meter that is generally required to have greater accuracy than its other functions. In addition, a reliable d.c. standard can be used indirectly to calibrate other meter functions or other types of instruments, if desired.

As to battery properties, the mercury cell, for example, has a very uniform discharge voltage over its useful life, as indicated by Fig. 1. For light loads (like the one imposed in this application), the curve is almost a horizontal line. For calibration purposes, the duty cycle is so intermittent that the total hours of useful service approach the storage life of the battery, which is several years. Accordingly the standard cell chosen for the calibrator is the *Mallory* RM1R, which is rated at 1.35 volts output and is small and inexpensive.

Fig. 2 is the schematic of the instrument, which provides accurate d.c. calibration voltages from .03 volt to 100 volts. It uses precision (1 per-cent) resistors in a voltage-divider network consisting of resistors R_1 through R_{12}. A regulated d.c. voltage is supplied to the entire divider through calibrating potentiometer R_3.

To set the calibrating pot, a null indicator is connected between the terminals marked "Meter." The indicator itself does not have to be a highly accurate device. A v.t.v.m. with a zero-center scale will be more than adequate, and the polarity with which it is connected is not important. If the voltage applied across the entire divider (100 volts) is accurate, exactly 1.35 volts d.c. will appear at the take-off terminal for calibration purposes. Since this is the output of the reference battery, a null is indicated. Accordingly R_3 is adjusted until a null is obtained. When this is done, all points along the divider will be accurately set to the indicated voltages, within the limits of accuracy of the divider resistors.

The meter (or other instrument) to be calibrated is then connected to the terminals marked "Output" and the voltages required for calibration are selected by range switch S_2. Correction factors can then be recorded for those ranges or portions of the dial where significant deviation is noted, and the instrument may then be used to obtain readings of greater accuracy than those provided in its original design.

Construction and Parts

Straightforward construction is used throughout and the arrangement of parts is not critical. For convenience in wiring, the author placed the power supply on a subchassis which, in turn, was mounted in an aluminum chassis box 6 inches by 8 inches by 4½ inches. A rotary switch was used for S_1 so that both control knobs (R_3 & S_1) would give uniform appearance; a simple toggle switch could be used instead.

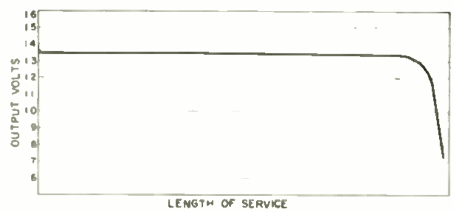


Fig. 1. Life curve of a typical mercury cell shows stability of output voltage.

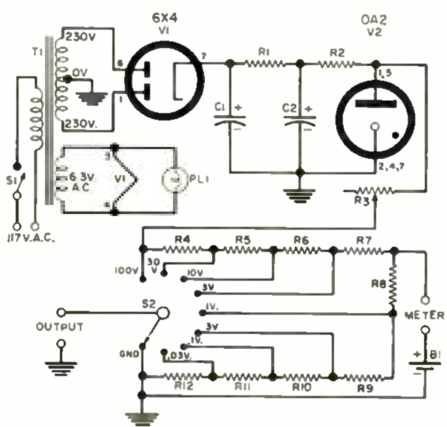


Fig. 2. Unit is simply a power supply and divider with a means for calibration.

R_1—4500 ohm, 5 w. res.
R_2—2250 ohm, 5 w. res.
R_3—20,000 ohm linear taper pot
R_4—14,000 ohm res. ± 1% (see text)
R_5—4000 ohm res. ± 1% (see text)
R_6—1400 ohm res. ± 1% (see text)
R_7—330 ohm res. ± 1% (see text)
R_8—70 ohm res. ± 1% (see text)
R_9—140 ohm res. ± 1% (see text)
R_{10}—40 ohm res. ± 1% (see text)
R_{11}—14 ohm res. ± 1% (see text)
R_{12}—6 ohm res. ± 1% (see text)
C_1, C_2—40 µf., 450 v. elec. capacitor
S_1—S.p.s.t. rotary switch (Switchcraft Type 20016 or equiv. See text)
S_2—S.p. 11-pos. rotary switch (Mallory 172C or equiv.)
PL_1—6-volt pilot light
B_1—Mercury battery (Mallory RM1R, 1.35-volt output)
T_1—Power trans. 230-0-230 v. @ 50 ma.; 6.3 v. @ 2.5 amp. (Stancor PC8418 or equiv.)
V_1—6X4 tube
V_2—0A2 tube

When connecting the battery, care should be taken to observe polarity, since the case of a mercury cell is positive. With conventional batteries, the reverse is true. An insulated bias-cell holder was used for mounting the RM1R battery because the latter is not itself insulated.

Concerning the divider resistors, the values given for R_4 through R_{12} are not standard EIA values. However these are all conventionally available within the stated tolerance in standard lines of precision resistors. It is also possible to make up every one of them from a series or parallel pair, within close tolerance, from standard values. For example, 6 ohms may be obtained by using a 10-ohm resistor in parallel with a 15-ohm unit. For the 70-ohm unit, precise 130-ohm and 150-ohm units in parallel would come to 69.6 ohms, or a series pair (68 and 2 ohms) would come to the required 70 ohms. For many of these resistors, more than one pairing is possible to obtain the desired value.

Some saving is made possible by the fact that required power ratings are low. Since only 5 milliamperes passes through the divider, ⅛-watt types are adequate for all units except R_4, which should be a ½-watt unit. Further cost reduction is possible if the requirements of the potential user can be met with accuracy less than one per-cent, or if components of lower nominal tolerance can be matched on a bridge or other accurate resistance-measuring device.

Application

This instrument should find many uses around the shop for checking and calibrating test equipment. For example, it can even be used to calibrate an oscilloscope by noting the extent to which a straight, horizontal trace shifts vertically when the calibrator is applied across the scope's vertical input. If the oscilloscope has a d.c. input, this is relatively simple. However, it may be done with an a.c. input too, if the user is quick enough to note the extent of shift before the trace settles.

Calibration for negative voltage readings is obtained simply by reversing connections to the output terminals. In order to insure accurate readings, it is advisable to adjust R_3 prior to each occasion when the calibrator is to be used.

—30—

ELECTRONIC INDUSTRIES OUTLOOK FOR 1961 vs. 1960

Total electronic output is expected to reach an all-time high in 1961. Factory output may pass $6.8-billion mark.

TOTAL electronic output should reach a new all-time high in 1961, according to industry spokesmen, despite the temporary slackening in economic expansion and the recent weakening of consumer durable goods markets, the Business and Defense Services Administration, U.S. Department of Commerce, reported recently. Factory output of electronic equipment is expected to pass the $6.8-billion mark, total components output increasing proportionately. These projections do not include the value of electronic research, development, evaluation, and test expenditures —already around $2.0-billion a year—or distribution, service, installation, and operating revenues.

Not all the electronic industries are expected to share in the upward swing. This year may bring more intense competition, especially among consumer products and electronic components. In addition, the seasonal variation in output may be wider than in recent years, the first half of the year being slower and the second half stronger than in 1960.

At the beginning of 1960, one of the largest increases in output in the history of these industries was expected. Although all the gains anticipated did not materialize, the high combined output pushed 1960 volume to a new record. Electronic-equipment output increased 10 per-cent over 1959 to $6.4-billion, and factory sales of electronic components exceeded the $3-billion mark by almost 10 per-cent. Only electron tubes failed to share in the rise.

Although the falling-off of consumer electronic equipment sales in late 1960 is expected to continue through the first half of this year, the healthy growth factors in these industries preclude a prolonged leveling-off in total output. Thus, consumer electronic equipment sales are expected to be higher in 1961 than in 1960.

1960 Consumer Equipment

Total factory value of output of consumer electronic equipment increased 2 per-cent in 1960, although production rates were higher during the early months. Production of black-and-white television, the most important consumer product by value, was down about 10 per-cent from 1959 levels. Output totaled 5,720,000 units in 1960, compared with 6,350,000 units in 1959. However, the trend in 1960 toward larger picture tubes, resulted in higher average unit prices. As retail sales slowed in the usually brisk fall months, manufacturers cut back production to avoid accumulation of excessive inventories. Color television sales increased sharply in 1960, but not enough to offset the decline in black-and-white television receiver sales.

Despite keen competition from imports of Japanese transistor radios, U.S. manufacturers produced 17.2 million receivers in 1960—the highest level in 13 years and the second highest in history. An increase in auto radio output of almost a million units above 1959 was responsible for most of the dollar increase of radio output.

Production of phonographs and radio-phonograph combinations increased about 18 per-cent in value in 1960, accounting in large part for the net gain in total value of consumer electronic equipment output. This sharp increase accompanied the introduction by radio and television manufacturers of packaged "hi-fi" systems, including relatively expensive stereophonic phonograph and radio-phonograph systems, for the mass market. Unit sales of stereophonic phonographs and radio-phonograph combinations increased almost 30 per-cent in 1960. The development and sale of packaged hi-fi systems contributed to the 15 per-cent decline in sales of separate hi-fi components in the year.

Production and sales of other consumer electronic equipment such as tape recorders, electronic organs, electronic toys, electronic cooking ranges, and garage door openers increased slightly from 1959 levels. Sales of phonograph records and magnetic tape increased from $250-million in 1959 to about $280-million in 1960.

The 1961 Outlook

The 1961 outlook for the electronic industries as a group is favorable, although the various industries and sectors may grow at different rates. The equipment industries expect an increase of about 6 per-cent in the value of output, and total components about 5 per-cent. The first half of the year is expected to be slow, output and employment gaining momentum during the last half. The up-trend is expected to be stimulated by the need for more advanced weapon systems, expanding space and missile programs, and rise of electronics techniques in the modernization of production facilities and in reducing business costs.

Factory sales of consumer electronic products are expected by the industry to be slightly higher in 1961 than in 1960. The lower production schedules of the last few months of 1960 are expected to continue into the spring of 1961. Over-all consumer product output and sales in 1961 are expected to follow the traditional seasonal pattern, wherein almost 60 per-cent of total output is produced during the last half of the year; in 1960, production was almost evenly divided between the two halves.

Industry bases these projections on the assumption that consumer incomes and expenditures will remain relatively high and that the durable goods buyers' resistance encountered in late 1960 will dissolve by mid-year as business conditions improve.

Production of black-and-white television receivers is expected to decline moderately in 1961, to about 5.5 million units having a factory value of $810-million. Television manufacturers may face more difficult sales problems in 1961 because of near-saturation of the home market for first sets and increased competition from other products for the consumer dollar. Improved styling and technical advances should stimulate sales. In the area of radio-receiver sales, market saturation is not absolute, and demand can be sustained indefinitely through new product development and aggressive sales promotion. Normal population growth and new household formation will, of course, strengthen the market.

Factory production and sales of color television receivers are expected by industry to increase substantially in 1961, continuing the healthy growth of 1960, and may reach the $100-million mark.

(*Continued on page 83*)

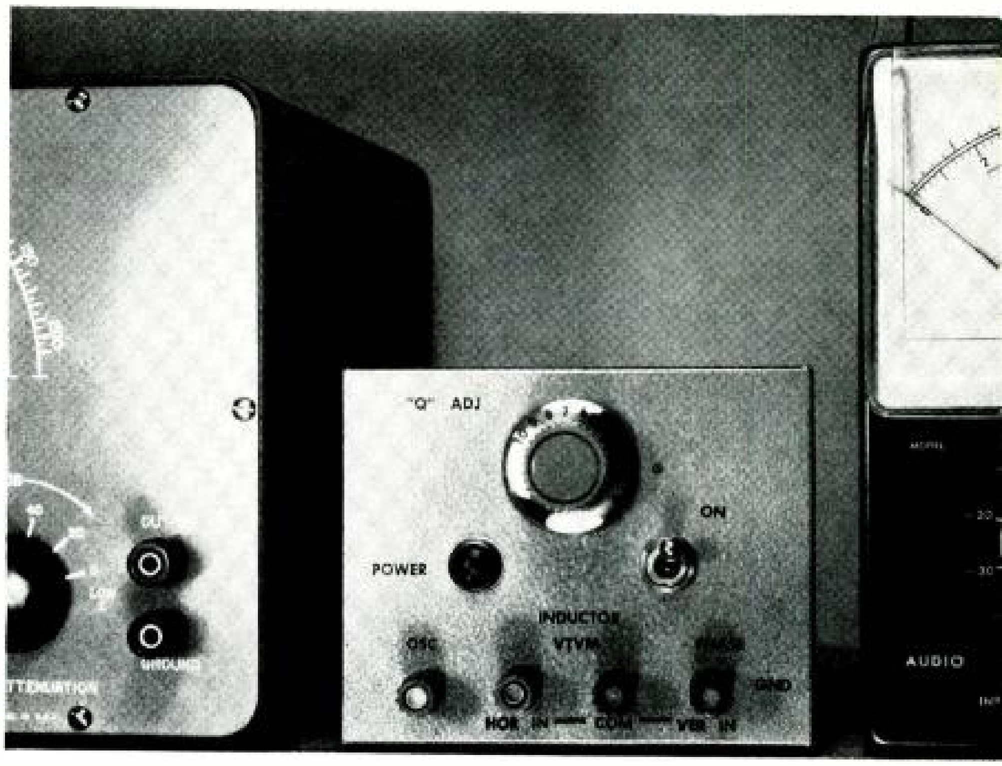
ADVANCES in all phases of conventional and solid-state circuitry have greatly increased the number and variety of coils in electronic equipment. It is almost superfluous to say that those engaged in circuit development and prototype work—as well as servicing—often need to measure inductance with convenience and accuracy.

Unfortunately, specialized meters for this purpose are rarely found outside well-equipped laboratories. Inductance bridges are more widely available, but they are expensive and delicate. An inductance meter that is rugged, small, and at least as accurate as the 20 per-cent tolerance on commercial coils would be a very useful instrument. The meter to be described satisfies these conditions almost ideally: It is compact, accurate to within ± 10 per-cent over a wide range of inductance, and pleasantly straightforward in construction and operation.

To avoid unnecessary duplication of instruments, we elected to use an audio v.t.v.m. or scope for readout, rather than attempt to incorporate a direct-reading voltmeter into the circuit. Inductance values may be read on a graph. This is almost as convenient as direct readout, and certainly less expensive. In addition, an oscillator must be used to supply a variable-frequency signal to the meter. If the oscillator is tunable in the range from 20 cps to 1 mc., the meter can cover an inductance range of 2.54 μhy. to 6300 hy.

Before proceeding to construction and operating details, let's discuss a possible—and, seemingly, reasonable—objection to the use of a meter for the measurement of inductance: Why not calculate inductance directly by applying a known a.c. voltage to a coil, measuring the resulting current, and dividing voltage by current? This method has little to recommend it except simplicity. What this technique really measures is impedance rather than inductive reactance, making necessary a resistance measurement followed by additional calculations to arrive at actual inductance. Also to keep current large enough to be measured with an ordinary a.c. milliammeter, a variable-frequency oscillator must be connected to the coil. Unless reactive elements in the output circuit of the oscillator are bypassed, they will contribute to the over-all error. Clearly, this "simple" method is far too inaccurate and unpredictable (but predictably vexing) to be of any practical value. The objection having been answered, we offer the circuit of Fig. 1 as an attractive alternative to a bridge.

Fundamentally, the circuit consists of a two-stage *RC*-coupled amplifier having a reasonably wide bandwidth (flat to 100 kc., down 10 db at 1 mc.). V_{1A} is coupled to the input oscillator through blocking capacitor C_1. Bias for this stage is obtained across R_2, which is bypassed with C_2, a .02-μf. "postage stamp" ceramic capacitor. This value was chosen to preserve gain at the higher frequencies. Reduced distortion at low and medium frequencies is a



Use of separate generator and separate v.t.v.m., between which the inductance meter is shown, keeps its construction simple and also enhances its versatility.

A Wide-Range Inductance Meter

By DAVID G. BETHANY

An accessory, simple to construct, with which you can read values from 2.5 microhenrys to 6300 henrys with good accuracy and reliability.

result of inverse feedback across R_2, since C_2 is practically an open circuit much below 1600 cps. The mid-frequency gain of this stage is 21. It was perhaps an unnecessary frill to bypass the "B+" supply lead to V_{1A} with C_4, but doing so should improve the high-frequency response. The meter is designed to operate satisfactorily with an input signal of .1 volt r.m.s. All audio oscillators and nearly all r.f. generators can develop this voltage at any frequency across the moderately high input impedance of the meter. Input voltage is not normally critical, since the readout indication is qualitative rather than an absolute number.

Assuming a .1-volt input, signal voltage at the grid of V_{1B} will be 2.1 volts. The signal input of V_{1B} is isolated, through V_{1A}, from any reactive elements in the oscillator's output circuit. Further amplification in V_{1B} results in 44 volts between C_6 and ground at mid frequencies. R_5, the cathode resistor for V_{1B}, is bypassed with C_5 to provide adequate gain and good linearity for correct meter operation.

R_7 is a 10,000-ohm wirewound pot connected between BP_2 and ground, as shown. Its purpose is to permit changing the "Q" (ratio of reactance to resistance) of the series circuit consisting of C_6 and the unknown inductance.

The power supply is a conventional half-wave voltage doubler, using a pair of *International Rectifier* SD-94 silicon diodes. These "top hat" diodes have a p.i.v. rating of 400 volts and can supply in excess of 300 ma. These diodes were chosen for availability and compactness rather than current-handling capacity.

The rectified current supplied to the 12AT7 is only 5 ma., which permits considerable latitude in the choice of diodes.

Note that diodes having a p.i.v. rating of much less than 400 volts should not be used since SR_2 is subjected to a peak inverse voltage of nearly *twice* the peak value of the a.c. input voltage, as this diode is followed by a capacitive filter network. R_8 is a 5-ohm, 5-watt wire-wound type that acts as ballast by preventing current surges through the diodes when the power supply is first energized.

The power supply terminates in C_9, which removes most of the remaining ripple. A bleeder resistor was not used across the "B+" supply so as to keep operating voltages as high as possible. Be careful of the filter capacitors! Without a bleeder, they remain heavily charged for several hours after the meter has been turned off.

Construction

Fig. 2 shows details of the power supply and other above-chassis wiring. For convenience, C_8 was placed along the left edge of the chassis and connected to the remainder of the power supply *via* a pair of twisted wires placed behind, and away from, V_1. Partially obscured by V_1 is a large (5/8") hole, covered with a rubber grommet, through which all connections to the subchassis are made.

All above-chassis grounds are brought to a control-type lug, used between the

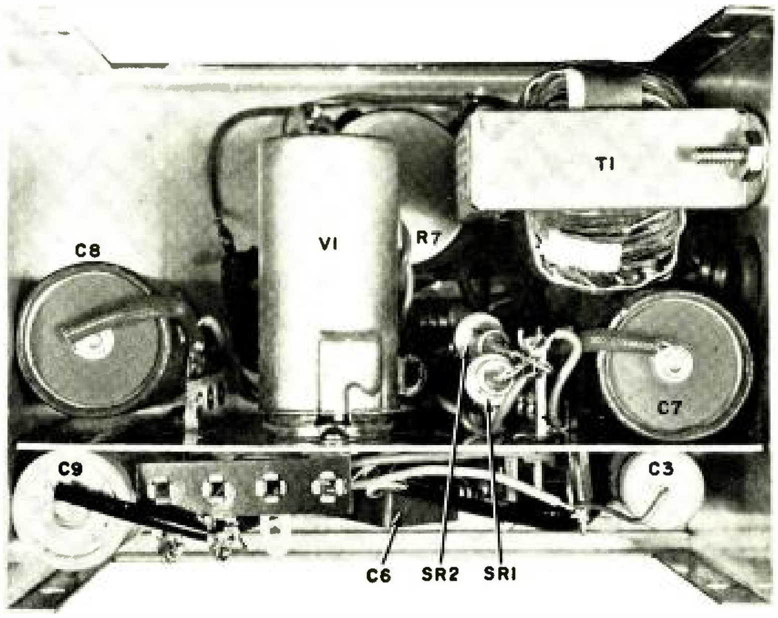
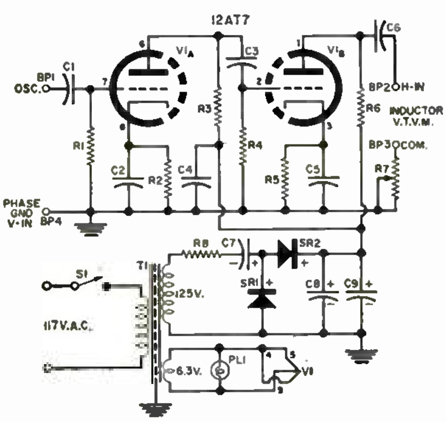


Fig. 2. As viewed from the rear, the chassis shows layout of power supply and other components. Note the use of space above the chassis as well as below it.

Fig. 1. The accessory is basically a two-stage amplifier for the generator.



R_1—100,000 ohm, ½ w. res. ± 10%
R_2, R_5—470 ohm, ½ w. res. ± 10%
R_3, R_4—22,000 ohm, ½ w. res. ± 10%
R_6—1 megohm, ½ w. res. ± 10%
R_7—10,000 ohm wirewound linear taper pot
R_8—5 ohm, 5 w. wirewound res.
C_1—.1 μf., 200 v. capacitor
C_2, C_5—.02 μf., 30 v. capacitor
C_4—.25 μf., 400 v. capacitor
C_3—.01 μf., 400 v. capacitor
C_6—.01 μf., 300 v. mica capacitor ± 5% (see text)
C_7, C_8—50 μf., 350 v. elec. capacitor
C_9—20 μf., 450 v. elec. capacitor
SR_1, SR_2—300 ma., 280 volt r.m.s. silicon rectifier, 400 volts p.i.v. (International Rectifier SD-94 or equiv. See text.)
S_1—S.p.s.t. switch
PL_1—6.3 volt pilot light
BP_1, BP_2, BP_3, BP_4—Six-way binding post (E. F. Johnson Type 111)
T_1—Power trans. 125 v. (½ wave) @ 15 ma.; 6.3 v. @ .6 amp (Stancor PS8415 or equiv.)
V_1—12AT7 tube

case and the shaft of R_7. The heater leads of T_1 were twisted tightly and connected to the lugs on PL_1. Another twisted pair from these lugs was run through the large hole to pins 4, 5, and 9 on V_1. Also passing through this hole are the twisted pair from R_7 and the "B+" lead from C_8.

The remainder of the wiring can be seen in Fig. 3. Heater leads for V_1 were connected first so that they could be twisted and pushed down against the chassis. To minimize losses, the leads of C_1 were kept short and connected directly to BP_1 and pin 7 of V_1, as shown. R_1 may be seen to the right of, and below, C_3.

The chassis was cut to fit the 3" x 4" x 5" aluminum case and mounted with its lip about 1/8" above the lower lip of the front of the case. Once in this position, the two were securely clamped together and four 5/16" holes were drilled through both, permitting the chassis to be supported by the four binding posts. In this type of construction, screws do not deface the front panel.

More than casual attention should be given to proper lead dress, as the circuit is required to operate at frequencies up to 1 mc. Keep all r.f. leads short and separated from the chassis. Any inductance (or stray capacitance) beyond the plate of V_{1B} will affect meter accuracy. It is therefore advisable to connect C_6 directly from pin 1 on V_1 to BP_2. C_6, a .01-μf., 5% silver mica capacitor rated at 300 volts, was chosen for accuracy and thermal stability. These are important considerations, since it must resonate with the inductor under test.

Operation

Meter operation is made clear by Fig. 5A, which shows a series circuit consisting of a coil, a capacitor, and a variable-frequency oscillator. As frequency is varied, current through the coil also varies and reaches a peak at f_0, the resonant frequency of the circuit. At this frequency, X_L and X_C are equal in magnitude and have opposite signs, leaving only the winding resistance of the coil, R_L, to limit current flow. The circuit therefore behaves as a pure resistance, so that current and applied voltage are in phase.

The resonant frequency of this circuit could be found by placing a voltmeter across the coil and adjusting the oscillator until a maximum reading results. Or else, a scope could be used, as shown in Fig. 5B. Here, the oscillator's frequency would be varied until a circle is displayed, indicating resonance by the in-phase condition ("phasing circle" measurement).

For maximum accuracy and flexibility, the inductance meter has been designed to incorporate both methods for determining f_0. Theoretically, either method will result in measurements of equal accuracy. Oddly enough, this isn't so! In checking out the completed instrument, we consistently arrived at slightly more accurate measurements of low inductance (r.f. coils, a.f. air-core inductors) using the meter-peaking method, and about equal accuracy (5 to 10%, plus or minus) when measuring high inductance (filter chokes) using the phasing-circle method. Although deviation between the two sets of measured values is not great, precision dictates use of the peaking method for *low* inductance, and the phasing-circle method for *high* inductance.

As explained earlier, the amplifiers are designed for an assumed input of .1 volt r.m.s. While checking standard inductors against the meter to determine its accuracy, we uncovered another peculiarity: accuracy depends on input voltage. By reducing the input voltage to .01 volt (20 db down from .1 volt if your oscillator has logarithmic attenuation) accuracy is rather improved for high values of inductance. Increasing the input voltage to 1 volt (20 db up from reference) improves meter accuracy when measuring low inductance values through the unit.

To use the meter, connect an unknown inductance across binding posts BP_2 and BP_3. Connect an audio oscillator or r.f. generator across terminals BP_1 and BP_4. Allow sufficient time for the oscillator to stabilize before attempting to use the meter. If the peaking method is to be used, insert the signal lead of a v.t.v.m. into BP_2 and its common lead into BP_3. Adjust R_7 for maximum *"Q."* Now vary the oscillator's frequency for *maximum* meter deflection. The actual reading does not matter, but try to read as far up-scale as possible, on general principles. The pointer should rise as the resonant frequency is approached, then peak at resonance and fall as the frequency of the oscillator is increased beyond f_o. Read the frequency setting of the oscillator corresponding to the voltmeter peak.

The readout chart (Fig. 4) covers a frequency range from 10 to 1000 cps and an inductance range from 25,000 hy. to 2.5 hy. After determining the frequency setting that gives a peak voltmeter deflection, to find the corresponding value of inductance, enter the chart at this value of frequency and read inductance on the other axis. For greater convenience, copy the chart on 3-cycle by 5-cycle logarithmic paper (*Dietzgen* 340-L35) and hang it near the meter. Or make a reduced-size copy and glue it to the rear of the meter case.

Suppose that the oscillator must be set to some frequency higher than 1000 cps to peak your voltmeter. The chart can still be used by applying this rule: If frequency is increased by a factor of ten, inductance is decreased by a factor of one hundred. For example, assume that 16 kc. gives a peak deflection with a certain coil. Simply read the value of inductance corresponding to 160 cps, which is 90 hy. Now the actual frequency is one hundred times the value read. So, by the rule, actual inductance will be one ten-thousandth of the chart indication. Therefore, 16 kc. indicates .009 hy., or 9 millihenrys. With a little practice, reading the chart becomes virtually automatic.

To use a scope for readout, set the *"Q"* control fully counterclockwise (minimum *"Q"*). Adjust the scope for "H Input" (no time base). Connect the *V* input lead to BP_4, the *H* input lead to BP_2, and the common lead to BP_3. Vary the oscillator frequency while adjusting the scope's vertical and horizontal gain controls for a circular trace. At this point, the chart can be used exactly as before.

Unless your scope has considerable gain, the phasing-circle method probably cannot be used except with rather large values of inductance. Also, difficulty may be experienced in recognizing the difference between a circle and the inclined ellipses that precede and follow resonance. It is doubtless advisable to use the peaking method for all measurements until you become more familiar with operation.

It should be realized that the inductance of a coil depends not only upon its geometry and winding, but also upon the amount of direct current passing through it. Filter chokes, in particular, are designed to operate under a certain level of d.c. saturation. It would be meaningless to measure the inductance of such a coil without d.c. saturation, since the measured value would probably differ widely from the "loaded down" value.

Fig. 5C shows an acceptable procedure for measuring this incremental inductance of a filter choke. Adjust the power supply so that the d.c. milliammeter reads the actual operating current of the choke. Once again, peak the v.t.v.m. with the oscillator and read from the chart the value of inductance corresponding to the peaking frequency.

A final statement regarding meter accuracy may be in order. Accuracy is primarily limited by the tolerance of C_6 and the precision with which the input oscillator can be read. Clearly, if C_6 is within ± 5 per-cent of .01 μf., and the oscillator dial cannot be set closer than ± 5 per-cent of actual frequency, then over-all meter accuracy is not better than ± 10 per-cent. There are also high-frequency losses that necessarily arise when measuring very low values of inductance. Fortunately, such losses can be minimized by correct lead dress and short, direct connection of the test coil to the meter. —30—

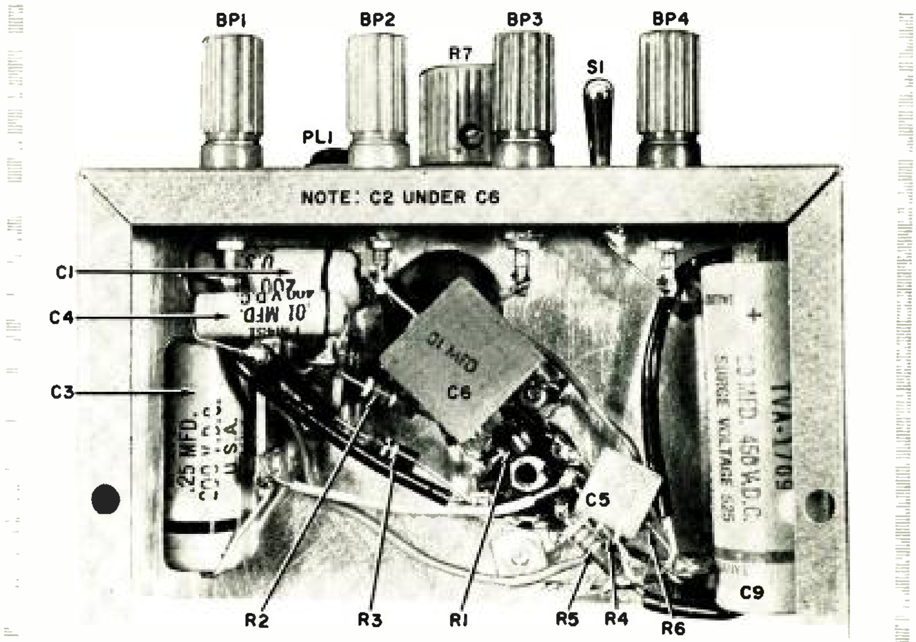


Fig. 3. Component layout and wiring under the chassis. Virtually all wiring and parts placement may be determined from this photo and the one of Fig. 2.

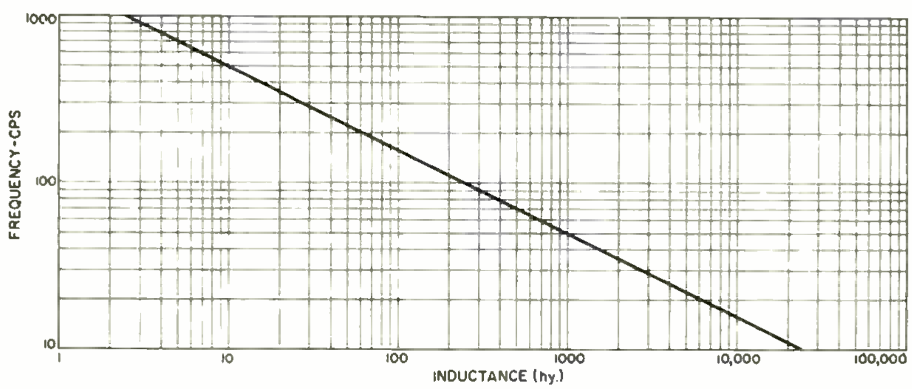
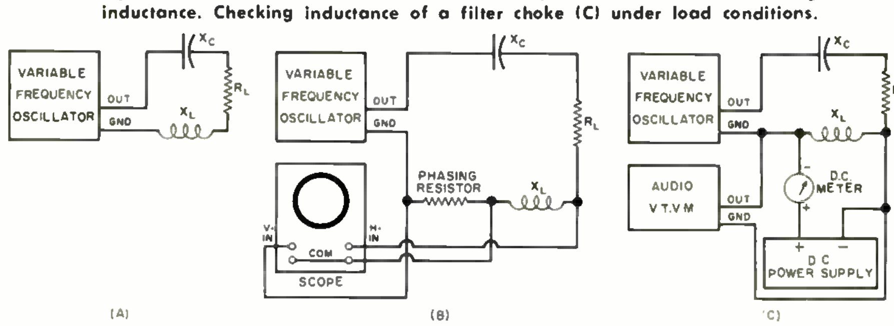


Fig. 4. Inductance can be read from this chart once peak frequency is known.

Fig. 5. Basic operation (A) of test circuit. Scope method (B) for measuring inductance. Checking inductance of a filter choke (C) under load conditions.



USING THE BC-221 TO CHECK CB FREQUENCY

By R. L. CONHAIM, 19W7577
President, Dayton Citizens Radio Assn.

There is some controversy about using this surplus meter for CB gear. Here are some convincing arguments from a proponent who spells out how to get maximum accuracy with this unit.

DESPITE EVERYTHING that's been said or written about the BC-221 Frequency Meter, many people still have doubts about its accuracy as a Citizens Band frequency measuring device. Opponents of the instrument cite its basic military accuracy as being entirely too coarse for CB use. Proponents of the BC-221 point out, however, that with careful use, the instrument is quite capable of reading within the 0.005% tolerance required of CB transmitters.

Who's right? That's what the author set out to find. Armed with several different models of the BC-221, various methods of use were checked against a laboratory standard, the *Hewlett-Packard* Model 524B Frequency Counter. Since this counter is accurate to ±1 cycle, we emerged from the experiment with some pretty solid answers to the BC-221 controversy. And, oddly enough, we found both factions to be right—provided the conditions of use are stated.

The "aginners" are right if the instrument is used as originally intended—battery operated, used under field conditions and only turned on when it is to be used. Under these conditions the instrument is certainly inadequate, especially when you consider that a frequency-reading device should have a tolerance at least twice as good as the transmitter specifications. That means the meter should be capable of an accuracy of 0.0025% or about 650 cycles in the 27-mc. band. Under battery-operated field conditions, the BC-221 simply can't approach this kind of accuracy.

But, if we can control certain conditions under which the instrument is used, and if we resort to a fairly unusual frequency-reading procedure, we find the BC-221 is capable of truly amazing accuracy on CB. In many cases the author was able to read within 200 cycles of the counter and, in a few cases, as close as 10 cycles of the counted frequency. Not all the BC-221 models tried would achieve this kind of accuracy, but all were well within 500 cycles—ample accuracy for CB use.

To get this kind of accuracy from the BC-221 is just a question of controlling certain factors which normally contribute considerably to the basic error of the instrument. In no case was modification of the instrument required to control these factors and all the measures can be taken easily.

Briefly stated the conditions for accurate use of the BC-221 are these: 1. Use a voltage-regulated power supply. 2. Zero the internal BC-221 crystal with WWV. 3. Leave the instrument on at all times and in an area where temperature and humidity remain fairly constant. 4. Use the additive method of frequency measurement. 5. Operate carefully.

Let's consider these conditions and see how they can be accomplished.

The BC-221 was designed as a battery-operated field instrument. Because aging batteries naturally affect accuracy, we can eliminate this error by operating the instrument from 117-volt a.c. power lines with a voltage-regulated "B+" supply. Fig. 3 is a schematic of a supply which performs admirably with the BC-221. Construction is straightforward and can be done on any convenient chassis. One word of caution: *Do not* place the power supply in the battery compartment of your BC-221. Keep it external to the frequency meter and several feet away so that heat from the supply will not affect the BC-221. The author keeps his power supply on the floor beneath the bench on which the frequency meter is utilized.

Although the BC-221 was designed for a "B+" voltage of 135 volts d.c., we have found no difference in operating characteristics when using the 150-volt supply shown in Fig. 3. However, in some cases, because the BC-221 may have been stored in a warehouse under unfavorable conditions, it would be a good idea to check each of the crystal check points on both "High" and "Low" ranges. If you find that zero-beat cannot be reached for some of the check points, internal adjustments can be made to bring the instrument within range. The physical location of these internal capacitors may vary from model to model. Location of these capacitors for an "O" Model of the BC-221 is shown in Fig. 2 and in the schematic of Fig. 4. To make these adjustments, proceed as follows:

Make a cable harness with banana plugs on one end and banana jacks on the other so that the instrument can be operated outside of the case. After the instrument has warmed-up outside the case, check each of the crystal check points on the "Low" band of the instrument. If some points do not reach zero-beat, make the correct setting for the lowest crystal check point and center the "Corrector" knob between 0 and 10 on the "Corrector" scale. Now adjust the "Low" internal capacitor for zero-

Fig. 1. Control panel of a BC-221-O. Identification plate has been removed to show crystal-oscillator padder at bottom center.

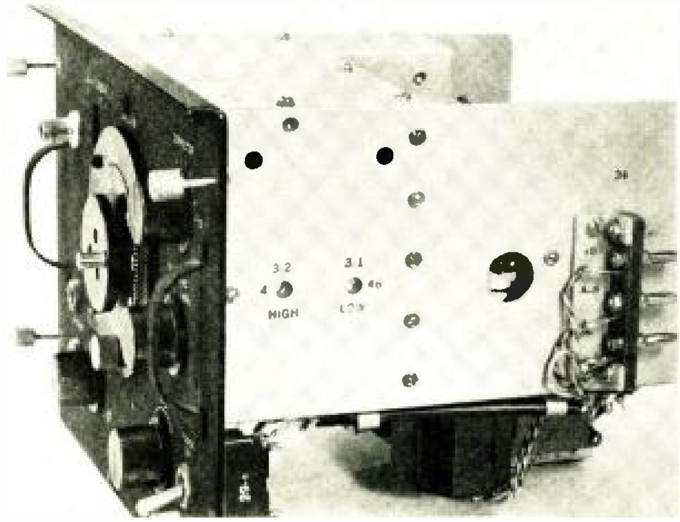


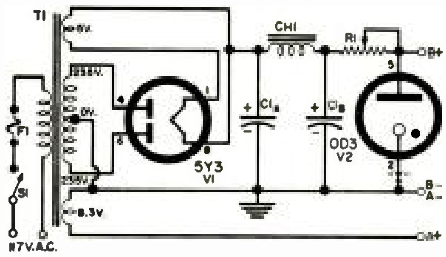
Fig. 2. Location of the "Corrector" padder capacitors in the right side of the BC-221-O. Refer to the text for proper use.

beat. Check the highest check point in the "Low" band to determine if zero-beat can be reached through the use of the "Corrector" knob. By varying the initial setting of the "Corrector" knob either a little to the left or right of center position and adjusting the internal capacitor, some point will be found in the setting of the internal capacitor which will allow the "Corrector" knob to be adjusted for zero-beat on all check points in the range. The procedure should then be repeated for the "High" band of the instrument using the "High" internal capacitor.

For best operation, leave your BC-221 turned on at all times. This will result in maximum stability and avoid errors caused by warm-up.

If your BC-221 employs 6SJ7 or 6SJ7Y tubes, these can be replaced with the *RCA* "Special Red" type 5693 which has a 10,000-hour life and exceptional stability. No modification is required for using this tube.

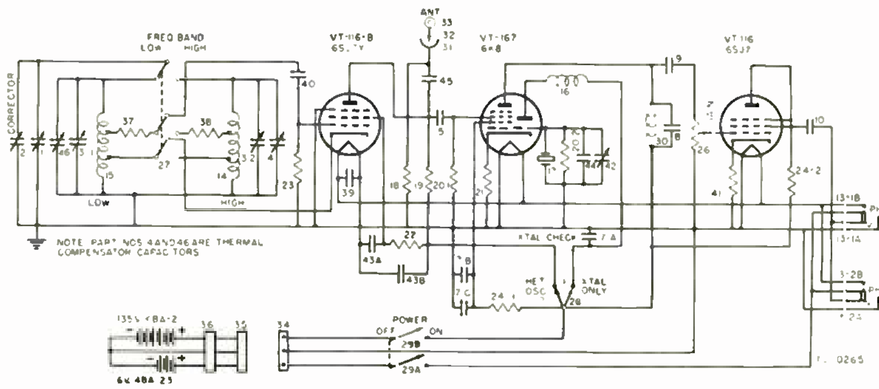
Some BC-221 models have excessive hum when used with an a.c. power supply. This can be eliminated by using a d.c. heater supply capable of providing 6.3 volts at 1.0 ampere. You can also use a constant-voltage transformer in place of T_1 in Fig. 3. This will provide regulation for both heater and high-voltage supplies, but is not absolutely essential for good operation.



R_1—7500 ohm, 10 w. adjustable wirewound res. (Ohmite 1036. With a d.c. milliammeter inserted at point "X," adjust R_1 for 15 ma.)
C_{1A},C_{1B}—20/20 μf., 250 v. elec. capacitor
CH_1—8 hy., 50 ma. filter choke (Stancor C1003, Triad C3X, Merit C2976 or equiv.)
T_1—Power trans. 235-0-235 v. @ 40 ma.; 5 v. @ 2 amps; 6.3 v. @ 2 amps (Stancor PC-8401, Triad R6A, or Merit P3149, see text)
S_1—S.p.s.t. switch
F_1—1 amp fuse
V_1—5Y3 tube
V_2—0D3 tube

Fig. 3. Voltage-regulated power supply used.

oscillator only. Since we are using a relatively high harmonic of the variable frequency oscillator to bring us within the CB range, there is the possibility of considerable error. The percentage error will always remain the same, irrespective of harmonic used, but the error in terms of numbers of cycles increases proportionately with the harmonic being employed. In other words, when we employ the 8th harmonic of the BC-221 high band to bring us up to 27 mc., we have 8 times as many cycles of error as we would have at the fundamental. We also find that the "Low" band of the BC-221 is more accurate and more precise than the "High" band. This is true because the "Low" band covers only 125 kc. over the spread of the dial compared to 2000 kc. covered by the same dial spread in the "High" band.



REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION	REF	DESCRIPTION
1	17 μμf	13-1A	JACK	19	56,000 OHM	29	SWITCH	38	100 OHM
2	3 μμf	13-1B	FIL SWITCH	20 1&2	1 MEGOHM	30	4?0 HENRIES	39	[illegible]
3-?A	[illegible]	13-2A	JACK	21	1?0 OHM	31	ANT PLUG	40	[illegible]
4	12 μμf	13-2B	FIL SWITCH	22	9,?00 OHM	[illegible]	CONTACT SPRING	41	700 OHM
[illegible]	10 μμf	14	HIGH FREQ COIL	23	150,000 OHM	33	BINDING POST	4?	12 μμf
7 A&B	[illegible]	15	LOW FREQ COIL	24 1&2	[illegible] 000 OHM	34	POWER PLUGS	43 A&B	[illegible]
8	.001 μf	16	RF CHOKE COIL	26	[illegible] MEGOHM	35	POWER JACKS	44	6 μμf
9	.02 μf	17	CRYSTAL	27	SWITCH	36	BATTERY TERM	45	15 μμf
10	0.5 μf	18	[illegible] OHM	28	SWITCH	37	[illegible] OHM	46	4 μμf

Fig. 4. Circuit diagram and parts listing for the surplus frequency meter.

Setting the Crystal Oscillator

Although most models of the BC-221 have provision for accurate setting of the crystal oscillator, this operation was not performed under military usage. Consequently, considerable error could result because the internal calibrating standard is not accurate. This error can be eliminated or drastically reduced by zeroing the crystal oscillator from time to time with the primary standard, WWV. This is accomplished with the aid of a communications receiver and with the BC-221 internal adjustment. The adjusting capacitor location varies from model to model. In the BC-221-O, this adjustment capacitor is located behind the nameplate and can be reached without removing the meter from its case (see Fig. 1). In other models, it may be necessary to remove the unit from the case and operate it externally with a wiring harness as previously described. It is possible in some such cases to drill a hole in the back of the case to make the adjustment screw accessible without removing the unit. Some of the very early models of the BC-221 did not have this crystal oscillator adjusting capacitor. Such units should be avoided unless it is definitely known, by beating with WWV, that the crystal oscillator is within 10 cycles of its 1-megacycle frequency.

The communications receiver should be equipped with an "S" meter for greatest accuracy. If it does not have an "S" meter, an oscilloscope can be connected to the speaker leads to give visual indication of zero beat.

With WWV tuned in at 5 or 10 mc., set the BC-221 function control to "Crystal" ("Xtal." on some models) and listen for a beat note in the receiver speaker. For this purpose, it is best to pick a time when an unmodulated signal is being broadcast. To bring this beat down to or approaching zero, adjust the crystal oscillator capacitor in the BC-221. As you turn the adjustment screw in the right direction you will hear the beat note lower in frequency. When you approach zero-beat, you will notice the "S" meter needle in the receiver begin to vibrate rapidly over a very small arc. The excursions of the needle will become slower and wider as you get close to zero-beat. It is usually possible to bring these excursions down to about 1 per second or less with WWV received at 5 mc. Experience will tell you how often to employ this calibration procedure. When you first begin to use your BC-221 with these methods, check the crystal oscillator each time the meter is used. After it has been left on for several weeks, less frequent zeroing will be required.

Additive Method of Measurement

In normal usage, the internal crystal is employed merely as a means of checking the variable oscillator at different check points. All our frequency-determining settings when checking a transmitter are done with the variable oscillator only.

Now, if we could find some way of preserving this "Low" band precision, accuracy, and low cyclic error, but up at 27 mc., we would have a truly accurate frequency meter for CB use. In other words, we need an electronic stepladder to raise the BC-221 "Low" band frequency into CB range.

Such a technique, known as Additive Frequency Reading, is possible with the BC-221. In this method, the output of two precision oscillators is added together to produce a frequency which is the sum of the two oscillator frequencies. You can compare this method with the principle of the superheterodyne radio. In such radios, the incoming signal frequency is mixed with the frequency of a local oscillator to produce the intermediate frequency. In both the superheterodyne radio and the Additive Frequency Meter, there are actually two output frequencies. One is the sum of the two original frequencies and is known as the additive frequency. The other is the difference between the two and is known as the subtractive frequency. We will deal only with the additive output when using the BC-221 by this method. Although the subtractive frequency still exists, it is more convenient for calculation and use to employ only the additive result.

To employ this method with the BC-221, we use both the crystal oscillator and the "Low" band of the variable oscillator at the same time. This is done by leaving the instrument in the "Check" or "Xtal. Check" mode of operation. We employ either the 26th or 27th harmonic of the crystal oscillator. Since we have previously checked this oscillator with WWV, we know it is quite accurate. If we have found that this oscillator is within 1 cycle with WWV at 5 mc., this means that we have only a little over 5 cycles of error at either the 26th or 27th harmonic.

For the variable oscillator, we have a wide choice of harmonics from which to choose. After considerable experimenting, the author finds that the best choices are the 5th harmonic for channels 1 through 13, the fundamental for channels 14 through 22, and the 2nd harmonic for channel 23. For the first 13 channels, we add the 5th harmonic of the variable "Low" band to the 26th harmonic of the crystal. For the balance of the channels, we add the variable output to the 27th harmonic of the crystal. Although this sounds as if a great deal of computation is required, it is actually very simple. To help you determine the correct settings for your BC-221, the correct frequencies for each channel have already been computed and are shown in Table 1. All you have to do is determine the settings from your calibration book for each of the frequencies shown in Table 1. You will find direct settings for all these frequencies. No interpolation has to be done.

When you have determined the correct settings for a particular channel, zero your BC-221 by making the appropriate "Crystal Check" point setting and adjusting the "Corrector" knob for zero-beat. Now, leave the function selector in "Xtal. Check" position which will leave both oscillators turned on. This is very important. Make the correct dial setting for the channel to be tested. Loosely couple a short length of hook-up wire from the antenna post of the receiver to the transmitter output. This is easily accomplished by connecting a short length of another lead from the antenna output. The leads from the transmitter and the BC-221 should be close together, but there should be no electrical connection.

Now key the transmitter. If the transmitter is within 2000 cycles of center frequency, you will hear a weak beat note. You may also hear, in many cases, other beat notes caused by the variable and crystal oscillators beating with each other. You can always identify the correct beat note by keying the transmitter on and off. Now adjust the tuning dial until the transmitter reaches zero-beat with the combined output of the oscillators in the frequency meter. You will find the dial may have to be turned over a considerable range to reach zero-beat, and in some cases, the exact location of zero-beat may have to be estimated. This great dial spread to reach zero-beat is one indication of the greater accuracy of this method. A tenth of a dial division on channels 1 through 13 will represent about 14 cycles; only 2 or 3 cycles on channels 14 through 22; and only 6 or 7 cycles on channel 23.

To find the approximate frequency of your transmitter, a number of different methods can be employed. The simplest is to compute the correct settings for center frequency plus 1000 cycles and center frequency minus 1000 cycles to provide a tolerance range. This can be done with the aid of Table 1. Another method is to compute the number of cycles represented by a tenth of a division. In making these computations, bear in mind which harmonic is being employed by the variable oscillator. Your figures should be approximately the same as those previously mentioned. A third method requires the use of an oscilloscope and an accurate audio oscillator. With this method, you feed the beat note output from the second headphone jack of the BC-221 to the vertical amplifier of the oscilloscope,

(*Continued on page* 128)

Table 1. Chart for using the BC-221 with the "Low" band additive method that is described by the author.

1	2	3	4	5	6	7	8	9	10	11
							UPPER AND LOWER LIMIT			
Channel	Freq. MC.	Variable Harmonic	Fundamental Freq. of Variable KC.	Crystal Check Point Setting for Freq. in Col. 4	Variable Setting for Freq. in Col. 4 (Center Freq.)	Cycles Per 10th Div.	Fund. Freq. of Upper Limit KC. (+1000 cps)	Setting for Freq. in Col. 8	Fund. Freq. of Lower Limit KC. (−1000 cps)	Setting for Freq. in Col. 10
1	26.965	5	193.0				193.2		192.8	
2	26.975	5	195.0				195.2		194.8	
3	26.985	5	197.0				197.2		196.8	
4	27.005	5	201.0				201.2		200.8	
5	27.015	5	203.0				203.2		202.8	
6	27.025	5	205.0				205.2		204.8	
7	27.035	5	207.0				207.2		206.8	
8	27.055	5	211.0				211.2		210.8	
9	27.065	5	213.0				213.2		212.8	
10	27.075	5	215.0				215.2		214.8	
11	27.085	5	217.0				217.2		216.8	
12	27.105	5	221.0				221.2		220.8	
13	27.115	5	223.0				223.2		222.8	
14	27.125	F	125.0				126.0		124.0*	
15	27.135	F	135.0				136.0		134.0	
16	27.155	F	155.0				156.0		154.0	
17	27.165	F	165.0				166.0		164.0	
18	27.175	F	175.0				176.0		174.0	
19	27.185	F	185.0				186.0		184.0	
20	27.205	F	205.0				206.0		204.0	
21	27.215	F	215.0				216.0		214.0	
22	27.225	F	225.0				226.0		224.0	
23	27.255	2	127.5				128.0		127.0	

*This frequency is not shown in calibration book. It can be computed within a few cycles as follows. Determine the number of divisions difference between the High setting for channel 14 in Col. 8 and the normal setting in Col. 6. Subtract this difference from setting in Col. 6 and enter in Col. 11. This is the minimum setting for channel 14.

Note: This chart is based upon using the fifth harmonic for channels 1 through 13. If your BC-221 has a low audio output making the beat note difficult to hear, you may get more readable results using even-order harmonics, such as the 4th harmonic for channels 1, 2, and 3 and the 8th harmonic for channels 4 through 13.

TEMPERATURE METER FOR THE BOATSMAN

By GEORGE R. WISNER

Build this easy-to-install temperature indicator for your outboard motor at a cost of about five dollars.

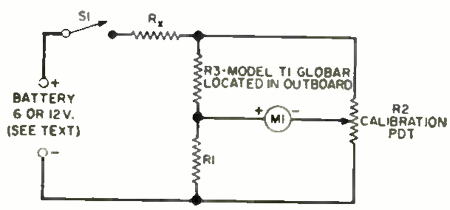
THE BIGGEST HEADACHE for the average outboard boatsman is the condition of his motor. Cooling-system failure is at the top of his list of worries. Stoppage of water flow through the cylinder head for even a few minutes can mean severe damage to the engine. The way to avoid this, of course, is to check from time to time to see if the stream of water is coming out of the motor. Your author, being naturally lazy and not inclined to leaning over transoms to inspect such matters, decided to do something positive about the situation.

The obvious solution is some sort of temperature-sensing unit; a rugged, reliable, but inexpensive device which would give the operator a constant indication of his engine's temperature. A commercial model is on the market which accomplishes such a feat but is relatively expensive and lacks a metered indication of temperature. The 1961 outboard motors have overheating indicators but this doesn't help the fellow who still happens to own an earlier model.

The outboard temperature meter described in this article can be built for little more than five dollars and provides the operator with a metered indication of the outboard's temperature. Further, installation of this unit is simple and will in no way affect the resale value of the outboard engine. No holes need be drilled or modifications made which would corrupt the motor's original design.

The Circuit

The circuit is merely a simple Wheatstone bridge with one element functioning as a temperature-sensitive resistor. This resistor, which is normally used as a current-sensitive device in many modern television sets, is manufactured by *Workman TV Inc.* of Sarasota, Florida. In the author's area it is readily available from all parts jobbers under the name of "Globar" Model T1 current-sensing resistor. In its original application, the Globar's resistance lowers as the current through it increases, resulting in its use as a current limiter when used in series with the filament string of a television set. In the outboard temperature meter, the resistor is heated by the motor and, as a result, its resistance falls. The varying resistance unbalances the bridge circuit and this condition is indicated on a meter having a "Safe-Danger" scale. This meter is an inexpensive 2½-inch plastic-face job with a 0-1 ma. range. Most mail-order houses stock a suitable version so obtaining the meter should present no particular problems to the home constructor.



R_1—10 ohm, 1 w. res., ±10%
R_2—300 ohm wirewound pot ("Calibration Control")
R_3—185 ohm (nominal cold resistance, 14 ohms hot resistance) current-sensitive res. (Workman "Globar" Model T1, see text)
R_x—68 ohm, 1 w. res. ±10% (for 12-volt operation. Omitted for 6-volt operation, see text)
M_1—0-1 ma. d.c. meter (see text)
S_1—S.p.s.t. toggle switch

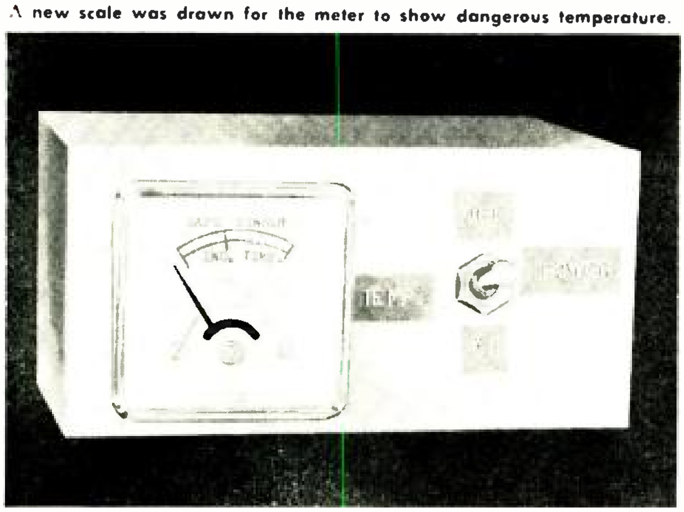
Fig. 1. Schematic of simple bridge circuit.

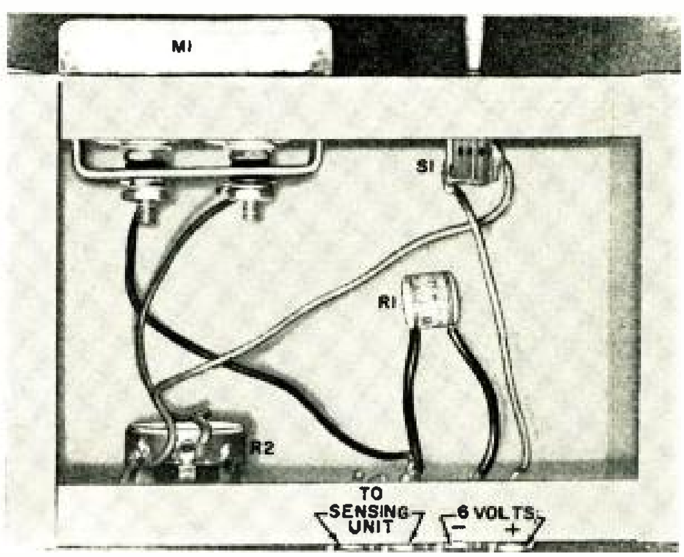
The rest of the bridge circuit is straightforward, consisting of a calibration control and a 10-ohm resistor which completes the Globar's half of the bridge. The calibration control actually serves as two elements of the bridge. The slider of the calibration pot is connected to the minus side of the 0-1 ma. meter and supplies it with a potential which gives the meter a relative reading. From the schematic diagram, Fig. 1, it can be seen that when R_3 decreases in resistance, that is, R_3 is heated thus decreasing its resistance, the ratio of R_3 to R_1 changes and, in turn, produces a deflection in the reading of M_1. R_2 merely serves to set the relative meter reading

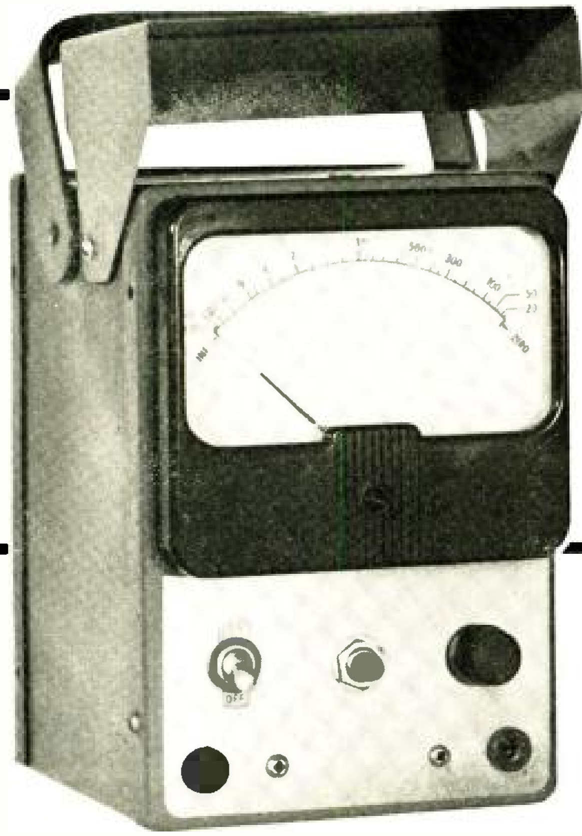
(Continued on page 90)

Under-chassis view shows the few components that are employed. ▶

A new scale was drawn for the meter to show dangerous temperature.







A Transistorized Megohmmeter

By **J. P. JEFFRIES**

Low-voltage batteries are used to generate high voltage for measuring from 20,000 ohms to 100 megohms.

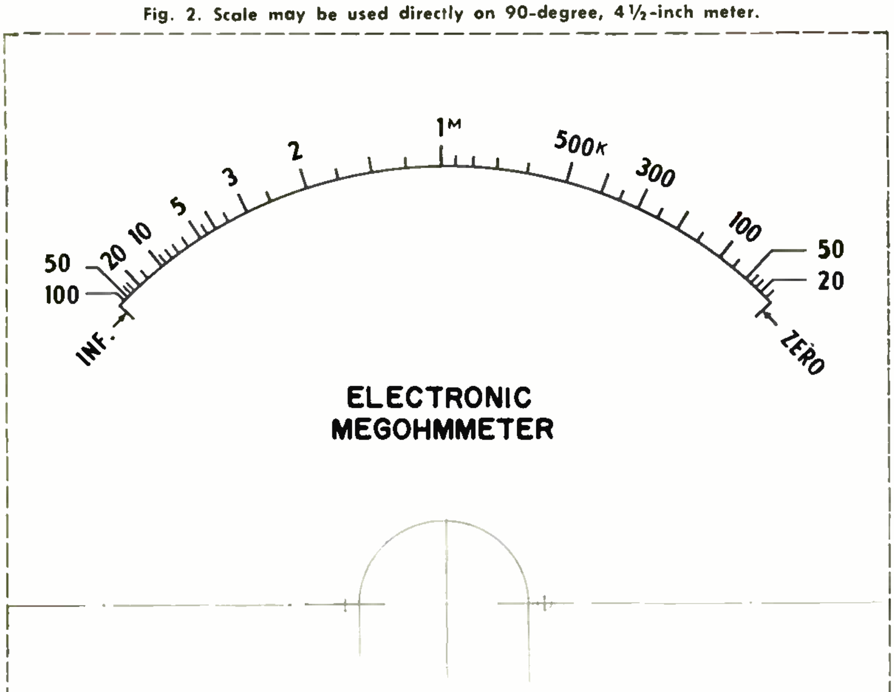
◀ Fig. 1. The self-powered unit needs only a pair of test leads.

FOR THOSE cases when fairly high resistances are to be measured, as when checking insulation breakdown, for example, the ordinary ohmmeter cannot be relied upon for reasonably accurate readings. A special instrument for reading such higher resistances and depending on a higher source voltage than that directly provided by low-voltage batteries is desirable. This device, Fig. 1, powered by low-voltage dry batteries, provides a test potential of 500 volts. It may be conveniently read in the range from 20,000 ohms to 100 megohms, with the 1-megohm reading at center scale.

A transistorized-oscillator power supply is used, with the stepped-up voltage regulated to within 1 per-cent by negative feedback. This regulation is effective during the useful life of the batteries and for a considerable range of temperature variation. The stabilized high voltage powers a simple ohmmeter circuit using a 500-microampere meter movement and a 1-megohm series resistor.

A 6-volt lantern battery powers the d.c.-to-d.c. converter. Current drain varies with load changes, which depend on the magnitude of resistance being measured by the external prods. This is as low as 20 milliamperes of idling current and goes to a peak of 80 ma. drawn when the test prods are shorted. A size D flashlight cell supplies a reference bias current of about 150 microamperes for the feedback amplifier.

Fig. 2. Scale may be used directly on 90-degree, 4½-inch meter.



The Circuit

The power supply uses a conventional transistor oscillator (Fig. 4). Similar circuits have been described many times. A modified output transformer, T_1, and power transistor V_1 resonate at an audio frequency so that battery current through the primary is a.c. The higher a.c. voltage induced in the secondary winding is rectified by silicon diode SR_1 and the elevated d.c. voltage is produced across capacitor C_1.

The desired output voltage may be regulated by adjusting the base current of V_1. Instead of a base resistor, the effective collector-emitter resistance of V_3 in the regulating amplifier serves this purpose. The direct-coupled d.c. amplifier, consisting of V_2 and V_3, automatically adjusts bias to the V_1 base to maintain constant output voltage of the latter at the desired level.

Input current for the amplifier is tapped off between R_2 and R_1 in the bleeder network of the d.c. high-voltage output, and is applied to transistor V_2 so as to bias the latter in the forward direction. However this relatively high current is largely canceled out by a reverse bias supplied by the 1½-volt cell. The net effective bias can be adjusted by potentiometer R_3, which is effectively in series with the 1½-volt cell. This adjustment affects the collector current of V_2 which, in turn, affects the base current of oscillator transistor V_1, and therefore determines the level of the output voltage.

Should the output voltage decrease for some reason, a corresponding decrease occurs in the forward bias current of V_2. This, in turn, causes an increase in the collector current of V_3 and thus also in the base current of power transistor V_1. Oscillator output is thus raised to restore the d.c. output voltage to its original level. If output voltage should increase, the forward bias current of V_2 increases, and oscillator output is reduced.

Thus, when the gain of the d.c. amplifier is properly adjusted, any change that affects the level of the desired output voltage is automatically counteracted by a change in the oscillator.

Components & Construction

The output transformer is virtually any type with a husky, one-inch core. The one used was selected from a junk box because it was of a type easily dismantled for modification. The outer, secondary winding was removed and replaced with a center-tapped winding consisting of approximately 250 turns of number 28 enameled wire. This served as the T_1 primary, with the original primary becoming the high-voltage secondary winding.

Rectifier SR_1 should have a peak inverse voltage rating of 800 volts. Silicon diodes with such ratings are available, but it is possible to get around the use of a special component by using two such general-purpose diodes in series, each rated at 400 p.i.v. There are suitable units, available at low cost, for example, in the *Sarkes Tarzian* F and H series. Since current drain is so small, this factor will not be critical. The requirement for an oil-filled capacitor may also be reconsidered. A pair of molded tubular capacitors in series, rated at 600 volts and 1 μf. (or somewhat less) each, should serve. Single capacitors of this type rated at .1 μf. and 1000 volts are also available.

The 6-volt lantern battery used (*Burgess* Type F4H or equivalent) has positive coil-spring contacts. Its holder was formed from a strip of 18-gauge sheet metal. Two brass contacts, insulated from the metal holder by a sheet of ⅛-inch fiberboard, make good contact with the spring terminals.

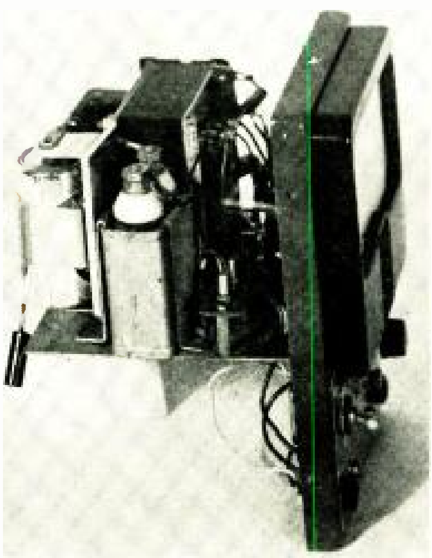
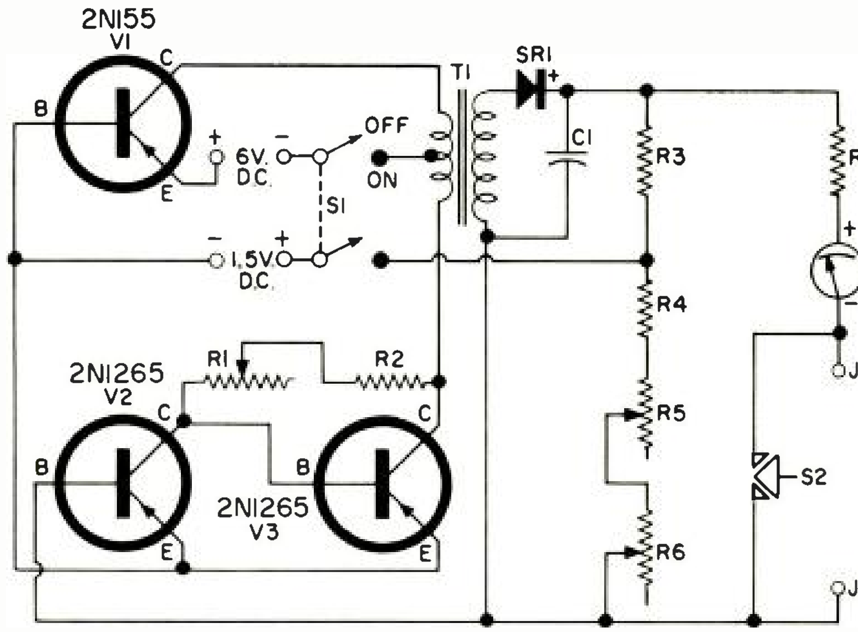


Fig. 3. The main chassis, including bias cell, is mounted to the front panel.



R_1—50,000 ohm linear taper pot (screwdriver adj.)
R_2—25,000 ohm, ½ w. res.
R_3—3.3 megohm, 1 w. res.
R_4—5000 ohm, ½ w. res.
R_5—5000 ohm linear taper pot (screwdriver adj.)
R_6—2000 ohm linear taper pot
R_7—1 megohm, 1 w. res. ± 1%
C_1—.1 to 1 µf., 1000 v. oil-filled capacitor (see text)
S_1—D.p.s.t. toggle switch
S_2—Normally open circuit push-button switch
T_1—Osc. trans. (see text)
SR_1—See text
J_1, J_2—Phono tip jack
M_1—0-500 µa. meter
1—1.5 volt "D" cell
1—6 volt lantern battery (see text)
V_1—2N155 power transistor (or equiv.)
V_2, V_3—2N1265 transistor (Sylvania)

Fig. 4. Circuit includes step-up power oscillator and feedback regulator-amplifier.

The main chassis (Fig. 3) is mounted on the front panel of the instrument, which was designed to fit into a metal cabinet (Fig. 5) 5 inches wide, 7 inches high, and 5 inches deep, with a hinged door on the back. The lantern-battery holder slides right out of the cabinet to facilitate replacement, and an adjustable, metal visor was added to protect the meter face when the instrument is not in use.

A reproduction of the meter scale as used by the author appears in Fig. 2. It is suitable, in the size shown, for any 4½-inch square meter having a standard 90-degree scale arc. It may be scaled proportionately for meters of other sizes with a 90-degree arc.

Wiring and parts placement are generally not critical. All components are standard items, with the exception of the already-mentioned oscillator transformer. In connection with the latter, there is one further note. Since the waveform generated by the oscillator is not symmetrical, the rectified output voltage may depend on which way the leads from the transformer secondary are connected. During adjustment, it may be necessary to reverse these leads for best results.

Potentiometers R_1 and R_5, to be used in initial adjustment of output and regulation of the amplifier, are screwdriver-adjusted types located at the rear of the chassis. Potentiometer R_6, the zero-adjust control in regular use, is knob-adjustable and mounted on the front panel, along with "on-off" switch

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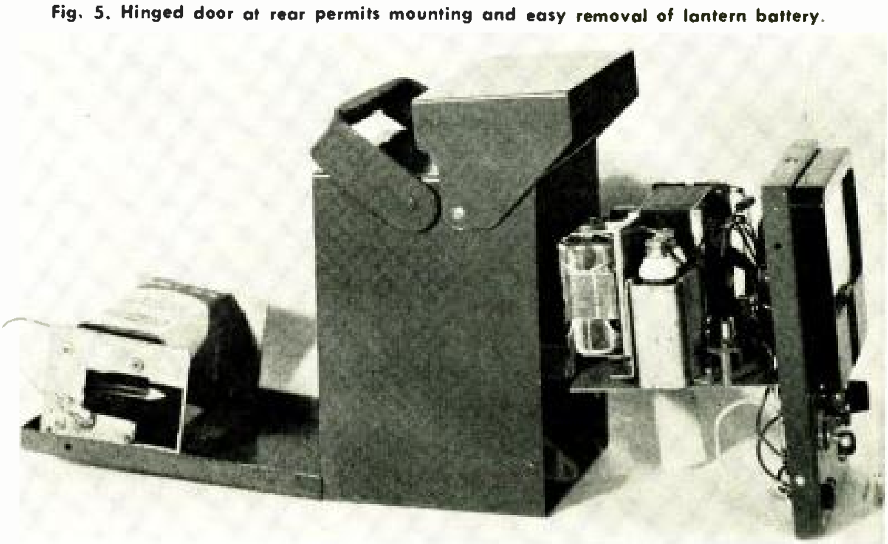
Fig. 5. Hinged door at rear permits mounting and easy removal of lantern battery.



EDITOR'S NOTE: *For most service-business problems, there are no pat answers. The handling of repair estimates, generally expected by the customer, is no exception to this rule. What works for one dealer may be of no use to another. A good part of "Home-Call TV Diagnosis," in last month's issue, was devoted to this problem. John Frye (see this month's "Mac's Service Shop") suggests a somewhat different technique. Here the author offers still another method. One of his premises is that the customer will not sit still for an estimate charge, if he does not order the work. (Frye and many others will disagree.) He therefore projects a technique that avoids extensive diagnosis. Compare these various approaches and make your own choice. It's good to have this much variety to pick from!*

PRACTICAL REPAIR ESTIMATES

By **ALLAN MARSH**

The customer demands them, but doesn't want to pay—and they cost you money. A way around the dilemma.

ONE OF THE great banes of electronic repair is that most of the work on most jobs must be done before the jobs are actually started. From this paradox arise the woes associated with the custom of "estimating." As those who have done various types of service work know, the practice requires that the customer be told the cost of repair before repair is undertaken.

This tradition, not native to electronics, was passed on to it from other types of service work. However, a peculiarity of electronic service makes the practice particularly troublesome. Take the case of a defective car, for example, in which the owner complains of a fearful noise coming from under the chassis as he rides. The mechanic listens, bends down for a quick look, and notes that the tailpipe is disconnected because a mounting clamp has come loose. With practically no time or effort, he knows what is wrong. He mentions the cost of repair, which *will* take time and effort. If the car owner decides to go elsewhere, little has been lost.

With malfunctioning electronic equipment, the cart is before the horse. The defect is seldom obvious. To make a repair, the technician must analyze the equipment and locate the defect or defects. To come up with an accurate estimate, he must perform essentially the same work. Actual replacement of defective parts is generally simple and routine. In a sense, the money the dealer gets for most repairs is largely for diagnosis rather than repair.

The practical solution to this problem is the development and use of a simple, methodical system for approximating the cost of a projected repair. Note that we have used the word "approximating" rather than "estimating." A sharp distinction is made between the two. We will go into details later but, for the present, it is enough to say that the difference is that of five minutes on the one hand and an average of perhaps half an hour on the other. Calculated in dollars and cents, that is quite a spread.

How is this conclusion reached? Assume that you have a technician in your shop who is good enough to repair just about anything that may come in through your door and pleasant enough to do a good job of handling any customer who might come in through the same door. Let us say that you can't hold on to this gem for less than three dollars an hour. Without even trying, we can add another two dollars an hour for lights, rent, advertising, coffee breaks, and an endless list of other expenses. This will bring you to at least five dollars an hour to keep the shop going. Also assume that you are not in business for laughs. A reasonable, average gross from your business (whether you are actually getting it or not) is eight dollars an hour.

For those who may think the eight-dollar figure too high, let us digress briefly. You may have been so conditioned by the unhappy situation of the electronic service industry in so many places that you are resigned to it. Or else you may not have stopped to figure things out in the way that any businessman should. Instead of analyzing the situation in detail, we will give some examples. Retailers who sell goods rather than supply services try to work on an average mark-up of thirty per-cent, although there is considerable variation. A lumber yard, for example, works on fifty to one hundred per-cent. We are not talking about people who are growing wealthy: these are simply businessmen who are doing well, but no better than you have a right to expect. In short, you (or your technician) must bring in an average of eight dollars an hour, not counting parts, if you are to remain in business and smile at the end of the week.

High Cost of Diagnosis

Now let us see how this eight-dollar figure applies to the practice of giving estimates. A customer enters your shop with a defective piece of equipment and says, "Please tell me exactly what is wrong with this thing and exactly how much it will cost to have it repaired."

You accept the unit and diligently try to establish the cause of malfunction. On rare occasion the trouble can be spotted immediately. More frequently you will require almost any amount of time up to several miserable days. There are such things as tough dogs, you know. Since we must have an average time, let's assume half an hour. However, we have not included what may be called "talking" time. You are going to have to discuss symptoms with the customer. It may be diplomatic to mention the weather and a few other irrelevant items. You will also have to fill out a ticket. Thus the half-hour figure is not high.

Now if every diagnosis-and-estimate turned into a repair job, we would not have to worry about how much the procedure cost your business because this amount would be recovered in the repair fee. But that does not always happen. The percentage of service "shoppers" will depend on location, general financial conditions, and perhaps even the weather. In any event, a significant per-cent of customers will try for free estimates at several shops before giving out the job, and you will lose out on many of these. In other cases, when the customer hears the estimate price, he may decide not to have the work done at all. Perhaps he thinks it more practical to go out and buy a new set—elsewhere.

We must therefore decide on the cost of estimating. Half an hour at eight dollars an hour makes it appear that the average estimate costs the company four dollars. We say "appear" because the cost is actually more. Take the case where the customer can't make up his mind right away. Perhaps he has to go home and confer with the little woman. Then, even if he decides to have the work done, he doesn't rush right back to your shop. By the time he gets around to returning, you have forgotten all about your first, four-dollar exploratory investigation, and you start from scratch. When you get paid for the completed repair, this covers only one diagnosis fee. The other is out of your pocket.

Suppose that, when the customer comes back, you are lucky—you remember your earlier diagnosis. There is still some duplication of effort that you haven't reckoned with. The simple job of removing the set from the cabinet must be repeated. At eight dollars an hour, the time required just to remove two screws will pay for "coffee and." It may take time to set up equipment all over again to make the repair.

The Element of Error

Another fallacy of the diagnosis-based estimate is the fact that it frequently fails in its purpose. The reason for preliminary diagnosis is to eliminate or at least reduce doubt as to what is wrong. In most cases, however, the investigator stops as soon as he has found a defect. This may mean trouble.

For example, an open i.f. transformer is found on a radio that has not been producing any output. It is neither usual nor practical for the technician to replace the defective transformer temporarily and try the set out. Perhaps the set also has a bad speaker or some other defect that will remain hidden.

As a result, when the estimate is in error, it will be on the low side. If the customer has told you to go ahead with a repair based on one price and finds that you ask for more after you are done, you may have a sticky situation on your hands. Yet it was specifically to prevent this that you spent time in diagnosis.

Possible Solutions

How can you cope with this dilemma? There are many answers, some of them obvious. Let's consider them:

Stop giving estimates. This is fine if you can get away with it. For most shops it will not work. The customer must have something to go on in order to decide whether the repair is at all worthwhile or not, or whether he may run up a bill he is not ready to pay. If you won't oblige him, somebody else may.

Charge for estimates. This is the ideal solution and, if you can get away with it, use it by all means. But it won't always work. If your local competition is giving free estimates, you are just out of luck. Besides, put yourself in the customer's shoes. He has a sixteen-dollar midget under his arm. Will he spend four dollars to find out what is wrong with it? Would you?

Charge less for estimates. Suppose you set a fee of only two dollars. You are still losing two dollars and, in addition, you are assuming all the disadvantages of the full estimate fee. Your customer, once he pays, feels he is entitled to a specific service—being told exactly what is wrong. Let us say he gives you the two dollars to learn that his speaker is defective, but does not authorize the repair. He decides to install the new speaker himself. But he does it *incorrectly*, causing damage, or the set still doesn't work because something else is also wrong. What a revolting development! He has paid you for something and he feels cheated. At the same time, you have lost two dollars.

There's another complication that is made clear by considering the house-call situation. Forget added costs—perhaps your house-call fee makes up for this. Diagnosis, which takes time to be good, takes even longer here because there is no convenient service bench ready and waiting—and it must be performed in the customer's presence. The impatient customer begins to think, "If this guy knew his stuff, he wouldn't horse around so much." He thinks you are fumbling and begins to lose confidence. This wouldn't happen back in the shop, out of his sight. Or else he decides, "This guy is trying to work up a case." Another dilemma! He would have more confidence in a quick (also careless and cheaper) diagnosis.

A Fresh Approach

At this point, the situation seems pretty hopeless. You must either charge a legitimate but completely unrealistic figure for estimates and lose business, or lose money in order to get the work. Don't give up; there is a way out. The practical solution is the "approximation," or the "guesstimate," if you will. This is an estimate that may be given free because it costs you practically nothing. It comes so cheap because it takes almost no time at all. It takes no time because it does *not* involve extensive diagnosis. This is neither as wild nor as reckless as it sounds.

Let's take the case of medium-priced, packaged, so-called "hi-fi" sets. Your books for the past year show that you repaired one hundred such units for a total charge of $2000 and that you made some profit on this work. In other words, your average charge for fixing such units was $20 each, regardless of what was wrong. Suppose you used this figure automatically as a free estimate on every such unit brought into your place without even looking at it. You would save your own diagnosis cost, upping your profit per job, and you would be giving the customer a prompt, confidence-inspiring answer. If you turn out to be wrong, you have not cheated the customer because you have not charged him for your mistake.

"But individual jobs are not average jobs," you protest. "Not every, specific job came to $20 exactly all year long, even though they averaged out to that figure." You are right. You cannot go to extremes with the "approximation." You cannot eliminate diagnosis altogether. But you can make practical compromises. In practice, the approximation method does involve some diagnosis, but only the kind that can be performed quickly and that will eliminate wild variations.

Let's try this out on the packaged "hi-fi," which probably comprises a record changer with cartridge, an amplifier, and one speaker or more. The amplifier includes an output transformer, which may be somewhat more expensive than other components used. This may also be true of the power transformer, although there is a good chance one is not even used in a moderately priced set of this type.

You use a simplified system we will call checking rather than diagnosis. By simply touching the grid of the output tube and hearing a recognizable output, you can clear the speaker and output transformer. This is not foolproof, but you are now working on a percentage basis. Remember that the complete-diagnosis method is not foolproof either. You now unplug the cartridge lead where it enters the amplifier and plug it into your shop amplifier (or clip a pair of probing headphones across this lead). You put on a record, start the changer, and listen. Everything here works. Changer and cartridge are eliminated. This leaves nothing but a straightforward amplifier, minus the output transformer, using standard components. Would five dollars for parts and one or two hours of time take care of almost every contingency? Of course it would. You have a basis for a sound "guesstimate."

Suppose that everything else worked but the changer didn't cycle properly or failed to set the stylus down at the right spot. You have already narrowed things down to a small area and have some idea as to whether parts replacement or mere adjustment will do the trick. Thus you have some basis for a price.

You could use similar methods for a TV set. You may eliminate the probability of a bad picture tube, tuner, flyback, or other expensive component quickly. You may be able to localize the circuit, if not the actual defect. If it is a standard circuit with no fancy components, you have done enough. We are not trying to present the specific technique for each type of equipment. We are stressing the *attitude* with which approximation methods must be worked out.

You will not always be right—but you will seldom be wrong. When you do slip up, the customer does not feel cheated because he has paid you nothing. He is much more willing to listen to your explanation that an estimate is only an estimate, and not a guarantee of the repair price.

The auto-repair industry has been using such techniques for years. Many shops rely on charts that list the probable time and parts required for various types of complaints. Estimates are based on such data. It is about time the electronic-service industry updated its methods. The problem is more one of business know-how than technical skill.

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NEGATIVE RESISTANCE | What It Is & How It's Used

By **RUFUS P. TURNER**

Negative-resistance devices have been with us long before the tunnel diode. Here are descriptions of some of them, along with how and why they operate.

THE TUNNEL DIODE has turned many minds toward negative resistance for the first time. Negative resistance is not new, but some electronics people just a few years ago had not heard of the phenomenon, or had forgotten what they once learned about it, because they would give a pitched battle on the subject. Always, they challenged. "How can you make any resistance lower than zero?", which only shows that they thought in terms of wiping out resistance, not of changing its sign. Zero resistance is one thing; while negative resistance is something else again.

The concept is easily demonstrated to the dubious, in the following common-sense terms. Consider a negative resistance (R_n) connected in series with a conventional (positive) resistance (R) and an adjustable d.c. source (E), as shown in Fig. 1. The following facts are evident: (1) the same current, I, flows through all parts of this series circuit and is determined by the voltage E and the sum of the two resistances (without regard to the negativity of R_n), so Ohm's Law is not violated. The interesting point is what happens to the voltage drops, e and e_n, produced by this current: whereas e increases with E and I in the normal manner, e_n decreases. (Increase I, and e_n decreases; decrease I, and e_n increases.) Thus, the EI curve of this component must have a negative slope. (2) Irrespective of their magnitudes, however, $e+e_n=E$. So Kirchhoff's Second Law is not violated. (3) Whereas the conventional resistance consumes power, the negative resistance seems to deliver power. Actually, the total power supplied by the d.c. source remains the same; it is only distributed differently between the positive and negative resistances. Thus, the Law of Conservation of Energy is not violated.

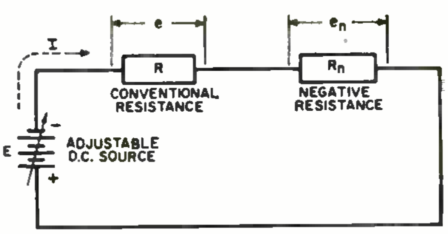


Fig. 1. Illustration of basic principle.

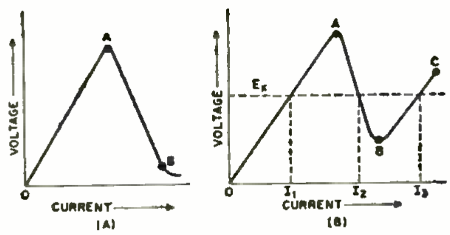


Fig. 2. Negative-resistance E-I curves.

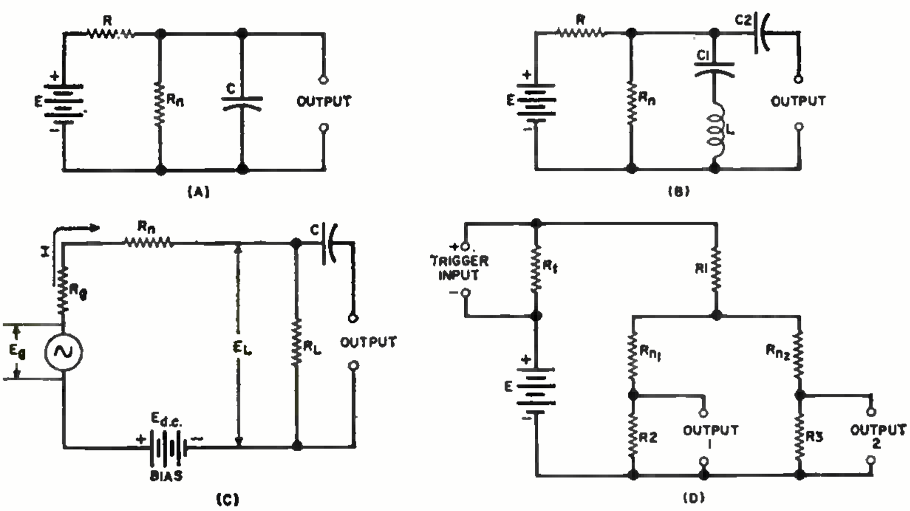
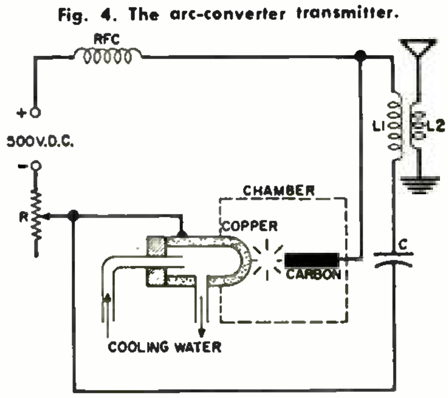


Fig. 3. Equivalent circuits of negative-resistance devices. Circuits simulated are (A) relaxation oscillator, (B) sinusoidal oscillator, (C) amplifier, (D) flip-flop.

Most negative-resistance devices have a current or voltage region in which their resistance becomes negative. Outside of this region, the resistance may be positive. In Fig. 2A, for example, as current through the device is increased, the voltage drop across the device increases from 0 to A, indicating positive resistance, but then decreases from A to B as the current is further increased, indicating negative resistance. In Fig. 2B, there is a negative-resistance region (AB) between two positive-resistance regions ($0A$ and BC). Thus, at voltage E_x the device current may have any one of three values (I_1, I_2, or I_3). Another type of negative-resistance device would have the current and voltage axes swapped. Positive-resistance regions are stable; negative-resistance regions unstable.

Negative resistance may be put to work for various tasks, such as oscillation, amplification, frequency conversion, harmonic generation, counting, and switching. The circuits usually are very simple, since the negative resistor generally is a 2-terminal device. Fig. 3 shows several typical circuits. A rule of thumb is that when a negative resistance (R_n) is operated from a d.c. supply in series with a positive resistance (R), shunting R_n with a capacitor (as in Fig. 3A) produces a relaxation oscillator, and shunting it with an LC tuned circuit (Fig. 3B) produces a sinusoidal oscillator. Fig. 3C shows one of many negative-resistance amplifier circuits. Here, the d.c. voltage, $E_{d.c.}$, biases the negative resistor, R_n, into its negative-resistance region, the a.c. signal is supplied by a generator having internal resistance R_g, and the output signal is developed across the load resistance, R_L. If R_n were not in the circuit, E_L would equal $E_gR_L/(R_g+R_L)$. With R_n present, however, operation is somewhat different. In this case, the gain increases so that the amplifier may go into oscillation. Here the negative resistance is simulated by the

Fig. 4. The arc-converter transmitter.



use of positive or regenerative feedback.

Flip-flop action may be obtained when a negative resistor is operated so as to provide three-point response, such as shown in Fig. 2B. The device is initially biased at its lowest *EI* point (I_1, the first stable state in Fig. 2B). If the voltage then is raised momentarily higher than the value E_1, the device conduction will flip to the second stable state (I_3 in Fig. 2B), where it will remain until switched back to I_1 or until the bias is momentarily interrupted. Fig. 3D shows a two-legged circuit (with two negative resistors, R_{n1} and R_{n2}) employing this principle. First, R_{n1} in one leg conducts at the low point (I_1 in Fig. 2B) and R_{n2} in the other leg is at point I_3 in Fig. 2B. Momentary increase of the bias by application of the trigger pulse shifts R_{n1} to point I_3. But because of the voltage drop across the common series resistor, R_1, both legs cannot be maintained "on" (*i.e.*, at conduction point I_3) simultaneously. So R_{n2} switches "off" (*i.e.*, to point I_1). Thus, alternate trigger pulses switch the output back and forth between Output 1 and Output 2.

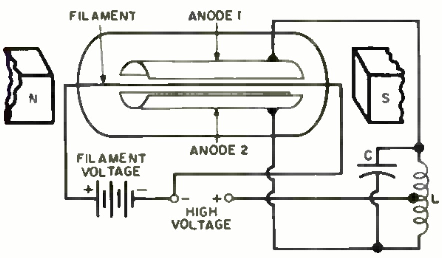


Fig. 5. The early split-anode magnetron.

Negative-Resistance Devices

The tunnel diode is a simple, convenient, and practical negative-resistance device but it is not the first component to provide $-R$. The answer to the question, "When were you ever able to buy a negative resistor?" is "For a long time, indeed, but it was called by other names; negative resistance was not its main function." Devices which exhibit negative resistance have come forward from the early days of wireless to the present time, and it seems likely that new ones will be discovered long after the tunnel diode has become commonplace. The following discussion describes a few of the most prominent devices other than the tunnel diode. Only d.c.-operated devices are included.

Arc. In 1900, Dudell discovered oscillation in the d.c. electric arc, and Poulsen soon put this device to work as a generator of continuous waves which finally actualized early radiotelephony. (The arc must not be confused with the spark transmitter, which generates *damped* waves.)

Fig. 4 shows the basic circuit of an arc transmitter. To increase efficiency, the arc was operated in a hydrocarbon atmosphere; and, for good heat conduction, one electrode was made of copper. The applied voltage was from 200 volts to several kilovolts d.c. and power ratings extended up to 1000 kilowatts. In the 1920's, many of the high-powered government radio stations were arc-equipped. Long wavelengths were used. The arc gave way to the more efficient and compact, clean-operating vacuum tube but it is important historically as an early, high-powered, negative-resistance device.

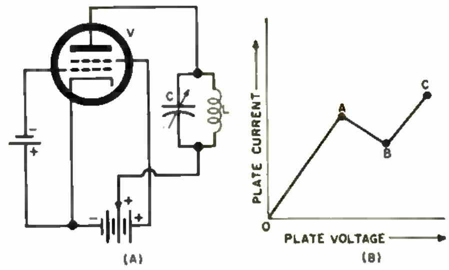


Fig. 6. Circuit and curve for the dynatron.

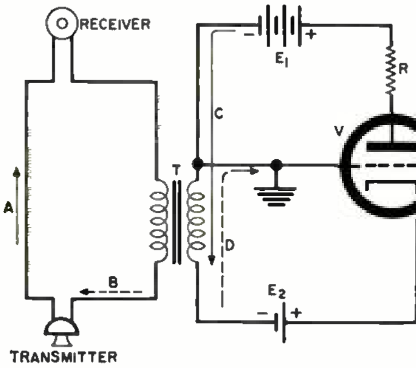


Fig. 7. Grounded-grid amplifier application.

Magnetron. The magnetron (first reported in 1921) is a vacuum diode tube in which negative resistance can be obtained through the action of electrons in a strong field produced parallel to the tube electrodes by an external permanent magnet. Fig. 5 shows one type of magnetron. Here, the anode (plate) of the tube is split into two halves. Electrons tend to pass from the filament or cathode to both halves of the anode; but actually pass in the greater number (producing high current) to the half which is at the lower potential. This effect of increasing anode current by lowering anode voltage corresponds to negative resistance. This type of magnetron is used up to 1000 mc.; other types at higher microwave frequencies.

Dynatron. Another old-timer (1918) is the dynatron effect in tetrode vacuum tubes. Fig. 6A shows a typical dynatron oscillator circuit. In this arrangement, the tube screen is operated at a higher positive voltage than the plate. Secondary emission from the plate is responsible for the negative-resistance effect. (As the plate voltage is increased, the velocity at which primary electrons strike the plate and the number of secondary electrons that accordingly are emitted increase. The secondary electrons are attracted back to the more positive screen, thereby reducing the plate current and resulting in the negative slope from *A* to *B* in Fig. 6B.)

Grounded-Grid Amplifier. Under certain conditions, a grounded-grid amplifier provides negative resistance. One such condition occurs in the telephone repeater amplifier, shown in simplified form in Fig. 7. This amplifier delivers power to the telephone circuit in which it "rides," instead of absorbing power, hence qualifies as a negative resistance. Voice currents from the transmitter (microphone) produce instantaneous currents represented by the dotted arrows, *B* and *D*. These currents, in turn, cause a plate current, represented by the solid arrow *C*, which is opposite to *D* because of 180° phase shift by the tube. This plate current induces a voltage across the line winding of the transformer, represented by solid arrow *A*, which is in series-aiding to the transmitter voltage. This induced voltage, being in-phase with the speech voltage, aids the latter, causing more current and power in the receiver. (One of the actions of a negative resistance is, as we have shown earlier in this article, the delivering of power to the circuit.) When the amplifier is not operating, the voltage drop across the transformer absorbs power (positive-resistance action).

Point-Contact Transistor. If positive feedback is introduced in a device which has a higher-than-1 current gain, the input resistance of the device will be negative over a portion of the conduction characteristic. The point-contact transistor is such a device. In Fig. 8A, positive feedback is provided by the external base resistor, R_b. As the d.c. input (emitter) current is increased, as shown in Fig. 8B, the emitter voltage (V_e) increases positively to *A* and then to *B*, then negatively from *B* to *C*, and positively again from *C* to *D*. The central

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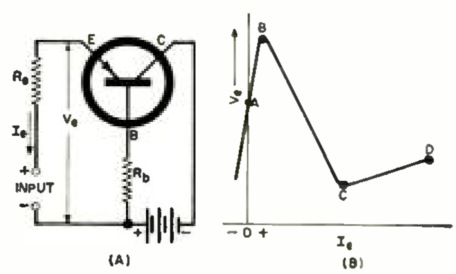
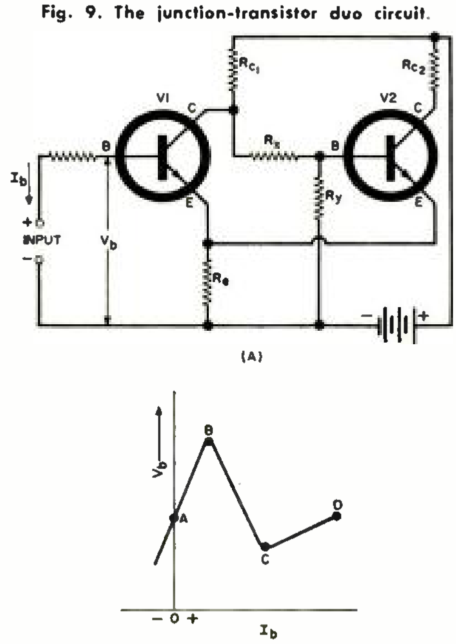


Fig. 8. Point-contact transistor operation.

Fig. 9. The junction-transistor duo circuit.



Power Supplies for Transistor Circuits

By **HOWARD BURGESS**

Construction techniques for easy-to-build, inexpensive a.c. power supplies with variable output for transistors.

THERE WAS A TIME when milliwatts were not in style, but with the transistor, low power has become quite respectable. Transistors do a great many useful jobs with just a fraction of a watt, but even milliwatts are expensive if they must always come from batteries, especially if frequent replacements have to be made.

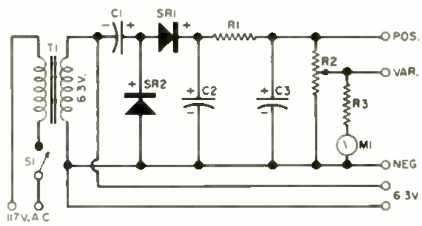
When transistor work is being done around the shop or work bench, small a.c. power supplies have several points in their favor. They are an economical source of power that does not run down with constant use. They can be adjusted to any desired value of voltage, and they have an unlimited "shelf life." The small power supply becomes even more attractive if it can be constructed for the price of a good battery.

A good share of transistor power requirements can be met with voltages in the range between 1½ and 20 volts with current ratings up to perhaps 30 milliamperes. Small power supplies in this range can be assembled from parts found in the junk-box of almost any experimenter or radio-TV service technician.

Power Transformers

Any power supply intended for experimental use should have a power transformer. In addition to reducing the line voltage to the desired value, the transformer gives isolation from the power line. This makes the unit safe for the operator even if he is a young beginner.

Power transformers for miniature power supplies are seldom listed as such in parts catalogues, however there is a plentiful supply in the form of audio-output transformers and filament transformers. As an illustration, the plate-to-voice-coil transformer from an old a.c.-d.c. receiver will give 1½ to 3 volts of rectified d.c. when used as a power transformer. A plate-to-line transformer of the tapped variety can be made to furnish up to 30 volts of d.c.



R_1 — 200 ohm, 1 w. res.
R_2 — 5000 ohm wire-wound var. res.
R_3 — 10,000 ohm, 1 w. res.
C_1,C_2,C_3 — 100 μf., 25 v. elec. capacitor
M_1 — 0-1 ma. meter
SR_1,SR_2 — Selenium rectifier (see text)
S_1 — S.p.s.t. switch
T_1 — Fil. trans. 6.3 v. @ 1.2 amps. (see text)

Fig. 1. This voltage-doubler circuit requires two rectifier plates as described.

with very good current capabilities. As shown in the following example, a small filament transformer of the 6.3-volt variety will supply a good husky 12 to 15 volts of d.c. when used with a voltage-doubler type of rectifier.

Rectifiers

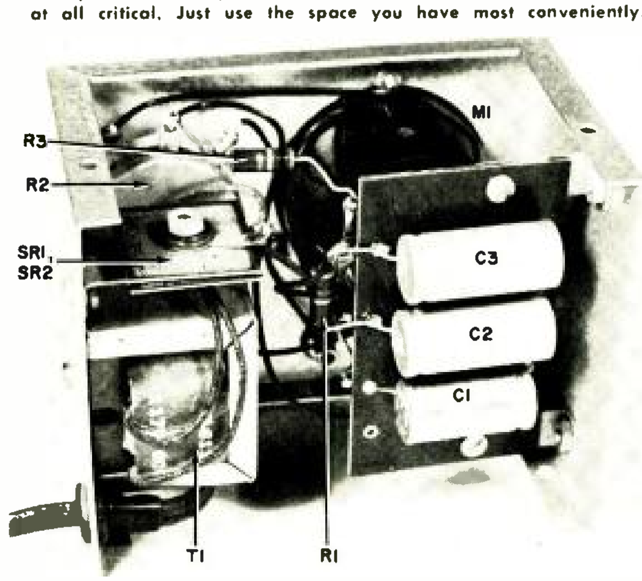
The rectifier is an important item. Because vacuum tubes have too much internal resistance to be used in this type of supply, the choice is between crystal diodes and the familiar selenium rectifier. To keep the cost down, selenium was selected. Many usable plates can be salvaged from discarded units. The salvaged plates from standard 117-volt rectifiers can be arranged to give either bridge or voltage doubler hook-ups.

Nearly all of the small selenium rectifiers can be dismantled by removing the center eyelet with a pair of side cutters. When the eyelet is removed the plates will fall apart unless the unit is one of the painted varieties. In this case it should be soaked for a few minutes in lacquer thinner or similar solvent. Never force the plates apart as this can destroy the thin coating of selenium that is on one side of each plate.

This coating appears as a thin layer of bright metal. If the plates are painted, a slightly raised area shows under the paint. This plated side acts as the cath-

The little power supply can be built on just a piece of board but a few extras can make even this simple project attractive.

The placement of parts in these little power supplies is not at all critical. Just use the space you have most conveniently.



ode in the rectifier's operation. In schematic diagrams the plated side is usually designated by a heavy bar and the uncoated side by an arrow. A voltage-doubler rectifier can be made with only two plates which are re-assembled as shown in Fig. 2 and the photographs. The plates are held together with a small bolt through the center hole but care must be taken to make sure that the bolt is insulated from the plates. This can usually be done with the fiber tube and washers that were on the original eyelet. The bolt should be tightened just enough to hold the plates snug. Too much pressure can damage the selenium coating.

Filters

The filter circuits in these small power supplies must have much less resistance than is customary in ordinary power supplies. The voltage is low to begin with and it is an easy matter to lose a large part of it in ohmic losses. It is fortunate that at these low voltages large capacities are easily obtainable, and for many uses the filter can consist of capacity only.

For better filtering a choke coil can be used but the d.c. resistance of the coil must be low. In most cases it should be well below 100 ohms. Many times the winding on a small transformer can serve as a filter choke. If the current requirements are low, a resistive filter can be used, as shown in Fig. 1. The resistance of R_1 in the filter is made as large as possible without causing too much loss of voltage. Many times a value between 50 and 500 ohms is satisfactory.

Circuits for these small power supplies are almost as plentiful as the simple parts required to build them. However our favorite has been the voltage-doubler circuit shown. The transformer is a small 6.3-volt filament transformer and the rectifier consists of two plates recovered from a used rectifier stack. A wire-wound variable resistor was added to make the voltage adjustable from 0 to 12-15 volts. The 6.3 volts a.c. is also brought out to terminals on one end of the case as an added feature. This is for filament use with many of the vacuum-tube circuits that will operate with less than 15 volts on the plate. To make this a "deluxe" model, a voltmeter was added to monitor the output voltage. The voltmeter consists of a 1-ma. meter and a 10,000-ohm series resistor. This combination has a full-scale value of 10 volts. Since many transistor circuits operate at 6 or 9 volts, this full-scale reading should be adequate. A higher range can be had by increasing the series resistor at the rate of 1000 ohms for each volt of increase desired.

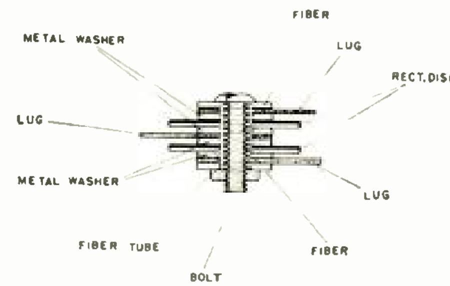
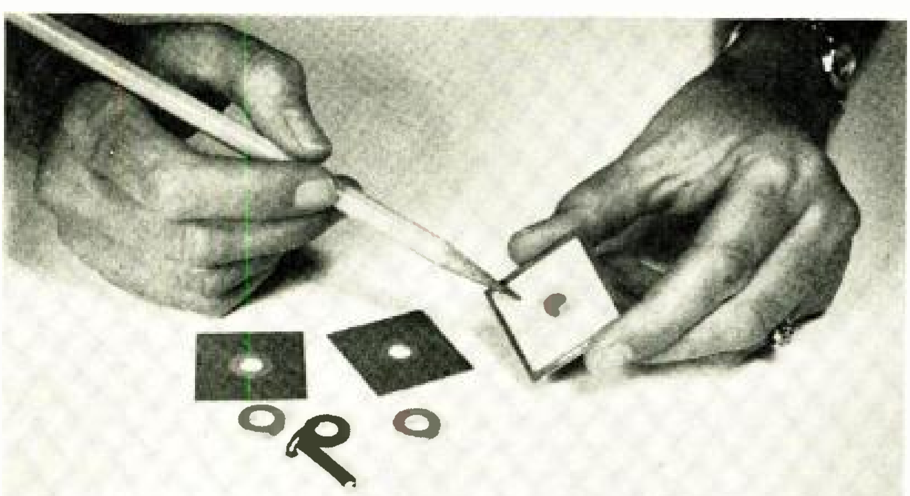


Fig. 2. The two-plate rectifier is simple to assemble but the center bolt must be insulated from the rectifier plates used.

Selenium rectifier is dismantled by clipping off center eyelet.



The selenium appears as a thin layer of a rather bright metal.

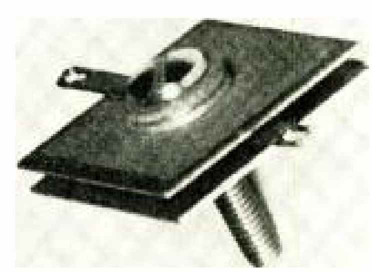
Construction

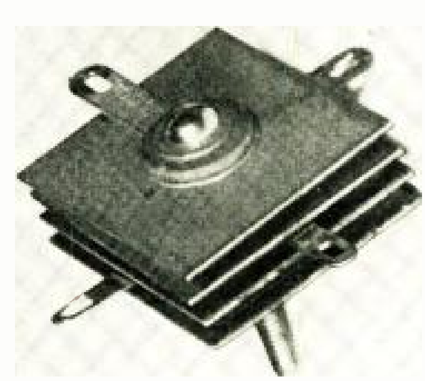
In the construction of small power supplies the parts placement is usually not important. The parts can be mounted on a small board, a metal chassis, or in a case. If possible, the selenium rectifier should be mounted where it gets air circulation for cooling. However if the parts are mounted in a metal case, such as the 3" x 4" x 5" aluminum box shown here, the rectifier can be mounted inside, but bolted to one side of the case and the metal box then becomes a heat sink.

In their simplest form these power supplies can be constructed entirely of parts salvaged from discarded material or surplus at a total cost of less than a dry battery.

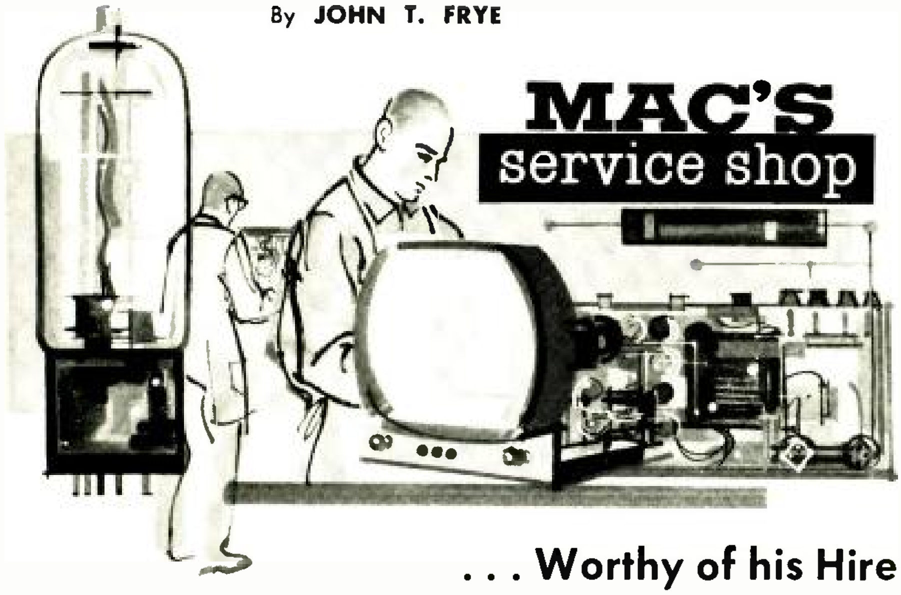
Additional accessories such as pilot lights, fuses, and switches can be added as the builder sees fit. When completed these small supplies will have almost unlimited life and, best of all, the drain from the power line is almost too low to measure. –30–

A bridge rectifier can be made up of four plates or the voltage doubler from two.





By **JOHN T. FRYE**



MAC'S service shop

. . . Worthy of his Hire

BARNEY had been down to Center City for two days attending a color television service clinic put on by a manufacturer. His employer had had quite a time persuading the youth to go, for Barney simply couldn't convince himself Mac could keep the store without him; but finally the prospect of a couple of days in the city with all expenses paid won him over.

Wednesday morning, though, bright and early, he came bouncing into the shop with the air of a knight returning from a long crusade. He made quite a production of presenting Matilda, the office girl, with a dainty little compact he had bought for her; then he marched back into the service department and thrust a black metal object into Mac's startled hands.

"What's that?" Mac demanded as he stared down at it.

"What's it look like?"

"Well, a little like something that started out to be a hand stapler and didn't quite make it," Mac hazarded.

"It's a *nibbling tool*. Here, let me show you," Barney said, taking the instrument from Mac's hand. He grabbed up a little sheet of aluminum and held it against the top of the tool as he worked the handle vigorously. The device ate through the aluminum, leaving a quarter-inch-wide gap behind it. Barney executed sweeping curves and right-angle turns in the clean-edged path cut by the nibbling tool.

"It's actually a little hand-operated punch that stamps out a bite about a sixteenth of an inch deep and a quarter of an inch wide every time you work the handle," he explained. "You can cut up to 18 gauge steel or up to 1/16" copper or aluminum with the thing, and you don't have to cut in from the side. All you need is a 7/16" hole to give the tool a start. And it's real neat the way you can nibble right along a guide line. I figure it will be the cool, cool cutter for enlarging a chassis opening to take a slightly bigger replacement transformer, for making permanent templates out of sheet metal, or for cutting any odd-shaped hole in chassis or panel for mounting things. I know we'll find lots of uses for it here on the bench, and I'm hoping you'll let me borrow it now and then when I'm building something for my ham shack and need to nibble some special holes."

"Wel-l-l-l, I'll think about it," Mac promised with a teasing grin; "but thanks a lot, Barney. It looks like a real handy gadget, but you shouldn't—"

"Hey!" the redheaded youth interrupted as he glanced across at the set-to-be-repaired rack, "where did all the beat-up radios and TV sets come from?"

"It's spring housecleaning time, remember?" Mac said quizzically. "This is the time of year when the little woman wraps up her head in a handkerchief, puts on her oldest and least-becoming jeans, and starts taking the 'sweet' out of Home Sweet Home. But you're a bachelor and mustn't be exposed to these horrors. Anyway, she pounces on any non-operating electronic equipment in attic, basement, or storage closet and speaks thusly to her miserable spouse: 'Either you get that thing fixed or throw it out. I'm not going to have it sitting around gathering dust in *my* house.' Then he brings it down here and says something like, 'Look this thing over and see if it's worth fixing. If it costs very much, I'm going to junk it.'

"Now when a customer says that, all your caution flags should come unfurled and flutter warningly in the breeze. His wife has presented him with a problem, and he's sliding out from under by dumping it squarely into your lap. He wants you to spend your time; use your expensive tools, instruments, and service literature; and apply your hard-earned technical knowledge to confirm his already-made decision not to spend any money on his ailing device. What's more, in a surprising number of cases, he expects you to do this for free."

"Yeah! How about that?" Barney exclaimed. "Did you see the story about the dealer who took in a 14" portable TV set with instructions from the owner to let him know how much it would cost to fix it? Checking revealed the set needed a new CRT and two other tubes. When this information was telephoned to the owner, he said to let the set go and he would pick it up. When he came in, he refused to pay the $3.50 estimate fee and walked out. Shortly thereafter he sued the dealer for $115 damages plus the cost of renting a TV set while the portable was being held. The court ordered the dealer to return the set without charge and to pay the owner $30 for renting a substitute. Don't you think that's pretty dirty pool?"

"I saw the story in the February 'Service Industry News' column," Mac replied; "but I hesitate to pass judgment on the court's decision. Maybe some factors in the case didn't come out in the story. We have to believe our courts hand down decisions that are fair and just according to the evidence presented. Let us start doubting that, and we're all in big trouble. But that single decision certainly can't mean technicians don't earn and deserve a reasonable amount for the time and effort they spend in locating all the troubles in a set and determining the cost of repairing these, even though the owner of the set subsequently decides he doesn't want it repaired."

"I hope to kiss a pig, it can't!" Barney exploded. "Anyone with a lick of savvy about radio and TV servicing knows that the part of a service job that takes the time, the equipment, and the brains is locating the trouble. Once the trouble is diagnosed, a ten year old kid could usually make the repair, which probably consists of snipping out a defective part and soldering in a new one. You don't see any doctors handing out any free diagnoses, do you?"

"No, and maybe there's the rub: they call their troubleshooting a 'diagnosis'; we call ours 'making an estimate.' That word 'estimate' carries with it a certain connotation of quick, rough guessing; and it is quite often seen in the company of another word, 'free.' Yesterday, for example, I had a floor covering man come up to give me an estimate on the cost of putting inlaid linoleum on the floor of a room at our house. He came in, measured the room both ways with a six-foot steel tape, stared up at the ceiling for a few seconds, jotted down some figures on a piece of paper, and said, 'It will cost $204.50.' He was in the house five minutes; the cheap steel tape was all the equipment he used; and he was figuring on a job that would bring him in more than $200 if he got it. He could well afford to make a free estimate of this sort.

"But compare that with what happens when we take in a portable TV receiver for an estimate. We check all the tubes with a tube tester costing more than the TV set cost when new. This operation alone consumes twenty to thirty minutes if done right. If the trouble is not tubes, we may have to use a $200 scope, a $50 v.t.v.m., a $150 sweep generator, and our service library in which we have invested more than $1000 to locate the difficulty. It's not at all unusual for us to spend a full hour on

(*Continued on page* 98)

AUTOMATIC PHOTO-ENLARGER TIMER

By SILOM HORWITZ and H. L. MARSH, Jr.

Construction details on a simple photoelectric exposure timer that will more than pay for itself in paper saved.

THE PHOTOELECTRIC integrating enlarging exposure timer to be described can be constructed at a cost lower than that of a commercially available photographic clock-type timer, yet it automatically relieves the user of the burden of "guessing" exposure time.

Like the automatic cameras which are becoming more and more popular, this timer "senses" the amount of light on the photographic paper, integrates this with paper sensitivity, computes the exposure required, and turns the enlarger on and off for the required period of time. Yet, it is versatile in that the operator can lengthen or shorten exposure times for special effects, and even "dodging" can be accomplished without disturbing the timer's program.

Its simplicity and low cost make automatic timing during enlarging available even to the part-time darkroom enthusiast.

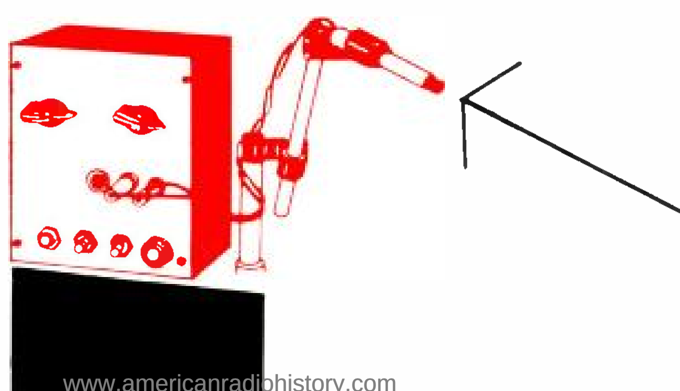
Except for rather expensive devices used in professional laboratories, especially those engaged in mass-production of color prints, determination of correct exposure during print making has been a "cut and try" proposition. Test strips are exposed to determine visually the proper print density and then the final print is exposed. This must be done for each negative of different density, for each different magnitude of enlargement, and, if a voltage regulator is not used, for different lamp intensities.

This is a rather odd condition, because for years almost all photographers, amateur and professional, have used photoelectric exposure meters to determine correct camera exposure. Although it is possible to proceed similarly when making enlargements, paper speeds (unlike film speeds) are usually unknown factors and, in addition, much more sensitive (and costly) instruments are required, as the amount of light is very small.

As normally practiced, after enlarging time has been determined, actual exposure is usually accomplished by some type of timer, either a synchronous motor type (in which a clock-type motor switches a relay on and off for the proper number of seconds), or electronically, through a device incorporating a resistance-capacitance (*RC*) circuit. Since *RC* circuit operation is fundamental to the design of this automatic timer, a basic *RC* circuit is shown in Fig. 1. Timing is related to the charging or discharging of a capacitor; in the schematic shown, decay (or discharge time) of the capacitor (*C*) through the resistance (*R*) offers the desired time interval. The capacitor charges during "off" time, when the plate of the tube is inactive and the grid acts as the plate, providing d.c. to charge the capacitor. When the switch is closed, the grid resumes its rightful role but restricts flow of electrons to the plate until the voltage supplied to it is sufficiently less negative to allow conduction. This time is governed by the size of the capacitor and, as noted previously, by leakage through the resistor. At the instant the grid allows sufficient current to flow through the cathode-plate circuit to energize the relay, the delay period is completed and the contacts on the relay open or close, depending on the action desired. This is a very useful circuit, used throughout industry for thousands of different control operations.

By using a photosensitive resistance element in place of the variable series-leakage resistance, we can integrate light to produce a time interval proportional to the amount of light falling on it. Momentary or prolonged changes in light intensity, different negative densities, and electric voltage variations are all integrated with the predetermined paper speed so that a proper exposure is produced every time.

Integrating exposure timers are not new. The first ones, designed in the



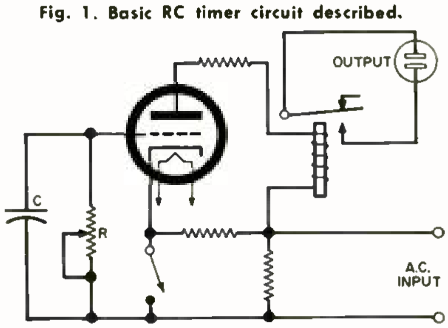
Mounting of photocell sensing unit, using the "Rotocon" assemblers.

early 1930's, utilized vacuum phototubes of the 917/919 type. Because of the very low emission (milli-microamperes!) tube amplifiers were required, which introduced possibility of non-linearity and necessitated considerable circuitry. In addition, humidities found in average darkrooms often resulted in a leakage current greater than that of the phototube, making operation erratic. As comparatively large amounts of light were needed, reflection from the photographic paper itself was not very satisfactory with this device. Prism or transparent mirror take-offs were used in some commercial units, while location under the paper is used in others.

When the photomultiplier tube was made commercially available at a reasonable price, circuits were designed for its use, and many present-day automatic enlarging printers use this type of photosensitive device. Such units can operate at very low light levels such as that reflected from paper during the enlargement process. For industrial and commercial use this is an excellent instrument, but it is quite expensive because of the circuit elements required, including the 1000 volts for the tube. It is difficult to miniaturize and the most popular and relatively inexpensive photomultiplier tube (931A) is "blind" to red and therefore is difficult to use with variable contrast papers or for direct color printing.

With the recent improvements in photoconductive devices, especially the cadmium sulfide cell, there is at last available an inexpensive means to integrate light output with a simple *RC* circuit for exposure timing. In addition, the cadmium sulfide cell is sensitive to all visual colors, so it can be used where the photomultiplier cannot, and with considerably less circuitry.

Fig. 1. Basic RC timer circuit described.



The schematic for the photoelectric integrating timer, Fig. 2, shows the basic *RC* timing circuit, but with a photoconductive cell as the variable resistor and the addition of a holding relay. With this relay, the total "on" time for both the circuit and the enlarger is the interval between the time the momentary "Start" switch (S_1) is pressed, and the release of the holding relay, which occurs when the plate relay is energized by the thyratron. This feature provides a very reliable circuit, and enables the use of a relatively inexpensive 117-volt a.c. power relay instead of a heavy-duty sensitive relay for the plate circuit. In addition, automatic "reset" action is provided by the use of the two relays, so the timer is always ready for immediate operation. (Correction: *almost* immediate. The capacitor will charge during one-half cycle, so with 60-cycle a.c., 8 to 17 milliseconds must elapse between operations. As this is a manually started device, this is not considered to be a problem!)

Other features of this timer are (1) provision for different paper speeds, accomplished by four capacitors which can be switched into the circuit as needed and a variable resistance for fine adjustment, (2) small size; even with conventional (not miniaturized) components it is no larger than a clock-type timer, (3) jacks are provided for an external footswitch, so the timer can be placed in any location, even if switch on front panel cannot be conveniently pressed, and (4) construction is simple enough so that even a novice can make it without difficulty.

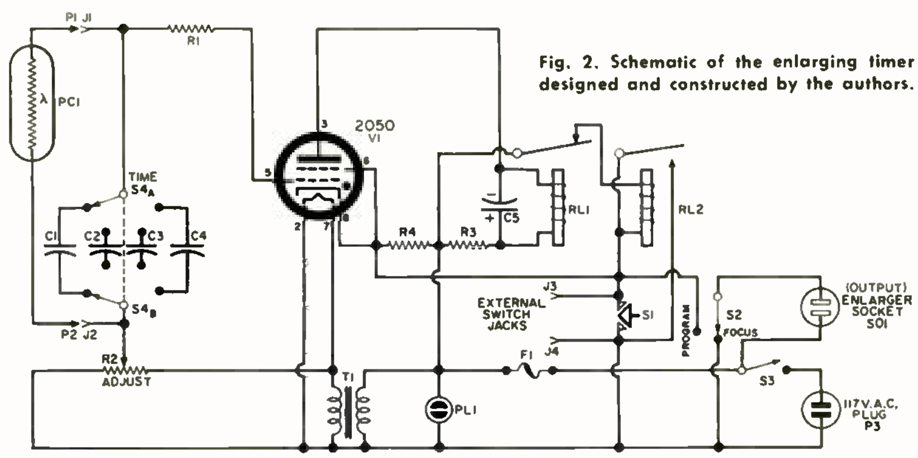


Fig. 2. Schematic of the enlarging timer designed and constructed by the authors.

R_1, R_4—50,000 ohm, ½ w. res.
R_2—5000 ohm var. res.
R_3—3300 ohm, ½ w. res.
C_1—.01 μf., 200 v. plastic capacitor (see text)
C_2—.02 μf., 200 v. plastic capacitor (see text)
C_3—.05 μf., 200 v. plastic capacitor (see text)
C_4—.1 μf., 200 v. plastic capacitor (see text)
C_5—4 μf., 150 v. elec. capacitor
S_1—Normally open push-button switch ("Start")
S_2—S.p.d.t. toggle switch (10 amps, 117 volts)
S_3—S.p.s.t. toggle switch (10 amps, 117 volts)
S_4—Two deck, 4-pos, rotary selector switch (non-shorting type)
RL_1—S.p.s.t. normally closed plate relay, 5000-ohm coil (Potter & Brumfield Type LB5, RS5D, or equiv.)
RL_2—S.p.s.t. normally open 117-volt a.c. relay, 10 amp contacts (Potter & Brumfield MR3A, Guardian 1R-500-A115, or equiv. Author used Ward-Leonard surplus relay)
PC_1—Photocell (Clairex CL-605, RCA 7412, or equiv. See text)
F_1—1 amp 3AG fuse in extractor-type fuse post
T_1—Fil. trans, 6.3 v. @ 1 amp
PL_1—Neon pilot light assembly (with built-in res., such as Dialco 95408-931) A 6.3-volt pilot light (with dimmer, such as Dialco 109-3830-111) can be used instead by wiring to low-voltage leads across var. res.
P_1, P_2—Banana plug
P_3—A.c. plug (for chassis mounting)
SO_1—A.c. socket (for chassis mounting)
J_1, J_2, J_3, J_4—Banana jack
1—6" x 5" x 4" cabinet with attached chassis (Bud #C-1796 or equiv.)
V_1—2050 thyratron tube

Construction

The cabinet is a standard unit with sub-chassis, 6" high by 5" wide by 4" deep, which is available from regular stock at most electronic parts stores. Although a smaller enclosure can be used if the 2D21 thyratron is employed, the size specified will be found most convenient for parts placement without crowding, as well as providing sufficient space for neat lettering.

Place the parts in the relative positions shown in the photographs. Exact positions will depend on the actual components selected. Mark positions and drill all required holes before mounting any parts. Two additional holes should be drilled between the tube socket and power relay for wire leads. Rubber or plastic grommets should be inserted in these holes to protect the leads.

When positioning the rotary selector switch, make sure enough space is allowed for capacitors so that panel and sub-chassis will fit the cabinet easily. Note also that the receptacle for the enlarger, receptacle plug for the 117-volt a.c. cord, and jacks for the external switch are located on the side of the rear panel opposite the tube, as otherwise there will be difficulty in assembly. (Incidentally, the three receptacles differ so that errors will not be made when inserting connectors.) Placement of parts and lead dress are not critical, but the positions shown in the photographs were found convenient.

After all the holes are drilled or punched (a chassis punch is recommended for the tube socket and receptacles) the parts should be mounted securely. The capacitors should be soldered to the rotary switch prior to mounting of the switch on the panel. These capacitors, incidentally, are the only critical parts in the circuit, and sealed, reliable units are an absolute necessity.

Two tie-points are required under the sub-chassis: one at the rear, for the common a.c. connection, and one between the tube socket and the switch, to support the relay filter capacitor. Unused terminals on the tube socket can serve as tie-points for resistors R_1 and R_2.

When components have been mounted, complete the wiring. As mentioned previously, lead dress is not critical and point-to-point wiring, as shown in the photos, is satisfactory. The leads to the receptacles and jacks on the rear panel should be cut to size, allowing some length for "maneuvering," but not fastened in place until after assembly of the front panel to the cabinet.

Before fastening to the cabinet, however, testing should be done to make certain all wiring is correct and components are operating satisfactorily. To prevent possible damage to the photocell, a one-megohm resistor is used as a dummy load. Two banana plugs are fastened to the resistor leads (or wire extensions to the leads) and these are plugged into the photocell adapter jacks. Temporarily rig the 117-volt input by clipping two wires to the receptacle leads (or fasten the receptacle plug temporarily) and plug or attach to a 117-volt source. Switch on the device and look at the tube heater—it should begin to glow. *At this time, and each time the unit is switched on, allow 30 seconds for the tube to warm up before pressing the "Start" switch.* This is an absolute "must" as application of plate current before sufficient electron flow has been established will cause ionization of the gas in the thyratron and damage to the tube.

Now position the rotary switch on C_1 (the 0.1-μf. capacitor) and turn the variable resistor completely to the left. Press the "Start" button, S_1. The power relay should close immediately, followed a second or two later by the plate relay, which will result in both opening and automatic resetting of the timer. If the action described does not occur, disconnect the line cord and check all wiring and components until the incorrect connection or unsatisfactory part is found.

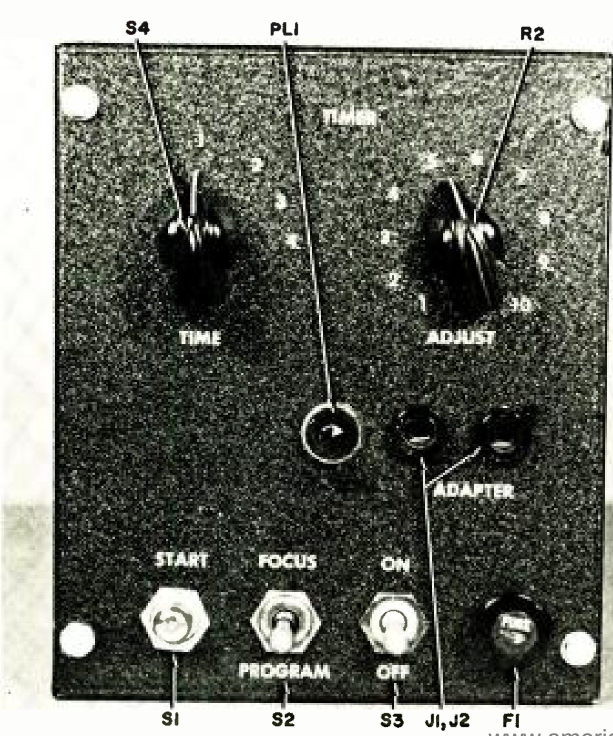
If all wiring has been properly done and the components are satisfactory, the device will operate as noted with the dummy load. It should be operated several times to make sure the relays are working properly. Then turn the variable resistor completely to the right and press the "Start" button. Note if the time interval between closing and opening of the power relay is shorter or longer than with the control to the left. It makes no difference, just as long as the pointer position is marked #1 for the shorter time and #10 for the longer interval. There should be about a 2:1 ratio between the two positions, for fine adjustment.

All the markings shown on the timer panels will be found in a standard "general purpose" set of decals stocked by most electronic parts dealers. If these are used, be sure to spray the panel with Krylon or similar clear lacquer after the decals have dried. This timer is sure to get a lot of hard use, so the rather fragile decal markings should be protected. One other point: when spraying, cover jacks and receptacles with masking tape, as otherwise the contacts may be coated with the lacquer, which is an insulator. It is best also to remove the knobs to make sure the spray reaches the surfaces under them, but the other items on the panels will not be harmed and need not be removed.

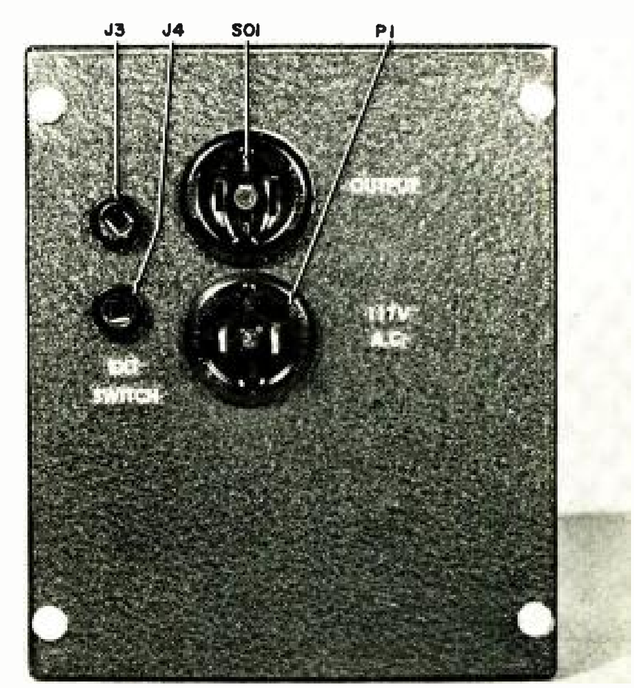
The photocell sensing unit itself may be constructed in a number of different ways, depending upon materials available to the constructor. For the unit shown in the photographs, which uses the *Clairex* CL-605 cell, two flexible leads are soldered to the cell leads, and spaghetti tubing slipped over each joint for insulation and protection. The tubing must be of very high resistance (the photocell will be operating in the 10- to 100-megohm range) so do not use varnished cambric, but plastic such as Teflon or polyethylene. The photocell is positioned in a 3/8" o.d. by 1 to 1½" long metal tube, with the photosensitive end of the cell about ½" from the front opening of the metal tube. This "overhang" protects the cell from stray light during use and further restricts pickup to a small angle. A piece of 3/8" i.d. metal or plastic tubing is then glued to the metal tube and the leads brought out through a grommet to hold them in place. A plug or cap should be made or obtained to keep the cell dark when not in use, for reasons which will be explained later. The ends of the leads are terminated with banana plugs to plug into the photocell adapter jacks on the front panel of the timer.

The photocell unit must be mounted so that its height (distance to enlarger base) does not vary for each size of enlargement made. It must be free to move horizontally, however, so that its shadow is not thrown on the enlargement image, and so that an appropriate gray area may be picked up during the timing operation. The photo shows a very convenient arrangement, with just enough rigidity and flexibility, using "Rotocon" assemblers. These assemblers are presently available only from the manufacturer, *The Unistrut Products Company*, 933 West Washington Boulevard, Chicago 7, Illinois. Five assemblers and a mounting base will cost

Front view showing the operating control panel of the timer.



The enlarger is plugged into the "output" socket on back panel.



about five dollars, but are well worth it for a permanent, lifetime installation. Laboratory-type rod clamps may be used or even a small microphone table stand. A temporary mount can be improvised from an "Erector" set or other toy building set. Since this unit will see much service, however, a really substantial mounting is necessary and any improvisation should be temporary. To prevent reflections, the sensing unit and mount should be painted flat black on the outside.

The photocell sensing unit shown in the photo and as described, is satisfactory for the *Clairex* CL-605 cell, and, with a 2" long metal tube, for the *RCA* 7412 cell. For a rectangular cell such as the *Jem Powermaster* CD-10, a different type of assembly will be required, in greater. So, always keep the photocell unit capped until just before use. One other precaution for a true reading: shade the enlarger base from the safelight or turn off the safelight during exposure, as even that small amount of light can affect the photocell reading. Better yet, install a relay in the enlarger circuit to turn off the safelight when the enlarger is turned on. If you wish, this can be done by another set of contacts (normally closed) on the power relay, with an additional receptacle for the safelight.

Back to calibration. All you need do is point the photocell sensing unit to a portion of the image that you consider a "standard" gray, make a sample exposure, and develop the print to determine if correct. As a starter, with the various diameters of enlargements.

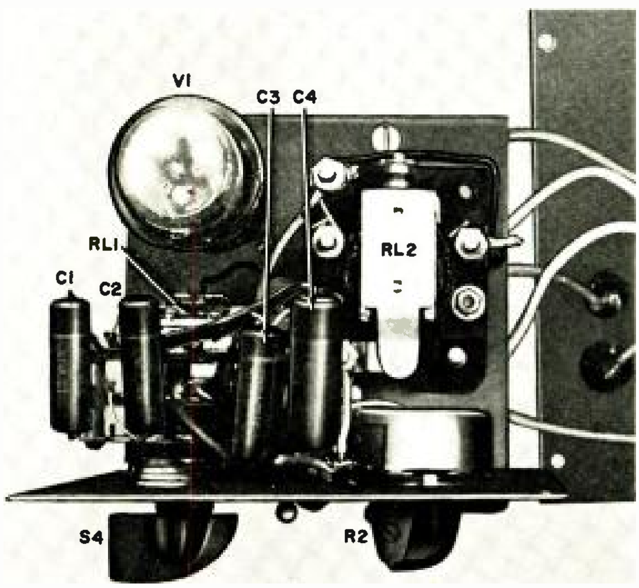
As each paper speed is established by trial (and remember that the same brand of paper will differ in speed for each contrast grade) record the proper setting for each, something like this: *Superbrom (Normal) 3-4 4"*. (Translation: for "Superbrom" normal paper, set "Time" switch on #3 and "Adjust" control on #4, for 4" height of photocell sensing unit from paper.)

After paper speeds have been determined, here is all you need do to make perfect enlargements every time:

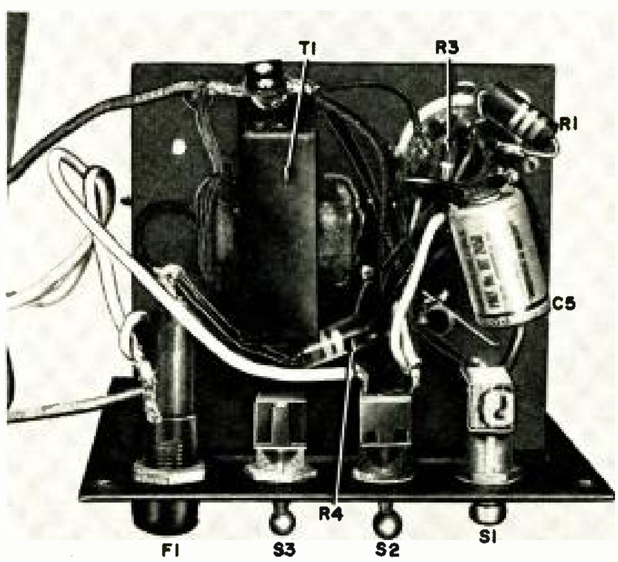
1. Plug in the enlarger, 117-volt a.c. supply, and external footswitch (if used).

2. Switch on the timer.

3. *Wait at least 30 seconds before operating.* (Steps 4, 5, 6, and 7 can be



Top-chassis view. Relay RL_1 is hidden beneath the selector switch.



Filament transformer T_1 is mounted below the chassis of the unit.

which it is mounted at the rear of a tube about 1" in diameter and 1" long. Even more than with the smaller cells, every precaution must be taken to prevent stray light from reaching the device.

Calibration and Use

Since enlargers are different, capacitors vary by 10% or more, photocells are not uniform in every characteristic, and exact distance of photocell to enlarger base depends on mounting, each timer will require individual calibration. Happily, this is easy to do and need be done only once.

First of all, the photocell sensing unit must have been capped for at least one-half hour before attempting calibration, and should never thereafter be exposed to any light brighter than a safelight (10 watts or less) at least 3 feet away. Like the eye, photoconductive cells increase in sensitivity in the dark until they reach a peak, which is the characteristic desired. Light reflected from the enlarger base or easel will be measured in thousandths of a lumen, while white light, even from lamps in the darkroom, will normally be thousands of times photocell unit about 4" above the paper, try the following switch settings: very fast bromide paper—#1; normal bromide paper—#2; fast chlorobromide paper—#3; and slow chlorobromide paper—#4 (also variable contrast papers with filter).

The variable resistance will multiply any basic speed (as set by the capacitor) by about 2X from its low to high positions. Although times will not be absolutely sequential, for convenience consider #1 "Time" switch setting with #10 "Adjust" (resistance) setting as equivalent to #2 "Time" setting with #1 "Adjust" setting. (In simple notation, "1-10" is equivalent to "2-1.") Thus, you can consider also 2-10 as equivalent to 3-1, and 3-10 equivalent to 4-1. This provides continuity for calibration. For example, if exposure is too long (print too dark) for a particular paper at 4-1, one-half the exposure time will be found at 3-1, or three-quarters of the time at 3-5. Note that calibration will remain remarkably consistent as the photocell will sense (and make adjustments automatically for) negative differences, light variations, as well as done during this period. Timer should be on for about 5 minutes to warm up properly before doing any critical work.)

4. Set controls to desired settings.

5. Place "Program" switch to "Focus."

6. Focus for enlargement desired and position photocell unit to point at suitable gray area.

7. Return "Program" switch to "Program."

8. Insert paper in easel or fasten to baseboard.

9. Uncap photocell unit and push "Start" button (or depress footswitch if you are using one).

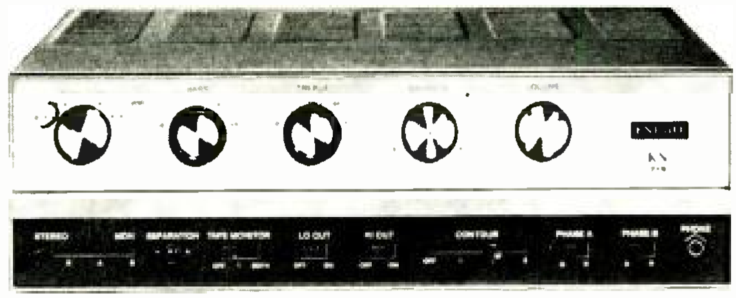
For subsequent exposures of the same picture, begin at Step 8; for different enlargements, begin at Step 4. It is best to allow timer to remain on for the duration of your work period—it uses less than 10 watts during standby, so it is quite economical.

Once you have this timer in operation, you will wonder how you ever made enlargements without it. It will pay for itself, and more, in photographic paper saved. —30—

Product Test Report

LAB TESTED ELECTRONICS WORLD

"Knight" 75-Watt Stereo Amplifier
Eico Model 1073 Variable A.C. Power Supply
DuKane "Ionovac" Tweeter



"Knight" 75-Watt Stereo Amplifier

A RECENT addition to the "Knight" line of hi-fi equipment is the Model KN-775 amplifier. This unit is the manufacturer's most powerful integrated stereo amplifier. It is conservatively rated at a continuous sine-wave power of 37.5 watts per channel, or 48 watts of music power per channel (IHFM standards).

The KN-775 includes all of the conventional controls and input circuits. It also incorporates a stereo headphone jack, individual phase-reversal switches for each channel, a circuit breaker instead of the conventional fuse, and horizontal lever switches for the contour (loudness control) and mode control. We like these switches in preference to rotary knobs in that the particular operating positions are more easily identifiable from a distance. Input level controls for magnetic phono, auxiliary, and tuner for each channel are also included for the convenience of the user. Equalization is also provided for tape heads and a tape-monitor switch is included to monitor either or both channels while recording.

The design is based around six 12AX7 twin-triodes and four of the popular EL34 power pentodes. Selenium rectifiers are used to supply heater voltages to all tubes while silicon rectifiers are used to supply high-voltage "B+."

The frequency response, measured with the tone controls in their mechanical center positions, was ±1.8 db from 30 to 15,000 cps. For flattest response, the treble control was set to the 1:30 o'clock position. Under these conditions the frequency response was ±.65 db from 30 to 15,000 cps.

The high-frequency scratch filter has a gradual roll-off starting at about 1000 cps, with response dropping off to −17 db at 15,000 cps.

The rumble filter is a sharp cut-off type, with response down only 2.8 db at 100 cps, and 15.8 db down at 30 cps.

The bass and treble controls are both quite effective and their operation and range are similar to other units on the market. The RIAA magnetic phono equalizing circuit is extremely good between 100 and 15,000 cps, being within ±.9 db from the standard curve. Below 100 cps, the response drops off to −5.8 db at 30 cps. This is apparently purposely designed into the circuit to reduce phonograph rumble. Under these conditions, one has a wider choice of turntables or changers that can be used with this amplifier without the necessity of using a bass tone control to compensate for rumble defects.

The sensitivity for the maximum 37.5 watts output is as follows: for auxiliary and tuner inputs, .188 v.; ceramic phono input, .195 v.; magnetic phono input, .005 v.; and tape-head input, .00375 v. All of these measurements were taken at 1000 cps.

Channel separation at 1000 cps and at 2 watts output is 34.5 db. This is certainly sufficient for good stereo reproduction.

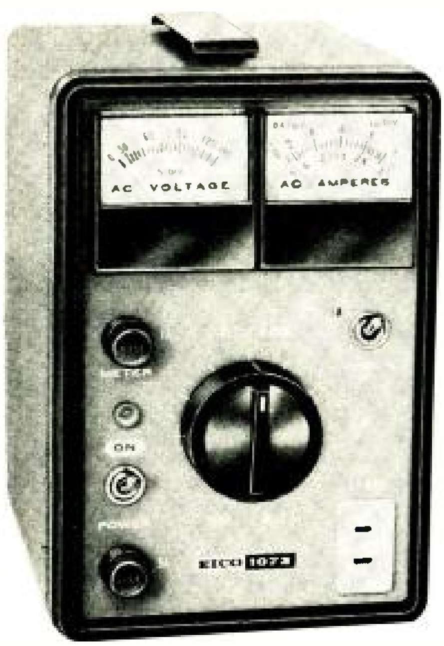
Output jacks are provided for a center-channel speaker. This speaker can be used to fill the "hole-in-the-middle" in stereo operation, or as a monophonic loudspeaker for placement in a remote location.

The harmonic-distortion characteristics proved to be extremely interesting. At 1000 cps the distortion at the rated power output of 37.5 watts was .46%. This is just under the manufacturer's published distortion figure of .5%. At 30 cps, the harmonic distortion was 2% at 31 watts, and at 15,000 cps 2% distortion occurred at 32 watts. Our own feeling is that an amplifier should not exceed 2% harmonic distortion over the above range. In this case we would rate this amplifier at 31 watts per channel, or 62 watts for both. On the other hand, we found that this amplifier was able to produce 47 watts of 1000-cps power at 2% harmonic distortion. Using the IHFM's power-bandwidth standard, which gives the power response between the −3 db frequency points, the manufacturer could have rated this amplifier at 47 watts for 2% distortion over a frequency range beyond 30 cps to 15,000 cps. Hence, the manufacturer's rating is quite conservative.

Next, we set the volume control to a point where 6 mv. into the magnetic phono input produced 2 watts output. Under these conditions, our hum and noise measured the following with respect to 2 watts: tape-head input –45 db, magnetic-phono input –54 db, ceramic phono input –55 db, and auxiliary or tuner input –65 db.

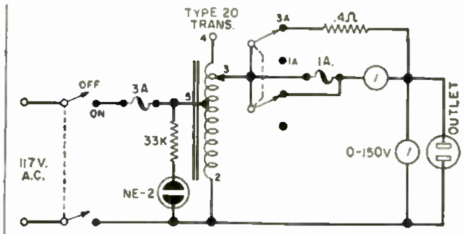
We are particularly pleased with this amplifier, not only because of its versatility as a control center for a hi-fi system, but, after spending quite a few hours listening to the unit, its performance proved to be outstanding. We did not encounter any listening fatigue. Its output proved to be extremely clean, and we noticed no hangover when playing music having many transients. We particularly like to use high-power amplifiers such as this since, when playing at a normal room listening level, there is no possible chance of driving the amplifier into distortion or of clipping during high peaks.

This amplifier employs military-type terminal boards which result in a sturdy construction and a uniformity of performance. The Model 775 is available factory-wired at $169.50 through *Allied Radio Corporation.* —30—



Eico Model 1073 Variable A.C. Power Supply

A VARIABLE autotransformer, with metered output voltage and current, in a convenient, ruggedly built carrying case has many uses in industry and on the service bench. The new *Eico* Model 1073 is just such a unit. It can be used for production testing, in quality control, at the engineering bench, and in the TV service shop. It is suitable for studying the performance of equipment at various line voltages and for



Circuit diagram of the variable a.c. supply switched to the 3-amp. range.

testing units for power consumption. It is also helpful in locating intermittents by inducing parts to break down by applying an overvoltage to them.

The circuit of the unit is shown above. Note that the power switch breaks both sides of the line for complete isolation with the supply off. However, when the supply is on, since the outlet is connected to an autotransformer, this does *not* provide a.c. line isolation. Therefore, suitable precautions must be observed when working on a "hot" chassis.

By adjusting the transformer slider, the output a.c. voltage may be varied from zero to 140 volts (with an input of 120 volts). The maximum current that may be drawn is 3 amps., and this output current as well as the output voltage are monitored with an a.c. ammeter and an a.c. voltmeter. Both the transformer and the ammeter are protected with fuses. The ammeter has a 1-amp. range in addition to the 3-amp. range so that small values of current can be read.

We checked the accuracy of the voltmeter against a ½ per-cent expanded-scale instrument. At an output voltage of exactly 120 volts, the voltmeter on the Model 1073 read about 117.5 volts. This represents a full-scale accuracy of just under −1.8 per-cent, well within the ±3 per-cent accuracy quoted by the manufacturer. Actually, the meter scale is such that extremely precise voltage readings cannot be made, nor can readings be taken below 30 volts. For very exact voltages and for very low-voltage settings, an external highly accurate meter would have to be used. For a very large majority of uses, however, where voltages are required that are within a couple of per-cent, the built-in meter is certainly quite adequate.

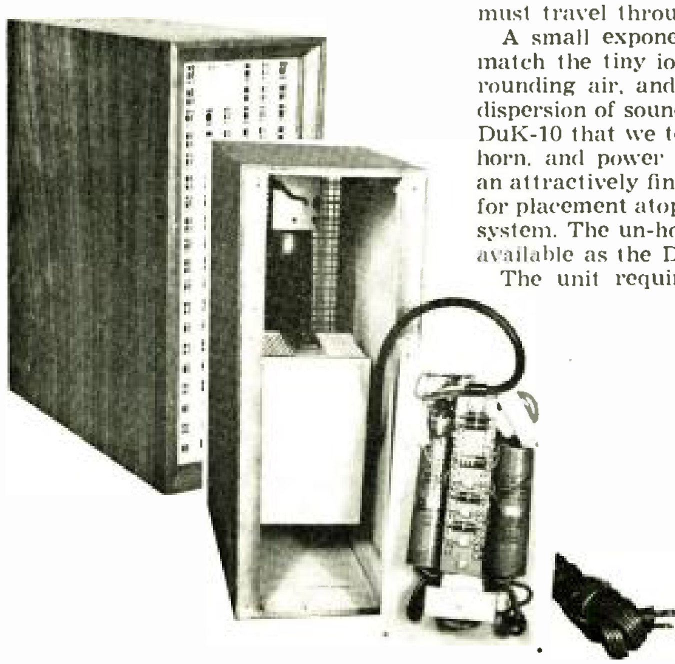
The heavy-duty construction of the supply as well as its enduring attractive appearance should make the Model 1073 a very useful long-term addition to the electronics lab of an industrial plant or to a radio-TV service bench. The supply is available in kit form for $35.95 or factory-wired for $47.95. For those requiring higher current capacity, a 7½-amp. Model 1078 is available in kit form for $42.95 or factory-wired for $54.95.

—30—

DuKane "Ionovac" Tweeter

A PERFECTLY massless tweeter—one whose radiating surface has absolutely no inertia—has long been recognized as the theoretical ideal. Tiny metal diaphragms came close to it and electrostatic tweeters took us several steps closer. But the *DuKane* "Ionovac" is a landmark in the quest for perfectly reproduced sound, for it is the first commercially available tweeter with a truly massless "diaphragm."

The heart of the "Ionovac" is a dime-sized quartz cell containing two concentric electrodes. A 27-mc. oscillator applies a high-intensity signal to the electrodes, to produce a steady corona of ionized air between them. The air density inside the corona is extremely low, and the more intense the corona, the more air is displaced by it. When an audio signal is fed to the corona, it modulates the intensity of the ionization cloud, compressing and rarefying the air surrounding it. Thus, the only mass to be moved by the "Ionovac" tweeter is that of the air itself, and while this is not 100% massless, it is as close to it as we're likely to come as long as sound must travel through air.



A small exponential horn is used to match the tiny ionized gap to the surrounding air, and to provide adequate dispersion of sound. In the $79.50 Model DuK-10 that we tested, the quartz cell, horn, and power supply are housed in an attractively finished wooden cabinet, for placement atop any existing speaker system. The un-housed components are available as the DuK-5 for $69.

The unit requires a source of 117-volts a.c. at 50 or 60 cps, and consumes 55 watts of a.c. power. It also requires an external 3500-cps, 12 db/octave, 8-ohm crossover network and a T-pad control, so we were surprised that these had not been included with the unit. We used a 5-µf. series capacitor followed by a 0.35-mhy. choke directly across the input to a T-pad. (Special crossover networks are available separately from the manufacturer, and these networks are included in the more elaborate wide-range speaker systems sold by the company.)

The DuK-10 is rated from 3500 to 30,000 cps within ±3 db. Sweeping an oscillator through its range was a waste of time. Above its 3500-cps crossover, the tweeter sounded perfectly clean and linear, and it was still going strong when our ears failed us. A later check with a calibrated microphone was equally unenlightening, and served merely to verify the mike's own calibration curve.

On program material, the DuK-10 yielded the silkiest, most transparent sound we have ever heard outside of a concert hall. We will not attempt to describe its sound, because our ears could detect no coloration at all; it just sounded completely natural, on any or all instruments which fall within its operating range. Record surface noise was reduced to inconspicuous sounds, without the spit, sizzle, or crackle associated with high-frequency peaking or ringing. Yet minute details in the sound cut through complex orchestral passages with an ease and naturalness that was sometimes startling. This was, in fact, the first tweeter we have heard that could reproduce the brassy bite of trumpets and the resinous sheen of strings with equal realism.

The DuK-10's high-frequency dispersion is rated as 160 degrees, with the horn slot mounted vertically. We could begin to detect a change in white noise at around 55 degrees off-axis, which is more than enough spread to give excellent stereo coverage of most rooms. In addition, the true point source of this unit makes it free from the cancellation effects which often mar the stereo coverage of multi-source tweeters.

Power capacity is rated at a very modest .07 watt, which means the "Ionovac" will *not* singe the hair off the cat. But it does operate over a range where power requirements are relatively limited, and it proved able to emit uncomfortably high volume levels before audible distortion set in. Overload does not harm the unit; it just sounds bad. But we suspect its power rating may be just a little too low to do it justice.

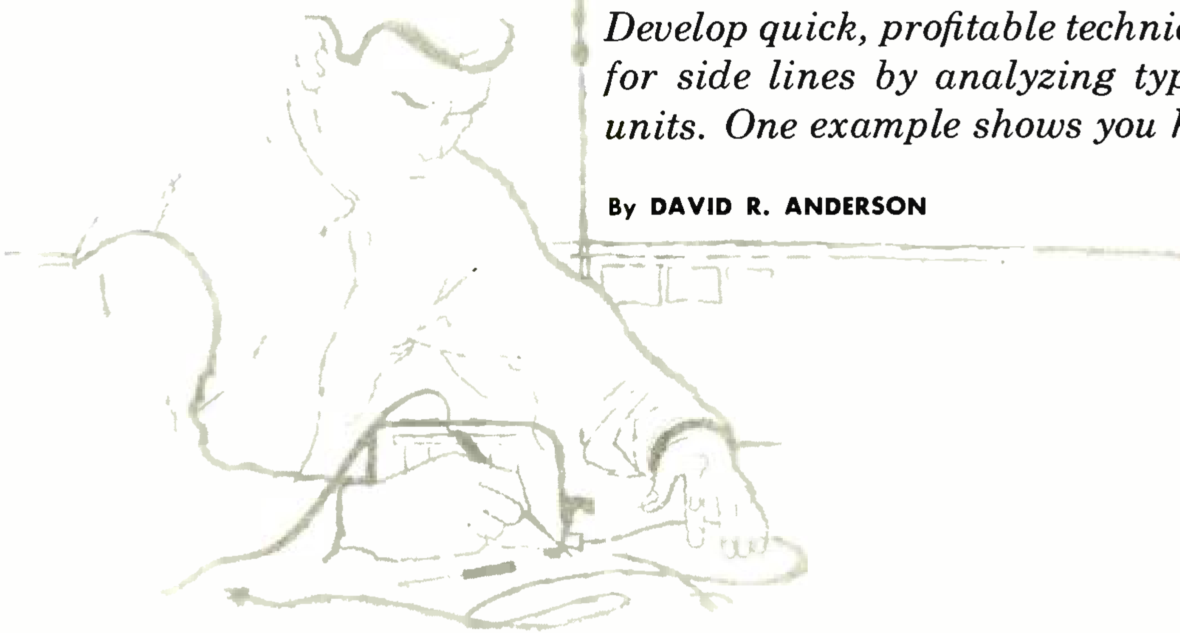
A small amount of ozone is generated by the ionization in the *DuKane* tweeter and can be smelled faintly in the room after an hour or so of listening. Ozone is perfectly harmless in these small quantities, and is an effective deodorant for cigarette smoke and cooking odors.

The "Ionovac" appears to be well designed and conservatively built, and all parts are readily replaceable at reasonable cost. (The quartz cell is guaranteed for 1200 hours, or 1 year, whichever comes first.) We do not envision any problems with the "Ionovac," however, and just hope that the next developments in the loudspeaker field will be speakers that can do for the middle and bass ranges what this "blue-glow" tweeter does for the upper range. —30—

Small-Appliance Service: Toasters

Develop quick, profitable techniques for side lines by analyzing typical units. One example shows you how.

By **DAVID R. ANDERSON**



SOME SERVICE shops, in addition to radios and TV sets, will take on anything from a steam iron or an electric heater to a table lamp with a frayed line cord. Others steer clear of appliance servicing, for a number of reasons. Since repair fees on these items must be low, it is quickly assumed that the work is unprofitable. Besides, this work may seem petty enough to detract from the prestige of a professional accustomed to dealing with equipment that is more advanced technically. On the other hand, some feel that their relative ignorance of small appliances and lack of experience with them will give them a hard time.

As to prestige, your customer is likely to have more confidence in a shop that can take care of all his service needs. In fact, if you turn him away when he brings in his electric shaver, and he goes into another shop that accommodates him, he may go back there when his TV set breaks down. Aside from the profit angle on these small jobs, they help keep old customers and attract new ones. From the viewpoint of immediate profit, the work involved is likely to be small, so that you can earn some extra money in spite of the low fees. As to know-how, anyone who has managed to do TV repair successfully should be able to take simpler appliances in stride easily.

Manufacturers' manuals on these items are available and very helpful. For practical experience, you can pick up an appliance of any type, take it apart easily, study it, even introduce defects and observe symptoms—and, from this, work up a standard trouble-shooting procedure.

As an example of what can be done, take that universally popular item, the automatic pop-up toaster. There are many manufacturers and models, as

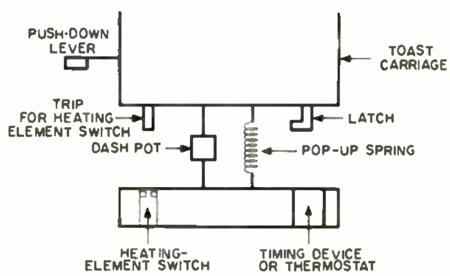
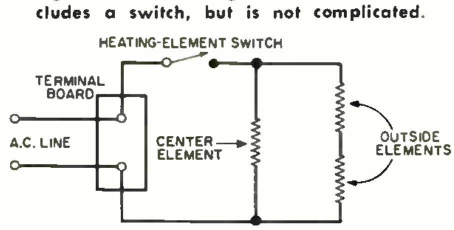


Fig. 1. This is a simplification of the mechanism that operates pop-up toasters.

Fig. 2. The heating-element circuit includes a switch, but is not complicated.



with TV receivers. Nevertheless, as with TV receivers, the principles of operation and many details are quite similar.

A simplified version of the basic toaster mechanism appears in Fig. 1. With bread in the slots, the user depresses the push-down lever, externally available, lowering the toast carriage and bread into the body of the appliance. When this is done, two principal connections are made. A switch is closed to apply voltage to the heating elements, and a mechanical latch or catch holds the carriage in its lower position.

Associated with the latch will be a timing device, which may be a simple form of mechanical clock or a thermostatic control, to release the carriage when the toast is finished. The pop-up spring then raises the freed carriage, and this action opens the contacts for the heating elements.

Since the spring-propelled upward movement of the carriage might toss the toast in the air, a dash pot is used to slow down this action to a reasonable rate. The dash pot consists of a plunger fitted into a cylinder, but not too tightly. Movement of the plunger is controlled by resistance of the air cushion in the cylinder. The action is similar to that of the pneumatic door-stops used on many doors to keep them from slamming as they swing shut.

Taking a typical unit apart, although

no great problem, usually requires more time than finding out what is wrong. Since there are model-to-model differences, no universal procedure can be outlined. However, as with most small appliances, this is largely a matter of dismantling typical units carefully—and noting, with equal care, exactly where each part belongs. Going through this procedure once or twice on an operating unit will make you an expert in a hurry. Just remember that every washer and other small, "unimportant" part is there for a reason, even if you are not sure what it is. It must go back in the same place when you reassemble the unit. Don't make the mistake of leaving out something that may be an insulating spacer to prevent shock hazard, or serve some other purpose.

The possible complaints on this type of unit are few. Two of them account for most troubles: the elements will not heat up, and the toast will not pop up. Consider the first complaint. The heating-element circuit is simple. Fig. 2 shows a widely used arrangement. The obvious cause of no heating is an open condition somewhere in this circuit, either in the heating-element wiring or in the switch. A point-to-point continuity check with an ohmmeter should give the answer quickly. However, the simple circuit of Fig. 2 does have some possibilities that are more interesting than this. A switch might short, or only one element might be open. What happens then?

It is quite possible to anticipate the effects without actually inducing the troubles, but the latter procedure helps the technician get the "feel" of the appliance and also makes sure he hasn't committed an error in analysis. If you short the switch contacts, you will find that the unit goes through its regular toast cycle. However, when the carriage is released by the timing device, the heating-element circuit would not be broken. As a result the lower portion of the toast, which remains in the housing after pop-up, will be burned unless it is removed immediately.

To observe this effect, it was only necessary to place a jumper across the switch contacts. Of course, in actual practice, you would start out with the symptom (the customer's complaint) and have to work back to the cause. But this simple experiment, although it reverses the usual sequence, establishes a direct association between the symptom and the cause. This association will be ready whenever you come across the symptom by itself.

If only the center heating element were open, the bread would be toasted only on one side. The same would be true, for the other side of each slice, if the outside elements were open. This defect could also be induced and observed. Observing the elements themselves would tell the story without having to use bread.

The second major complaint—the toast does not pop up—may involve the timing device, toast carriage, dash pot, or other moving parts. These all involve mechanical parts that may jam or bind. Jamming and binding can be located by visual inspection while attempting to put the appliance through its operating cycle, or by checking the proper motion of the parts involved by hand. The timing device, however, requires a little more investigation.

In general, toasters use two types of timing devices, as already noted. One is a simple clock mechanism with a spring that must be wound by hand. This winding is produced during the downward motion of the carriage when the push-down lever is depressed. A thermostat is the heart of the second type. A bi-metallic strip is heated and, as it bends, it actuates a switch that controls the operating cycle, terminating in the popping up of the toast.

Some toasters may use a combination or a modification of these basic methods. For example, an electrically operated clock timing mechanism may be turned on by the bending of a thermostatic metal strip.

In the clock type, an escapement mechanism is used to release the energy of the wound spring slowly. A typical example is shown in Fig. 3A. The balance swings back and forth, allowing the wheel, connected to the spring, to rotate one notch at a time.

In combination with the escapement is a latch mechanism like the one in Fig. 3B. When the carriage is pushed down, the detent on the cam is in the position shown, so that it presses against bar *B*. Bar *A* is lowered during push-down, and its indent is engaged by the detent on bar *B*, holding the carriage down. Since the cam is coupled to the escapement wheel, rotation of the latter by the spring also rotates the cam. Finally the cam detent is moved away from bar *B* so that it no longer presses against the latter, and the spring attached to bar *B* pulls it away from bar *A*. The latter can now be pulled up by its own spring. This action pops up the toast carriage and breaks the switch that energizes the heating elements.

Many defects can occur—or be introduced for observation—in this mechanism. For example, you could hold the balance arm of the escapement so that it would not swing free. Now neither wheel nor cam can rotate. Instead of popping up, toast stays down and burns. The clock's ticking, usually audible in this type of timer, would disappear. That would be a symptom to listen for when trouble occurs. Tightening, readjustment, or replacement may be the cure.

You can induce another defect by loosening the cam. This need not be fixed to the wheel rigidly, since its position may be adjustable to change the length of the timing cycle, to make the toast lighter or darker. If a loose cam in the wrong position does not rotate, the carriage may fail to stay down instead of failing to pop up, as bar *B* of Fig. 3 will not be pushed into engagement with bar *A*. Other defects can be introduced by manipulating parts of this mechanism, but the ones cited are enough to illustrate the possibilities.

In the thermostatic timer (Fig. 4), a small, separate heating-element coil is wound around the bi-metallic strip. When the carriage is pushed down, it energizes this coil as well as the toasting elements. Movement of the left end of the strip is relatively restricted so that, as it heats and bends upward, its free end finally closes a switch that shorts out the heating coil. This movement also mechanically moves the lower switch into the strip's return path. As the strip cools and bends downward to its normal position, it activates the second switch. This releases the toast carriage, permitting it to pop up and break the toasting-element circuit. In such a timing device, the click of the first switch usually can be heard near the end of the toasting cycle, but before it. The timing cycle's length can be altered with the gap-adjusting screw, to make toast lighter or darker.

An easily introduced defect is an open thermostat coil. Since it will not heat, no part of the switching cycle will occur and toast will continue to burn instead of popping up. You can trip the first switch by hand and observe subsequent effects. The same may be done with the second switch—or either may be made inoperative to see what happens.

The toaster has just been an example to illustrate a method. You can similarly take apart, analyze, and induce defects in electric coffee makers, steam irons, waffle irons, or other items. —30—

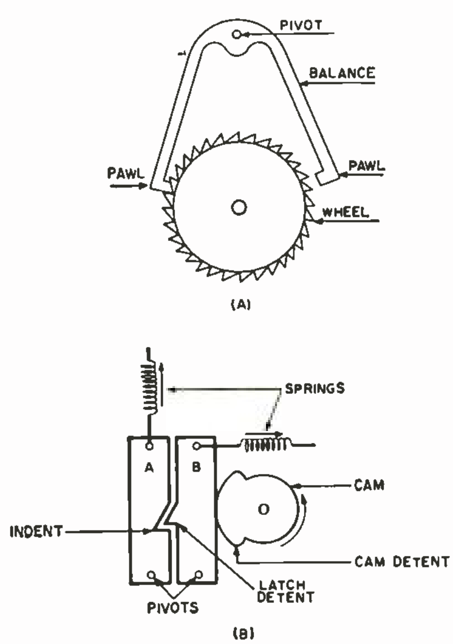
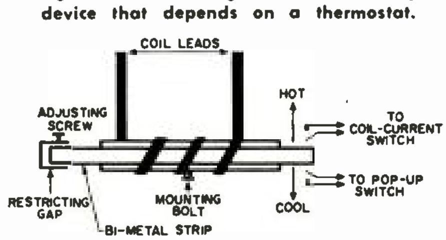


Fig. 3. Some timing devices (A) use an escapement to release energy from a mechanically wound spring, while (B) rotates a cam that releases the carriage.

Fig. 4. Basic arrangement of a timing device that depends on a thermostat.



Sound on Tape

By **BERT WHYTE**

THE ANNUAL May Parts Show in Chicago will soon be upon us and, if persistent rumors are correct, this is where the *Columbia/3M* tape cartridge will make its commercial debut.

This system has been described previously in ELECTRONICS WORLD and, at least on the basis of the demonstration I heard, seems to hold considerable promise as the medium that will bring tape to the public on a mass scale. At the time of the initial demonstration, there were announcements that *Zenith* and *Grundig* had signed as licensees to manufacture the new cartridge units. Since that time, *3M* has acquired the *Revere* company which, as you probably know, manufactures cameras and projectors and tape machines. While *3M* has not stated the fact directly as a reason for this acquisition, it can be assumed that since *Revere* is a precision mechanical manufacturing facility, it will be the manufacturing subsidiary that will produce the cartridge and/or the playback mechanisms.

Evidently this move caused quite some ire at *Zenith* which, at last report, has withdrawn as a licensee for the new cartridge.

The situation is very muddled and rife with all sorts of rumors, but if all the bugs have been worked out of these new cartridges, it is a pretty safe bet that they will indeed make their appearance at the Show. This is indicated because of the current slump in the record business and the fact that four-track tape, while selling in appreciable quantities, has not quite reached expectations. While one may have the tendency to view the introduction of the *3M* cartridge as an upsetting factor in an already confused market, it is really a calculated risk. The chances are that even if the new cartridge successfully meets its specifications, it will augment rather than supplant the present four-track medium. And I may be all wet, but I think there is a very good chance for an eventual intermarriage of the two systems, the resulting offspring of which will be very close to what most people want in a recorded tape.

In the meanwhile, four-track tape has shown considerable improvement in the last few months, especially as regards hiss and crosstalk. There is also a more varied supply, with *Victor* issuing quite a spate of them. *Columbia* had announced it was going to issue four-track tapes . . . as yet I have not heard any although I understand a few were actually released. *Capitol* announced its intention in the four-track format quite some time ago and has finally published its first release. Most of this first batch are remakes from successful two-track material, with little in the way of new material and a disappointingly slim and not particularly distinguished offering of *Angel* material. Of the tapes, no sign of them up to the moment. Nothing more of any consequence to report, so on with the reviews. . . .

BRAHMS
PIANO CONCERTO #2
Sviatoslav Richter, pianist, with Chicago Symphony Orchestra conducted by Erich Leinsdorf. Victor FTC2055. Price $8.95.

By now you have read as many reams of praise and adulation for Sviatoslav Richter as I have and perhaps, very humanly, you are curious as to whether he is really as good as his notices. Well, if you are looking for the note-perfect-flawless technique type, this is not Richter. Not that he is sloven in this respect, but he has his lapses. Richter's strength lies in his vast robust tone, his incredible control of dynamics and his expressive warmth and lyricism. His tone is big and impressive, but equally so is his mastery of *piano* and *pianissimo* where, through some alchemy, even these passages are completely articulate.

This tape is a good example of his *bravura* approach and it is unfortunate that he wasn't recorded as well as one could desire. In all fairness to *Victor*, it should be pointed out that this recording took place under rather less than ideal conditions. For one thing, Fritz Reiner was to have conducted, but was taken ill and Leinsdorf had to be rushed in at the last minute. And the recording time was literally "squeezed" out of Richter's crowded schedule of concert appearances.

Thus we have on this tape a monumental performance, with sonic flaws. The strings had a tendency towards stridency and the piano was not "projected" as far forward as one might wish. As a result it gets lost in the tumult of the *tuttis* and the central ghost image is not as sharply delineated.

Here is one of those rare instances where the usually felicitous acoustics of Orchestra Hall in Chicago were not properly utilized . . . the reverb is too great, especially in the *tuttis*, which blurs orchestral detail considerably. In quieter parts this is less of a problem.

There was a little crosstalk apparent and also some pre-echo due to layer-to-layer "print-through." As played back at full room volume, tape hiss was slightly obtrusive.

LALO
SYMPHONIE ESPAGNOLE
Henry Szeryng, violinist, with Chicago Symphony Orchestra conducted by Walter Hendl. Victor FTC2051. Price $8.95.

Szeryng is fairly new to the American concert scene, but he has already established a formidable reputation. He has plenty of technique and a big rich tone, but probably what has endeared him most to the critics is his straightforward approach to the repertoire. He is a great respecter of what the composer has written and tries no interpretive monkeyshines. While with some other artists, this would make for dull and routine essays, Szeryng's performances are clean, disciplined, and always lyrical.

This lyricism is very evident in his over-all conception of this work and is especially lovely in the second movement. Now here is the same Orchestra Hall in Chicago, with the same acoustics. But here we have a different recording engineer, who essays a different approach than his colleague in the Richter recording. Here he is recording the violin, which has a smaller acoustic output than the piano, yet he achieves a better balance and a much bigger sounding recording. The violin is recorded very close up and projected far forward, so much so at times that the accompaniment tends to get lost or subdued. The violin's ghost image is slightly to the left of center but the centrally located woodwinds do not project as much and their ghost image is a bit too "ghostly"!

Stereo direction and depth are well maintained and the over-all sound is quite clean. In spite of the "bigger" sound achieved here, the reverb is handled right and there is much less tendency to blur detail in the *tuttis*. There was some crosstalk noticeable as well as a little pre-echo, but not enough of either to cause any real worry, and tape hiss was commendably low with playback at full room volume.

In summation, some may find the intensity of the violin a bit searing, but it is clean and, in general, this is the best recording of the Lalo now available.

AMPEX CLASSICAL SAMPLER
United Stereo Tapes RQ402. Price $3.95.

With close to 28 minutes of music on this sampler, this is a good buy at $3.95. It is also valuable in introducing people to the four-track medium, *via* ten separate selections drawn from representative tape catalogues. There is not room for comments on the performances here except to say that with a couple of exceptions they are generally quite good. Also as an over-all observation, this tape had almost no crosstalk and the hiss level was pleasingly low with full room volume on playback. Now for each "cut" . . .

1. Kabalevsky's "Comedians" from *Vanguard* VTC1619—Over-all good presence and quite clean with good percussion, especially bass drum and xylophone. Not too much central image, but directionality and depth good.

2. "Rhapsody in Blue" from *Warner Bros.* WST1243—Very raucous "movie" type sound with evidences of "dial twiddling by the engineers." Over-all quite clean with piano well projected.

3. Vivaldi "Concerto Grosso" from *Concertapes* 4T3011—Nice "close-up" presence with all instruments well delineated . . . sound oriented somewhat to left channel . . . nice and clean over-all but a small amount of unfortunate hum runs all through the piece in right channel.

4. Mendelssohn "Violin Concerto" from *Westminster* WTC129.—Bright and clean, nice open acoustics. Violin is in left channel and with this and virtual lack of ghost middle, this was undoubtedly a two-channel master. However, good directivity and even depth is apparent . . . nice balance between violin and orchestra . . . violin tone very clean and smooth and sharp, well-defined tympani in right channel.

5. Bach "Mass in B Minor" from *Westminster* WTZ119—Here again lovely spacious acoustics with good feeling of depth in spite of fact that this is also two-channel master. Good directivity with choirs nicely disposed left and right. Excellent balance between choirs and orchestra.

6. and 7. Mussorgsky "Pictures at an Exhibition" and DeFalla "Three Cornered Hat" from *Everest* 43-001 and 43-003. I should disqualify myself on these two since I was the recording director on the sessions. If I may be permitted, I can point out the very well-defined central ghost images, the preciseness of direction, the depth effects and the extremely wide frequency response which can be heard in the DeFalla work in the section with bird call and the very high violin harmonics simulating bird calls.

8. Tchaikovsky "Pathetique" from *Vanguard* VTC1613— Sounds like another two-channel master but directionality is excellent. Very clean strings with especially nice celli and contrabassi. Excellent over-all balance, good spacious acoustics with no loss of detail.

9. Chopin "Polonaise" from *Warner Bros.* WSTP2401—Big, bright, well-projected piano with strong central image. Over-all sound again "movie" type and you can hear dials being twiddled to accent an instrument or choir.

10. Villa Lobos "Forest of the Amazon" from *United Artists* UATC2210—Rather much disposed to right channel, somewhat strident strings . . . voice of Bidu Sayao on right channel . . . bass rather tubby and ill-defined . . . sounds like a two-channel master with very little middle image . . . in *tuttis* detail suffers. In spite of good reviews elsewhere, this was only disappointment on the tape and I am a bit surprised *UST* couldn't find something else from its extensive catalogue. —30—

Four-Channel Stereo

(*Continued from page* 32)

Nortronics heads. It is necessary to disable the bias oscillator by pulling the tube or opening the power supply to the transistors when the audio current is measured. When the proper 0-vu (standard reference level) record current at 1 kc. is obtained (by inserting a 0.5-volt signal into the "Hi-Level Input"), the vu meter can be adjusted to 0 vu.

In place of the specific heads recommended above, it is also possible to use heads made by other manufacturers. Such heads should be low-impedance types for the transistorized circuits shown here, or high-impedance types for vacuum-tube circuits.

Erase heads have been omitted from all discussion in this article because of limited head space in most machines. Therefore, when making a recording, it is necessary either to use a clean tape or to bulk-erase an already recorded tape.

Microphone Technique

The quality of the microphone is a very important factor in determining the ultimate quality of the recording. For most professional applications, the use of a low-impedance microphone is desirable. If the impedance of the microphone is under 1000 ohms, it is possible to have microphone cable runs in excess of 50 feet without objectionable hum pickup. A good quality input transform-

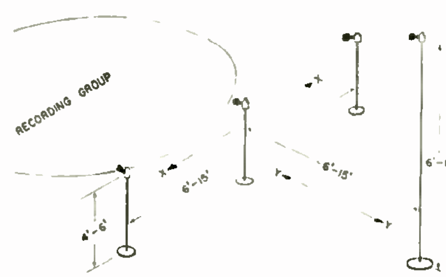


Fig. 5. Suggested microphone placement.

er is necessary to avoid frequency degeneration during recording.

A medium-priced microphone, such as the *Electro-Voice* Model 664, will provide excellent quality voice and music reproduction and still be within the range of the builder with a modest budget. It should be pointed out here that the quality of the microphone is a major factor in obtaining quality performance from any tape system.

The placement of the four microphones is shown in Fig. 5. This setup will provide good two-dimensional stereo for a small recording group such as a jazz combo or a chamber music group. If a large orchestra or choral group is to be recorded, it might be advantageous to change the location of the microphones to obtain the best balance for stereo recording.

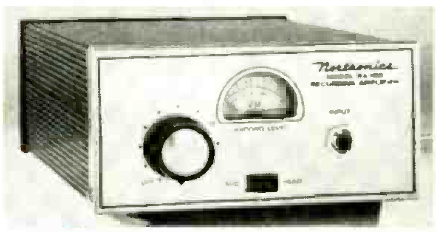
Part of the interesting possibilities in this system lie in the new dimension of sound. In other words, experimenters will probably want to work out microphone placement that will provide optimum realism and listening pleasure for the individual situation.

Demonstration Tape Available

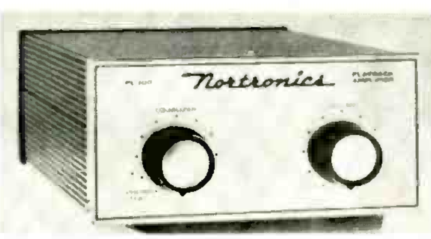
The *Nortronics Company* is providing a special tape, Model NT-400, to demonstrate how a professionally recorded four-channel tape will sound on playback. The purpose of this tape is to provide an incentive for further experimentation by the audiophile who is interested in making his own recordings. This tape is available from the *Nortronics Co., Inc.*, Minneapolis, Minn., at a price of $8.95.

Most current tape machines can be converted to the 4-channel system. Several decks, such as the *Viking* 75 series and late-model *V-M* machines are exceptionally easy to convert. *Viking of Minneapolis* will offer a complete deck (Model 76, as shown on our cover) or a head-conversion bracket for Model 75.

We are also hoping that *United Stereo Tapes* will consider the possibility of supplying professionally duplicated tapes to augment this first demonstration tape. Since all of the tracks for the four-channel system coincide with conventional current tapes, existing duplicators could handle the production of such tapes. —30—



Typical single-channel recording (above) and playback amplifiers that may be utilized.

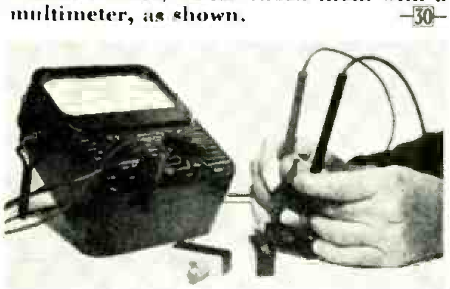


CHECK SURPLUS SWITCHES FOR CONTINUITY

By ROBERT HERTZBERG

MANY of the odd switches retrieved from surplus military equipment are foolers in that they are normally closed rather than open.

Before using them for conventional circuit control, better check them with a multimeter, as shown. —30—



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Kit AA-31... $6 dn., $6 mo. **$59.95**
Mic. Xformers, AN-11 **$11.95**

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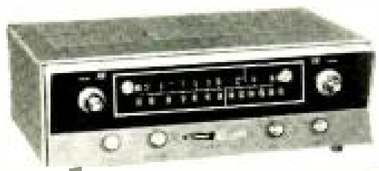
Kit AS-21W, wal... **$229.95**
Kit AS-21M, mahog **$229.95**

HEATH COMPANY Benton Harbor, Michigan / a subsidiary of DAYSTROM, INCORPORATED



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CALENDAR of EVENTS

APRIL 26-28
Seventh Region Technical Conference and Trade Show. Sponsored by Region 7 of the IRE. Westward Ho Hotel, Phoenix, Ariz. Progrom information from H. W. Welch, Jr., Motorola Inc., P.O. Box 1417, Scottsdale, Arizono.

APRIL 29
Tenth Annual Dayton Hamvention. Sponsored by Dayton Amateur Radio Association, Inc. Dayton Biltmore Hotel, Dayton, Ohio. Varied program of events has been scheduled. Contact Harry E. Covault, K8GCS, 4820 Archmore Drive, Kettering 40, Ohio for details.

MAY 2-4
Electronic Components Conference. Sponsored by PGCP, AIEE, EIA, WEMA. Jack Tar Hotel, San Francisco, Calif. Details from Daniel Breading, Fairchild Semiconductors Inc., Polo Alto, Calif.

MAY 4-5
Second National Symposium on Human Factors in Electronics. Sponsored by PGHFE of IRE. Marriott Twin Bridges Motor Hotel, Arlington, Va. Details from R. R. Riesz, Bell Telephone Labs, 2D-452, Box 262, Murray Hill, New Jersey.

MAY 6
Workshop in Graph Theory. Sponsored by PGCT of IRE. University of Illinois, Urbana, Illinois. Prof. M. E. Van Valkenburg, Department of Electrical Engineering, University of Illinois, Urbana, Ill. for program information.

MAY 8-9
Fifth Midwest Symposium on Circuit Theory. Sponsored by PGCT of IRE. Allerton Park & Urbana Campus, University of Illinois. Prof. M. E. Van Valkenburg, Department of Electrical Engineering, University of Illinois, Urbana, Ill. for program information.

MAY 8-10
Thirteenth Annual National Aerospace Electronics Conference. Sponsored by the IRE. Biltmore & Miami Hotels, Dayton, Ohio. Program details from Ronald G. Stimmel, 809 Larriwood Ave., Dayton 29, Ohio.

MAY 9-11
Western Joint Computer Conference. Sponsored by PGEC, AIEE, and ACM. Ambassador Hotel, Los Angeles, Calif. Prof. Cornelius Leondes, Department of Electrical Engineering, UCLA, 405 Hilgord Ave., Los Angeles 24 for program details.

MAY 15-17
1961 National Symposium on Microwave Theory & Techniques. Sponsored by PGMTT of IRE. Sheraton Park Hotel, Washington, D.C. Information on program from Gustave Shapiro, NBS, Washington, D.C.

MAY 22-24
1961 Electronic Parts Distributor Show. Conrad Hilton Hotel, Chicago. Closed Show. Hours 9 a.m.-6 p.m. Details from Electronic Industry Show Corporation, Suite 1501, 11 S. LaSalle St., Chicago 3, Illinois.

National Symposium on Global Communications. Sponsored by the AIEE and IRE. Sherman Hotel, Chicago. Details from Donald G. Campbell, ITT Kellagg, 5959 S. Harlem Ave., Chicago, Ill.

National Telemetering Conference. Sponsored by PGSET, AIEE, IAS, ARS, ISA. Sheraton Towers Hotel, Chicago. Jack Becker, AC Spark Plug Div., General Motors, Milwaukee, Wisc. for program information.

MAY 22-26
1961 Conference of Society of Photographic Scientists & Engineers. Sponsored by SPSE. Arlington Hotel, Binghamton, N.Y. Details from SPSE, Box 1609, Main Post Office, Washington, D.C.

MAY 30-JUNE 2
Radio and Electronic Component Show. Sponsored by Radio and Electronic Components Manufacturers' Federation. Olympia, London, England. Information and tickets from the Federation, 21 Tothill St., London S.W. 1.

JUNE 12-13
Third National Symposium on Radio Frequency Interference. Sponsored by PGRFI, Sheraton-Park Hotel, Washington, D.C. W. Gerald James, American Machine & Foundry, 1025 N. Royal St., Alexandria, Va. for progrom information.

JUNE 12-17
Conference on Components and Materials. Sponsored by the Electronics and Communications Section of The Institution of Electrical Engineers. The Central Hall, Westminster, London, England. Details from I.E.E., Savoy Place, London W.C. 2.

JUNE 13-14
Fifth National Conference on Product Engineering and Production. Sponsored by PGPEP of IRE. Philadelphia, Pa. Paul J. Riley, RCA, Building 10-6, Camden 2, N.J. for details.

JUNE 19-20
Second National Conference on Broadcast & Television Receivers. PGBTR and Chicago Section of IRE. O'Hare Inn, Des Plaines, Illinois. Contact Neil Frihardt, Motorola Inc., 4545 W. Augusta Blvd., Chicago, Ill. for program details.

JUNE 26-28
Fifth National Convention on Military Electronics. Sponsored by PGME of IRE. Shoreham Hotel, Washington, D.C. Harry Davis, SAFRD, Pentagon, Washington 25, D.C. for program details.

JUNE 28-30
Joint Automatic Control Conference. Sponsored by PGAC, ISA, AIEE, AICHE, and ASME. University of Colorado, Boulder, Colo. Dr. Robert Kramer, Electrical Systems Lab., MIT, Cambridge 39, Mass. for program details.

JULY 16-22
Fourth International Conference on Medical Electronics & 14th Conference on Electronic Techniques in Medicine & Biology. Sponsored by IFME, JECMB, IRE-PGBME. Waldorf-Astoria Hotel, New York, N.Y. Program information from Dr. Herman P. Schwan, University of Pennsylvania, School of Electrical Engineering, Philadelphia, Pa.

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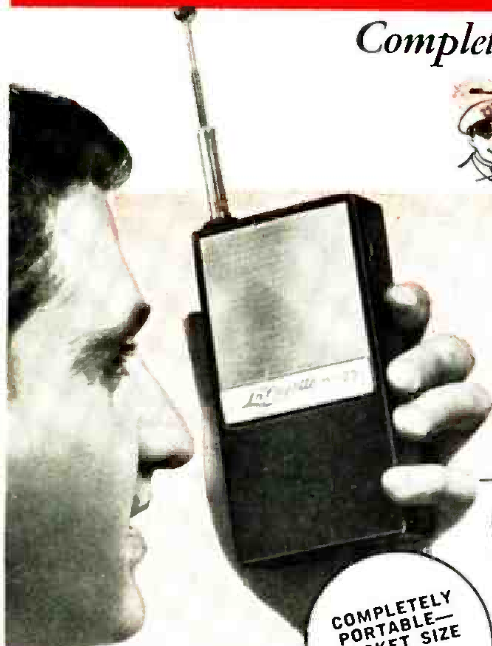

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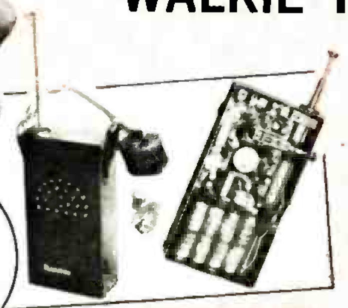

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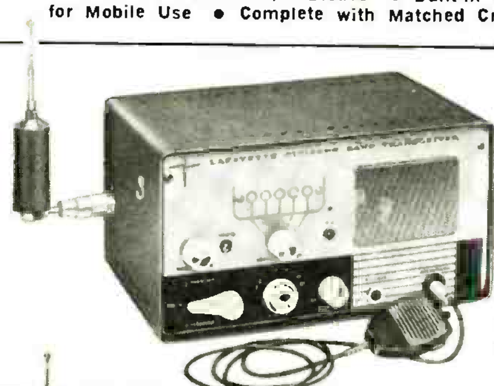

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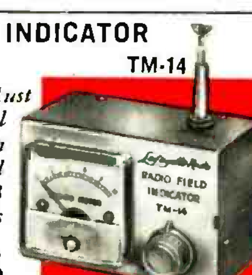

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FCC TO KEEP 5-WATT CB LIMIT

Also denies permission to use frequency modulation.

THE FCC has recently denied a petition by the *Connelly Sales Co.* of LaMirada, Calif. that would have permitted a boost in the plate input power of Citizens Band stations to 25 watts and the use of FM on the band.

Several reasons were cited by the FCC for not raising the power limit. It was felt that the higher power would produce greater interference, especially from "skip" signals. Also, a power hike would make hundreds of thousands of existing CB sets obsolete, or at least put them at some disadvantage. The Commission also indicated that they would have to increase the technical standards on higher-powered equipment, and this would, in turn, make the equipment more expensive to manufacture.

The FCC is convinced that the power permitted by the present rules is adequate and consistent with their purpose in establishing the Citizens Radio Service as a short-distance and low-cost radio service. Persons desiring increased coverage should investigate other mobile services, including the Business Radio Service.

FM for CB

On the matter of FM for the Citizens Band, the Commission feels that the present 10-kc. channel spacings preclude the use of frequency modulation. Such FM would have to be of the narrow-band type, falling within an authorized bandwidth of 8 kc. With such a narrow band for FM, the signal-to-noise ratio would be so poor that intelligible communications would be difficult.

Some of the other radio services do permit the use of FM with this narrow bandwidth. But, it is significant that no manufacturer has been given type-approval for a transmitter using FM modulation within an 8-kc. bandwidth.

Single Sideband

The Commission notes that single- and double-sideband, with or without carrier, are all permitted under the present AM modulation requirement. However, the Commission issued a warning with respect to the possible use of such forms of modulation. They warned that they intend to maintain a close watch for possible regulation abuses, particularly in connection with the power input. If there are a large number of violations or if undue interference is caused to conventional units, the Commission may consider prohibiting the use of such emission by class D Citizens Band stations.

From this action, it appears that the present CB rules will not be eased for some time to come. —30—

Electronic Industries Outlook

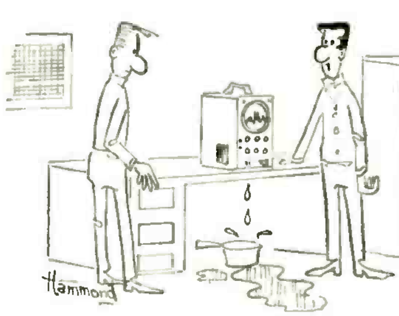
(Continued from page 44)

Whereas in earlier years manufacturers continued production long after retail sales weakened, television and other consumer product manufacturers adjusted their production rates in 1960 to keep inventories at all levels of trade reasonably in line with consumer sales levels. This practice should be beneficial, resulting in an increase in production as soon as consumer buying rises.

Radio-receiver production and sales in 1961 are expected to be below the very high levels of 1960. Although competition from Japanese transistor radio imports appears to have reached its peak in May 1960, a decrease in operations would follow any decline in automobile production, an activity that pushed radio receiver output in 1960 to a 13-year high. Production of FM radios and FM radio-phonograph combinations increased about 50 per-cent in 1960, but year-end data indicates that retail sales were lagging behind production. Sales of FM equipment should continue to increase during 1961. Adoption by the Federal Communication Commission of standards for FM stereo broadcasting should lead to increased dollar volume in production and sales of equipment.

Output of phonographs and radio-phonographs is expected to increase moderately as radio and television manufacturers provide additional packaged systems designed and priced to tap further the mass market for stereo "hi-fi." As in 1960, some of these increased sales may be at the expense of other entertainment electronic products such as television receivers and hi-fi components. Increased sales of high-priced stereophonic sound equipment are expected to continue to be a key factor in expanding consumer electronic product sales values.

Sales of other consumer electronic products—tape recorders, Citizens Band radios, electronic toys, electronic ranges, garage-door openers, household and automotive control devices, and related products—should also increase moderately in 1961 as new product development and promotion open new markets for these products. However, the growth in 1961 in this sector of the electronic industries, which has greater potential than any other major consumer product area except color television, will be only a beginning. —30—



"It must be the damper tube!"

Hams of the Year

Two radio amateurs, W6NLZ and KH6UK, share Edison Radio Amateur Award for their work in tropo ducting.

TWO radio hams whose transpacific experiments have set distance records and opened new horizons in u.h.f. communications, shared this year's Edison Radio Amateur Award sponsored by *General Electric*.

John T. Chambers, 40, of Palos Verdes Estates, near Los Angeles, Calif., and Ralph E. Thomas, 57, of Kahuku, Oahu, Hawaii, were chosen joint winners by a panel of three judges. A $500 cash prize and trophy have been awarded annually for the past nine years for outstanding public service by a radio amateur. This year, however, marks the first time that the award has been granted jointly to two amateurs, and also the first time for a scientific achievement. The presentation was made at a banquet in Washington at which Frederick W. Ford, FCC chairman, was the principal speaker.

John T. Chambers, W6NLZ, of California.

Ralph E. Thomas, KH6UK, of Hawaii.

Chambers, W6NLZ, a satellite communications project leader for *Hughes Aircraft Corp.*, and Thomas, KH6UK, engineer-in-charge of an *RCA* communications transmitting station in Hawaii, have been conducting experiments with the radio phenomenon "tropospheric ducting."

During the experiments, on July 20, 1960, the pair set a one-way communications distance record of 2540 miles on 432 mc. A bad tube in Thomas' r.f. amplifier prevented him from hearing Chambers, but his signals got through to Chambers.

This and earlier records set over the same California-to-Hawaii course, on 220 and 144 mc., confirmed the theory that u.h.f. radio communications was not limited to line-of-sight, thanks to tropospheric ducting.

Thomas and Chambers, whose four long years of patient and often fruitless experimentation paid off in the communication feats, were highly praised by the award judges.

Comparing the accomplishments to the first transatlantic radio communication early in the 1920's, the panel noted that the team had greatly enhanced the standing of ham operators in the scientific world. The judges were FCC Commissioner Rosel Hyde; Robert C. Edson, American National Red Cross; and F. E. Handy, American Radio Relay League.

Chambers, a ham since 1936, moved into the v.h.f. frequencies 15 years ago, and has been going higher ever since. His main reason for launching into high-frequency experimentation was that the lower bands were already too crowded with hams to suit him.

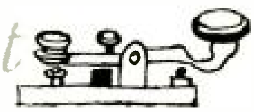
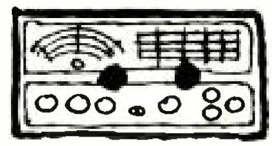
Thomas, a native of New Brunswick, N. J.—and a resident there until five years ago—has been a radio amateur for 45 years. He won the ARRL award in 1955 for his work during the three previous years with meteor scatter.

Tropospheric ducting occurs mainly during the summer inversion season. Chambers keeps his weather eye on the Los Angeles smog. When it lies low over the area, with church spires and hilltops protruding from it into clear air above, he has the sign he is looking for. The inversion of hot, dry air over the damp smog close to the ground indicates that tropo ducting is likely.

In Hawaii, Thomas keeps his eye on the evening sky, looking for low hanging clouds with flat tops. When these conditions are present in both Hawaii and California, tropospheric propagation of u.h.f. signals is likely and the hams go to work. Even so, it took them nine months of painstaking efforts before they had their first success on 144 mc.

The judging panel also voted special citations to six other American radio amateurs and a special commendation to a Chilean. Those cited were W7CKV, W6QIE, K4UUO, W4BAW, W6GYH, W3ECP, and CE7BC. —30—

EQUIPPING THE AMATEUR RADIO STATION

What you need  *in order to get on the air*  *and how you can get*  *the most out of your*  *equipment.*

By HOWARD S. PYLE, W7OE

AN ORDER for an "ideal" ham station is a fairly difficult one to fill when you take into consideration the wide variety of equipment available and the personal preferences of the amateur operator. Here we will attempt to analyze both the legal requirements and the preferences of the "average" ham.

In the first place, irrespective of personal preferences, you have a number of "musts" to comply with, both from the technical and legal angles. Obviously, you can't have an operating ham station without (1) a transmitter, (2) a receiver, and (3) an antenna. Accessories such as a key, microphone, and headphones we'll take for granted. While the above-mentioned components will put you on the air, you'll still not be a *legal* station until you provide a fourth major element—a Conelrad monitor. First, let us examine the four major elements which comprise a ham station.

Your transmitter, whether it be factory assembled, wired and tested, a kit you have built up yourself, or a completely "home-brewed" rig, must meet certain requirements both legally and technically: these more or less complement each other. For example, you can raise Ned with your fellow hams by phone splatter, key clicks, harmonics, and poor operation. By the same token you can cause a maximum of interference to your non-ham neighbor who likes to listen to conventional broadcast frequencies and/or TV programs. Don't think he is going to tolerate a bunch of jabber from you on either phone or c.w. when it is your responsibility to eliminate it. If the problem is *his*, then it is *your* problem to convince him of the fact and point out to him how certain filters and equipment adjustments will fix him up. This shouldn't prove too difficult providing *you* are legal. Before throwing your weight around, be sure you *are* legal because if you are not, the responsibility for eliminating the interference is up to you. Your transmitter must be as clean as a whistle.

You may need the help of the interference committee of your local ham club to determine this, but if you need such help, ask for it as that's what they are there for. What you want is an operative amateur station which causes no trouble to other services and a minimum of interference to other amateurs. At the same time, you want your station to deliver a maximum of pleasurable performance to you, its owner/operator.

Although you have a lot of your hard-earned cash invested in your station, remember that your neighbor has more than "peanuts" sunk into his equipment, hoping to get some relaxation and pleassure from the airwaves. Don't be an "air-hog"; the ether is *not* reserved for the exclusive use of ham radio as a whole, nor for you in particular. It is our democratic tradition to "share and share alike" and as amateurs, as well as citizens, we "play ball." In *your* hamming if you don't you are a poor sport and will be told so by many from both sides of the tracks.

Your receiver is, of course, a "must" for without some device for *receiving* radio transmissions, you just don't have a station. Likewise, lacking an antenna, your communication is going to be limited to the next block or, at most, across town. Your Conelrad monitor isn't going to add one iota to your transmission or reception, but it is a legal requirement which must be met in order to operate a licensed ham station.

Let's refer to the block diagram of Fig. 1, as we break this ham station down, item by item.

The ideal ham station does not mean only providing the equipment, but locating it properly and conveniently as well. This neat and attractive station of "Hap" Helgesen, W7AIB, in Port Angeles, Washington, emphasizes equipment arrangement both from the standpoint of pleasing appearance as well as operating convenience.

The Equipment

A. This represents your transmitter. Irrespective of its power—the input of which can be up to the maximum allowed for General and Extra Class licensees (1000 watts) or the 75 watt limit placed on Novice transmitters—it must be *clean* and free from harmonics, key clicks, phone splatter, and other illegal radiation.

The equipment itself may be of the commercially built variety, a kit which you have assembled, or a unit you have "built from scratch"—as long as it is electrically clean. It may include a built-in modulator or an integral v.f.o., either or both. These items may likewise be separate accessories, housed in their own individual cabinets.

B. This is an r.f. monitor which will enable you to listen to your own transmissions, whether phone or c.w., so that you can detect irregularities in the emitted signal. Again, this can be home-made, kit-constructed, or factory-built. This is not a legal "must" but very much of an operating convenience and highly desirable.

C. A control center is another station convenience which you will probably want to add. This unit you will have to make but it may be as simple or as elaborate as you like. It should, in any case, include a series of switches and fuses for the control and protection of every piece of equipment which is connected to an a.c. source. Those of you who have experienced a blown fuse in the middle of a QSO and have had to remove "umpteen" screws from the panel to get at the fuse beneath the chassis, will get the point. Make the fuses in your control cabinet of the insert type which can be quickly changed from the front of the panel. The switches can be of the s.p.s.t. toggle type, also mounted on the front panel. A "main" switch, preferably a d.p.s.t. toggle, should also be provided so that by throwing it into the "off" position you can remove all power from every piece of equipment connected to the control cabinet. In this way you can eliminate the nuisance of having to throw a handful of individual switches when the night's ham session is over. You can elaborate on the control unit to your heart's content: add a "pet" noise limiter and its controls; mount the station clock in it; and if you wish, install the r.f. monitor (B) in this cabinet. You have wide leeway here so use your ingenuity and imagination.

D. If you expect to work phone at all, this represents your microphone. Little needs to be said about this item other than to caution you to use the type specified by the manufacturer of your transmitter or the designer from whose article you built your rig.

E. Antenna choices are almost as numerous as hams. The antenna you pick is squarely up to you. The most widely used, all-around, "all-band" type is the folded dipole, cut to a half wavelength at the lowest frequency on which you will be operating. The so-called "Windom" or off-center-fed Hertz antenna is also excellent in this class. A random length "Marconi" works well although, theoretically, it is not as effective as the other two. If you are going to concentrate on 10, 15, and 20 meters, some type of beam antenna will produce the most effective results, particularly if it is of the rotating type. Vertical antennas for these higher frequencies have proven effective and many perform rather well on the lower frequencies as well.

F. Antenna switching also falls into several classifications. You can, as shown in Fig. 1, use a simple s.p.d.t. knife switch to accomplish the changeover from "transmit" to "receive." A relay in your transmitter, which serves simultaneously as a keying and antenna changeover relay, has achieved some popularity and does allow you to work "break-in." Electronic changeover relays are available—if you want to be real ultra-ultra. In addition, the phone operator can get "voice-operated relays" which switch back and forth from "receive" to "transmit" as your voice is impressed on the transmitter. Both of these relays permit excellent break-in operation.

One final word on antennas. Don't forget to provide adequate lightning protection by grounding your antenna when it's not in use.

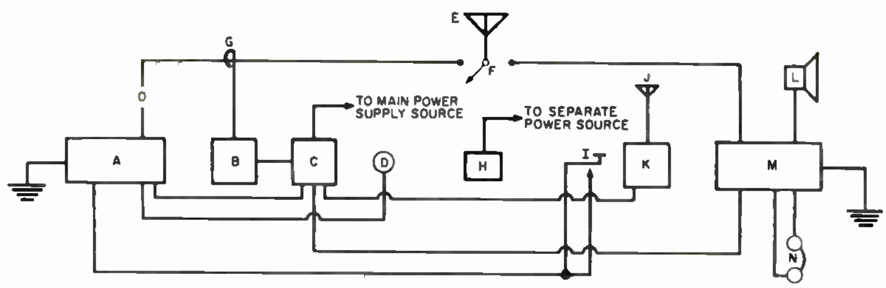
G. The pickup loop shown in the block diagram is merely a few turns of wire wrapped around the transmitter lead to the antenna, if other than coax cable. If a coax transmission line is used, a small opening made through the outer neoprene covering and the braided shield will generally allow enough pick up to actuate your r.f. monitor. Some antenna tuning units provide an internal connection for this purpose or you can mount the loop adjacent to the tank coil in the transmitter itself and bring it out through a small coax connector to the monitor.

H. The station clock is essential although your wristwatch or a garden-variety alarm clock will fill the bill here. The writer prefers an electric clock of some type but if you use such a timepiece, be sure that it is fed from a *separate* a.c. source, as indicated on the block diagram, so that the main switch on your control cabinet does not cut the clock circuit.

I. The key is obvious, whether it be of the hand variety, the semi-automatic "bug," or one of the trickier electronic keys. Even though your operation is confined almost entirely to phone, you should have a key of some sort—you never know when you'll feel the need of a bit of c.w. practice or your modulator gives up.

J. This represents a small pickup antenna for your Conelrad monitor. Generally only a few feet of wire is necessary for the reception of local broadcast stations. If you have no local stations, 15 feet of wire, indoors or out, will usually bring in good signals from broadcast stations several hundred miles away if you are using a reasonably sensitive

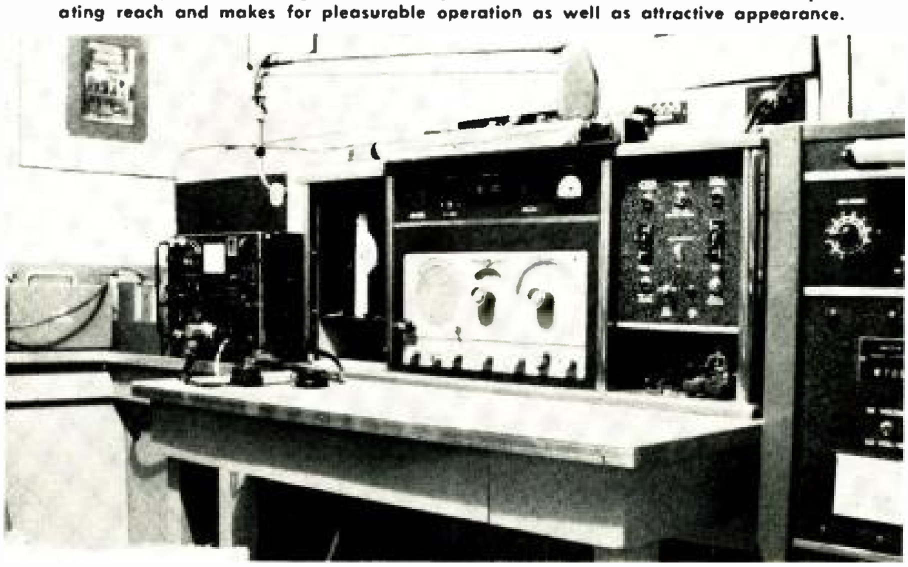
(*Continued on page* 92)



A-TRANSMITTER
B-R.F. MONITOR
C-CONTROL UNIT
D-MICROPHONE
E-ANTENNA
F-ANTENNA SWITCH
G-PICKUP LOOP
H-CLOCK
I-KEY
J-CONELRAD ANTENNA
K-CONELRAD MONITOR
L-LOUDSPEAKER
M-RECEIVER
N-HEADPHONES
O-ANTENNA TUNER IF REQUIRED

Fig. 1. Block diagram of the completely equipped amateur radio station described.

Another equipment arrangement which places all controls within convenient operating reach and makes for pleasurable operation as well as attractive appearance.



Within the Industry

(*Continued from page* 14)

merly general commercial manager of the division . . . **FRANCIS A. BOEHM** has been named editor of "*Sylvania* News," replacing **ALAN D. POSPISIL** who has been placed in charge of distributor national and local advertising campaigns . . . *Arrow Sales, Inc.* has appointed **PHIL KAY** to the post of merchandise manager for its entire chain of distribution outlets in California . . . **R. V. HAMJIAN** is the new distributor sales manager for *Corning Electronic Components* . . . **JAMES I. STULTZ** has been named sales manager, audio products, of *Vega Electronics Corp.*, Cupertino, Calif. . . . **ARTHUR F. R. COTTON** has been promoted to the post of vice-president and managing director for international operations at *Capitol Radio Engineering Institute*. He maintains offices in London . . . **HECTOR V. SLADE,** managing director of *The Garrard Engineering and Manufacturing Company Limited*, has joined the board of *Plessey International Limited*, parent company of the phonograph equipment manufacturer . . . **A. PROSE WALKER** has been appointed to a new post at the Cedar Rapids Division of *Collins Radio Company*. He was formerly manager of engineering for the National Association of Broadcasters.

* * *

H. S. MORRIS has been appointed marketing director for *Altec Lansing Corporation*. He was formerly product sales manager, holding the post for the past 18 years. In his new position he will direct enlarged sales activities from the corporate offices in Anaheim, California.

Concurrent with this appointment is that of G. L. Carrington, Jr. as general sales manager. He has been with the firm as commercial and marketing manager for the past 8 years and prior to that was associated with the company in engineering and production capacities.

* * *

CHARLES R. BILLMAN has been named vice-president of manufacturing at *Simpson Electric Company*. He will be responsible for operations at the firm's six plants located throughout the Midwest . . . **F. W. GUTZWILLER** has been named manager of application engineering at *General Electric's* rectifier components department in Auburn, N.Y. . . . *National Video Corporation* has named **ROBERT G. SCOTT** to the post of sales manager . . . **GEORGE M. STAPLETON,** vice-president of *Ward Leonard Electric Co.*, has been appointed general manager of the firm and will also continue as manager of dimmer sales . . . **NORMAN R. HUEY** will fill the newly created post of manager, new product projects, at *General Electric's* radio receiver department, Utica, N.Y. . . . *RCA's* communications products department has named **FRANK P. BARNES** manager of its Canonsburg, Pa. operation . . . **D. SCOTT BOWMAN** is the new director of marketing for *Amphenol-Borg Electronics Corporation* . . . **JOHN H. BOYLE** has taken over the post of general manager of the communication and data processing division of *Collins Radio Company* . . . **FRANK A. GUNTHER** has been elected president of *Radio Engineering Laboratories, Inc.*, the communications subsidiary of *Dynamics Corporation of America*.

* * *

SOLOMON HUDES has joined *Telechrome Manufacturing Corporation* as vice-president in charge of engineering. Formerly, he was executive vice-president of *Schaevitz Engineering*.

For the past ten years he has been associated with the planning and execution of weapons and missile systems as well as commercial and industrial control systems. He is a graduate of Sir George Williams College in Montreal and holds a B.M.E. from New York University.

In his new post he will be responsible for the coordination of engineering activities of the firm's divisions and affiliates. He will also head the company's new research and development group.

* * *

NATIONAL SCIENCE FOUNDATION has released the results of a study which shows that the employment of scientists and engineers in industry rose nearly 7 per-cent between January 1959 and January 1960.

The proportionate increase from 1959 to 1960 was greatest for physical scientists but the growth in number of engineers greatly exceeded that of other occupational groups.

According to the Foundation, more than 800,000 scientists and engineers were employed in January 1960 by the U.S. business firms covered by the survey. This compares with the 764,000 employed by a similar group of firms in January 1959. —30—

"Oh, somebody won that last week!"

Transistorized Megohmmeter

(*Continued from page* 53)

S_1, push-button switch S_2, and the two jacks for plugging in a pair of test leads. Panel layout for these components is seen in Fig. 1.

Amplifier Adjustments

The combined value of resistors R_1 and R_2 determine both the collector current of V_2 and the base current of V_3. Thus they have a rather critical effect on the gain of the amplifier. As a result, R_1 may be considered as the gain or regulation control for maintaining whatever output level is established for the circuit, but it has little effect on establishing that level. Potentiometer R_5 (also R_4) determines the base current of V_2. It directly affects the level of the output voltage but, on the other hand, has no appreciable effect on the gain of the d.c. amplifier.

To make these adjustments, set all three potentiometers to the mid-positions of their ranges before turning on the instrument. Then connect a 20,000-ohm-per-voltmeter or v.t.v.m. across capacitor C_1 to monitor output voltage, set to a suitably high d.c. range, and turn on the device.

Adjust R_5 for a reading of 500 volts on the external voltmeter. Now depress push-button switch S_2 on the front panel to apply maximum load to the power supply. This has the same effect as shorting together external leads connected to J_1 and J_2. Under proper adjustment (optimum regulation) there will be no perceptible change in the reading on the external voltmeter and the instrument's meter pointer will deflect to full-scale position, coinciding with the zero-ohms position on the megohmmeter scale.

However, when S_2 is first depressed, reading on the external meter may drop, indicating insufficient gain in the feedback amplifier, or rise somewhat, indicating too much gain. The gain or regulating control, R_1, is now adjusted in small increments or decrements, with S_2 being depressed at each setting, until the external reading remains the same whatever position this switch is in.

When adjustment of the regulating circuit is thus completed, remove the external meter and, with S_2 depressed, adjust R_5 until the instrument's meter pointer coincides with the zero-ohms point on the megohmmeter scale. The instrument case may now be closed. The unit is ready for use. The only adjustment that may be occasionally necessary in use is that for zero ohms, which may be performed with front-panel control R_4, in series with R_5.

Whenever zero adjustment is made, of course, it is always with the meter circuit completed by closing of S_2. While this switch was found to be a convenience, it could be omitted. Shorting together the two test leads connected to J_1 and J_2 could accomplish the same purpose. —30—

Temperature Meter for Boats

(*Continued from page 51*)

when the temperature meter is in operation. Adjustment of this pot makes it possible to use the meter with any outboard motor.

The Sensing Unit

The sensing unit consists of the Model T1 Globar resistor mounted in a bracket which serves to conduct the heat of the engine to the resistor's body. The bracket is made by bending a small piece of aluminum around the body of the Globar. Before this is done, however, the outside of the Globar should be covered with tape in order to electrically insulate it from the bracket. A terminal strip is also mounted on the bracket to provide a junction point for the element's pigtail leads. The photograph of the bracket should be consulted for further construction details.

The bracket with the Globar in position is fastened to the cylinder head of the outboard engine by removing the head bolt and slipping it through the hole in the bracket and re-tightening the bolt into the head. A two-lead cable is used to connect the sensing unit to the indicator.

Indicator Construction

The indicator section of the outboard temperature meter consists of all the parts shown in the schematic of Fig. 1 with the exception of the Globar resistor which is mounted in the outboard motor.

At this point in the construction of the temperature meter, it is wise to decide on your source of power. If you own an electric-starting outboard with a 12-volt starter and battery, 12 volts is the obvious choice. In this case, a 68-ohm resistor should be used for R in the schematic diagram. If you, as is the author's case, do not own an electric-starting job, your best choice of supply would be a 6-volt dry battery. If 6 volts is used, resistor R should be omitted.

If you decide on a 6-volt power source, it can take many forms. Four penlite cells mounted inside the indicator's case should prove satisfactory. In the author's unit, a 6-volt "Radar Lite" battery was used to power the temperature meter. This battery, mounted under the deck of the boat, also serves to operate the craft's running lights. Continuous operation of the meter while on a cruise appears to have little effect on the battery's life.

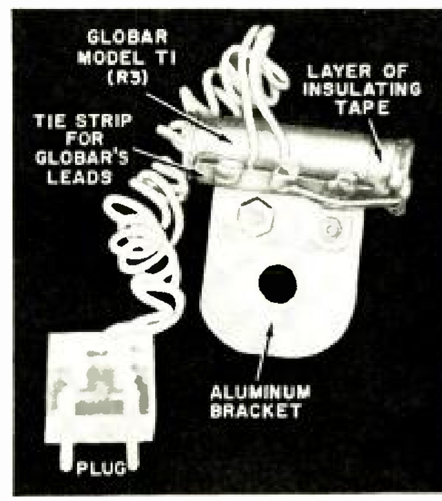
The construction of the indicator is straightforward and requires no explanation. The author's unit, as shown in the photographs, can be used as a general layout. However, any arrangement of parts which is suited to the reader's specific requirements should prove satisfactory. If it is desirable to install the outboard temperature meter on your boat's dashboard, the case for the indicator section can be omitted and all parts mounted behind the dash, leaving only the 0-1 ma. meter and power switch, S_1, visible.

One point worth mentioning is the new scale for the meter. This scale is laid out on a heavy piece of drawing paper with the left third of the scale shaded green and labeled "Safe" and the right two-thirds shaded red and labeled "Danger." The newly prepared scale is then glued into place over the old 0-1 ma. scale which came with the meter.

Installation & Calibration

Once the indicator has been mounted in a convenient position and the sensing unit installed in the engine, the interconnecting wires should be made secure. In the author's boat, the two-wire lead from the sensing unit was taped to the outboard's remote operating cables. In this way the possibility of tangling wires was eliminated.

A section of twin-lead TV antenna wire was used to supply the two-wire cable which connects the sensing unit to the indicator. Borrowing more parts from the television industry, the sensing unit cable, where it leaves the engine, was cut and a TV lead-in connector installed. This connector makes for the



The temperature-sensitive resistor is first wrapped with tape and then inserted into a home-made aluminum bracket. The bracket is positioned on the outboard's cylinder head where it is held into place by one of the head bolts.

rapid removal of the outboard motor. Rather than cutting the sensing unit's lead to take the motor off the boat, the connector is merely unplugged. The male end of the connector is shown in the photo of the bracket.

After the battery has been connected you are ready to proceed with the calibration of the instrument. Don't let the word scare you—it's really a simple process. First, get your boat out on a cruise and run your motor long enough for it to reach operating temperature. Then, turn on the temperature meter. Adjust R_2, the calibration control, until the meter's needle is about in the center of the "Safe" portion of the scale. Now you are ready to go. If your engine gets hotter than usual, the needle goes up. If your engine's cooling system fails, you'll get the message without getting a bill for a very costly motor repair job.

—30—

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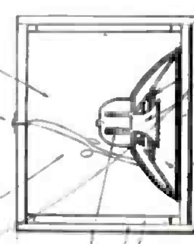

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Gentlemen please ship .... GIGOLOS.

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

Name ....

Address ....

City and State ....

Enclosed find check .... money order ....

Equipping the Ham Station

(Continued from page 87)

broadcast receiver as your monitor.

K. The Conelrad monitor itself need be nothing more than an obsolete a.c.-d.c. rig, obtainable at many salvage stores for a few dollars or it may be one of the more elaborate units specifically designed for Conelrad monitoring. Several such units are available on the market in both kit and commercially built versions. Just be sure you have a monitor of some kind as this is a *legal* requirement.

L. A loudspeaker is built into many communications receivers, in others it is not and such a speaker would then be mounted externally. Many receiver manufacturers offer such auxiliary equipment for their receivers and the speakers are matched to the receiver both electrically and physically. You will want a speaker in many cases, not only to rest your ears from the headphones but during stand-by periods while waiting for calls. Often they can be used in actual communication where signals are adequate.

M. This block represents the receiver itself. This is one item on which you should splurge a bit. Get a *good* one. It doesn't need to be new as very excellent second-hand receivers are often available from amateur supply houses at substantial savings. It is not recommended that you assemble and wire a really *good* kit receiver unless you have a pretty fair electronics background. The same applies to building your own. It is better to buy a used factory-built receiver, after trying it out of course, if you feel that a good new one is not in your budget. The price range for a new receiver of the communications type runs between $100 and $200—let your pocketbook be your guide. Be sure to get one of reliable manufacture. All such receivers are generally available on "easy payment" terms, if you prefer. While we are on the subject of receivers, it should be mentioned that you can use separate antennas for transmitter and receiver which would automatically eliminate the need for the antenna switch (F). Protect the front end of your receiver during transmission periods by shunting a small neon bulb across the receiver antenna and the ground terminal.

N. Last, but not least, are the headphones. No matter whether you work phone or c.w., there will be frequent occasions where signals on your loudspeaker may be too weak for good copy. Headphones will help immeasurably in such a case. They also are helpful in subduing room noises and other disturbances as well as insuring silent reception in cases where a loudspeaker would prove distracting.

Follow the hints and suggestions given here and you will come pretty close to achieving the "ideal" ham station. You can add furbelows and refinements as they occur to you but this, at least, gives you a sound starting point.

—30—

ELECTRONIC CROSSWORDS

By **BRUCE BALK**

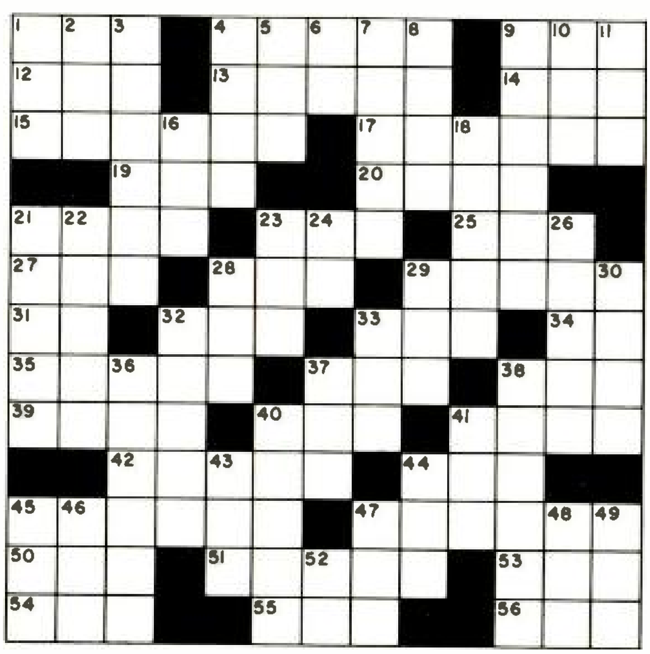
(*Answer on page* 125)

ACROSS

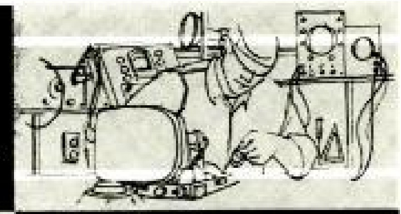
1. Type of telegraphic key.
4. Bolt used to fasten shielded coils.
9. Motor speed (abbr.).
12. Literary collection.
13. Sheet on which controls are mounted.
14. Professional engineering society (abbr.).
15. Color code for #4.
17. Element found as graphite; widely used in electronics.
19. To consume.
20. Grip on a control shaft.
21. Two or more variable capacitors mounted on a single shaft.
23. System now replaced by C.G.S.
25. Radio distress signal.
27. Southern state (abbr.).
28. Distortion in sound reproducing system.
29. Negative polarity.
31. One-thousandth of a liter (abbr.).
32. Small visible mark on a radar or scope screen.
33. Type of jack.
34. 3.1416.
35. Sub-atomic particle.
37. Devotee of DX (abbr.).
38. Unit of power ratios.
39. Again.
40. Low-voltage incandescent lamp.
41. Tree-trunk covering.
42. Reconvene (said of Congress).
44. Ident. Friend or Foe (abbr.).
45. Continuous tuner.
47. Low-frequency speaker.
50. Current-resistance-voltage (abbr.).
51. Electronic navigational aid.
53. Type of carbon mike worn on face.
54. Greek letter (pl.).
55. April 15th donation.
56. Stammering syllables.

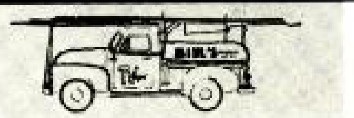
DOWN

1. Part of an antenna array.
2. One (Fr fem.).
3. Crystal.
4. Luminous area on CR tube screen.
5. Animal foot.
6. Article.
7. Tape transports.
8. Spirit.
9. Microphone with moving conductor.
10. Antonym of "amateur" (slang).
11. Males.
16. Electronic delay.
18. Material used in soldering.
21. Greek letter.
22. Type of setscrew.
23. Wash floors.
24. One-thousand watts (abbr.).
26. 3000-30,000 mc. h.f. band.
28. Emerge victorious.
29. Stylus radius measurement unit.
30. Material used in wire covering.
32. Energy per unit time.
33. New Deal agency (abbr.).
36. Type of part arrangements in a circuit.
37. Receiver (familiar).
38. Device to improve speaker fidelity.
40. Lamp used to light a tuning dial.
41. You can't receive code without it (abbr.).
43. Salvador, for short.
44. Charged particle.
45. Color code blue.
46. First transformer winding (abbr.).
47. Material used in making old record "masters."
48. Voltage, current, resistance (abbr.).
49. Speed (abbr.).
52. Egyptian sun god.



SERVICE INDUSTRY NEWS





THE POTENTIAL for mutually helpful cooperation between broadcasters and the service industry is far from being a new concept. However, regular readers will note that we have given more space to actual instances of such cooperation over the past year or so than any other time in the past. This is simply because more is being achieved along these lines than ever before. Good ideas sometimes take a while to gain acceptance.

A recent case does have a somewhat different angle. Generally the initiative for such cooperation is taken by the members of a service association, who thus sometimes feel that they are going to the broadcaster, hat in hand, seeking favors. "TESA News" (St. Louis, Mo.) reports a case in which a broadcaster has appealed to service people. The local channel 9 (KETC) is an educational TV station. As such, it probably cannot hope for the wide audience enjoyed by larger, network-affiliated rivals who primarily disseminate entertainment. However, it feels it may be getting less than its fair share because some potential viewers cannot receive it well.

It's an old story: earlier antennas may not have been designed or oriented for good reception on channel 9 when it was inactive. Improperly adjusted tuners may be losing other viewers. KETC has therefore appealed to TESA-St. Louis to ask its members to check out these possibilities on all sets they service, and the association has passed this information along. Broadcasters, you see, also need help, and service technicians can give it. In the meantime, this service group feels rightly pleased that it is doing something for the public good in promoting educational TV.

With the current growth of new FM stations, the service industry has an expanded opportunity for broadcaster cooperation. KAFM of Salina, Kansas sponsored a luncheon for local service technicians and gave a refresher course in FM service. It hopes that this will help get older FM receivers back into use and into good enough condition for satisfactory reception. In return for service cooperation, it is running a regular commercial on behalf of association members.

Such programs have become sufficiently important for NATESA to do something about encouraging them. This organization has available a "TV Station Liaison Brochure" outlining methods for establishing cooperative programs. It may be obtained from the national office in Chicago. We trust the recommendations will be just as useful for dealing with the growing roster of FM broadcasters. The industry needs prestige, and we know of few ways of obtaining it that are more practical.

Raytheon License Stand

In this space (March 1961), we reported on a speech by John Catterall, of the *Raytheon Company*, made before a NATESA meeting and relating to licensing. Our usually reliable sources slipped up in reporting this one, probably without improper intent. The informants, all pro-licensing, evidently heard one thing and believed another. However, we have statements by John Catterall himself and by E. I. Montague of the same company that should clear the air.

The latter reports his firm has "never taken and does not intend to take sides in the matter of licensing" because it feels that this is a question the service industry must decide for itself. Or, as Catterall puts it, "An issue as important as this must be decided by the men directly affected by it, not by any outside group." The viewpoint has great merit.

The misunderstanding seems to have arisen from two unrelated points made in the speech in question. "I stressed the fact that the independent serviceman is entitled to much more than he is presently getting," says Catterall. However, he did not recommend *service* licensing as a means for improving this situation. He then suggested such work as service on two-way radio systems as a means for improving income—and went on to note that a national license (the familiar FCC ticket, which has been a requirement for many years) is mandatory for this type of work. Eager *service*-licensing advocates in his audience jumped to the wrong conclusion too quickly. We are pleased to set the record straight on this matter.

Part-Timer Holds Office

We have frequently pointed out that the part-time service technician, who may be a competent and ethical individual, is not always identical with the so-called "night crawler," neither qualified nor honest, who has harmed the cause of service. We have pointed to the many reputable service associations which, recognizing this, make provision for admitting legitimate part-timers to membership. Nevertheless, we still get an occasional letter from a reader who feels that, as an honest and capable part-timer, he is being discriminated against by all the servicing industry.

Such individuals may take cheer from the recent elections for 1961 officers of TESA in Springfield, Ohio. The new vice-president, Lewis DeVore, is himself a part-time service dealer, yet this has not stopped his associates from honoring him with a responsible position. Other new officers include William Elliott, president; Roy Henderson, secretary; and Jack Carpenter, treasurer.

This election turns up another interesting fact. Neither the new president nor the new vice-president ever held office before. Each joined the association less than a year before his election. They were obviously not members of an established "clique" trying to control the Springfield group. How did they make the grade? Simply with ability and the willingness to carry the load. We hope disgruntled association members take full notice of this. Few associations are boss-run by controlling groups hungry for power, because few associations are million-dollar organizations that present opportunities for great personal power. Most of the "old-line" leaders, in fact, are more than anxious to have newer blood come up from the ranks to help them carry the load which is considerable when you are simultaneously trying to make a living by running a full-time shop. In other words, malcontented members can do something more useful than complaining. They can attend meetings regularly and pitch in.

RCA Dealer Authorization

A letter from W. C. Pecht of TEAM (St. Louis, Mo.) takes exception to the first item in this column for our issue of March 1961. This discussed a "new" *RCA* program for authorizing independent dealers in Indianapolis, Ind. The writer points out that this program is not unprecedented. He points to similar arrangements between this manufacturer and the independent service industry in his own city, in Columbus, Ohio, and in Detroit, Mich. that are not late developments. We are more than pleased to get this point across because we share Bill Pecht's feeling that amity and cooperation among industry segments should be stressed wherever possible, rather than dissension.

Nevertheless, the March report is essentially true. The program *is* new in Indianapolis and the apparent disposition by the manufacturer to make it widespread, instead of confining it to a few cities, is also newsworthy. It is commendable too.

Editorial Footnote

Have you noticed that, during the past year, we have changed the character of "Service Industry News" considerably? We have tried to make it more personal, more readable, and more "editorial" than it was in the past. Our reason is that we think you like it better this way. Do you? We'll try to satisfy your preference, whatever it is. Why not drop a line to the Service Editor letting him know how you feel? —30—

Technician & DIY Repairs

(Continued from page 33)

veal signs that a replacement had been made for the original.

Rather than re-replace a costly transformer, we were able to drop voltages adequately by inserting a resistor at the rectifier output, as shown in Fig. 1. Correct resistance was determined experimentally with a heavy-duty potentiometer, power rating was calculated, and a suitable fixed resistor was then installed. This owner was lucky.

There was one puzzling aspect to this job worth noting since, as often happens with DIY cases, it helped hide the clue: the set had been giving apparently normal, trouble-free service since the owner had made the replacement, and the latter had occurred some time earlier. A further check showed that a new 5U4 rectifier had been installed just prior to the breakdown of the width coil. The earlier rectifier had evidently already been weak when the transformer was replaced, so it managed to prevent the build-up of excessive "B+."

A somewhat similar condition was encountered in an *Admiral* TV using a vertical chassis. The immediate symptom was a shorted filter capacitor in the boosted "B+" circuit. After replacement, voltages were checked to determine whether failure was a normal breakdown of an aging component or some other condition was involved.

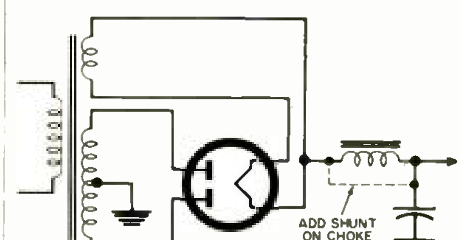


Fig. 3. Filter input choke was shorted to raise excessively low "B+" voltage.

Voltage on the high "B+" line was about 320 volts. This is not necessarily an unreasonable value, but it was noted that the electrolytic filters at the rectifier output were stamped with a rating of only 300 volts.

A check with the service data for the receiver showed that high "B+" should have been only 260 volts. There had been an increase of more than 20 percent. As in the first case, the abundance of "B+" was traced to an incorrect replacement of the power transformer.

The cure was also similar to that applied in the first case. Here the a.c. from the transformer secondary was dropped by placing the resistor between the center tap of the winding and ground, as shown in Fig. 2. Why the electrolytic capacitors, rated at 300 volts, stood up under the over-voltage so well is a mystery. Perhaps this is a salute to their manufacturer.

Another case similar to these, but in

which the effect was opposite, involved an old *DuMont* TV set with a split-sound design and the continuous tuner that could also receive the FM band. The owner was originally interested in restoring the FM function only, which he was using in conjunction with a hi-fi system that he had put together himself from kits. "Don't bother with fixing the TV," were his parting words as the chassis was being removed from his house. Hardly had the set reached the shop when the customer phoned. He had changed his mind. He now felt that he would like to have TV reception restored too, but with a familiar stipulation: "If it doesn't cost too much."

A new tube and re-alignment restored this RA-112 chassis to the good FM reception of which it is capable. When no raster could be obtained, a new 6SN7 in the horizontal circuit restored it. However the raster was short and narrow. A new 5U4 did not restore the low "B+" found in this set, which was 280 volts instead of the normal 340. Again, a close look revealed that the power transformer had been replaced, but this time with one supplying insufficient step-up.

At first, re-replacement of the power transformer was considered, but a check showed that the power supply used a multi-section filter network with the not-too-common choke input. Merely shorting out the input filter choke (Fig. 3) raised "B+" sufficiently to supply a full raster while leaving satisfactory filtering and regulation.

An *RCA* KCS47 was being serviced for poor sound. Replacing the FM discriminator tube and touch-up alignment restored normal audio reception, but another trouble was apparent. When the set was checked with an indoor antenna (the way the customer was using it), there was raster break-up due to regeneration. It was known that, in this case, the "do-it-yourself" owner had also once replaced the power transformer himself. Made suspicious by other cases, we checked this component carefully, but it couldn't be more correct—it was an exact *RCA* duplicate.

A full check of decoupling networks and video i.f. alignment revealed no defects; nor were there any peculiarities of lead dress in the i.f. section. However, it was finally noted that a shielded cable from the "TV-Phono" switch on the rear apron of the chassis was dressed over and close to some i.f. tube sockets. Restoring the cable to its normal position, indicated in the service data, cured the regeneration. The owner seemed to have altered the dress of this lead because it was in his way when he made his own replacement.

In this case, as in others, why did the set owner overlook the deteriorated performance that was evident after he made his own repair? Human nature being what it is, he was too eager to overlook his own imperfections. But he can suddenly become highly critical when the same symptom is in the hands of a professional. —30—

Mac's Service Shop

(*Continued from page* 60)

a set that has been out of commission for some time and may have three or four different things wrong with it, *for the only way we can be certain we've located all the troubles in the receiver is to restore it to normal operation—in other words, actually to repair it on a temporary basis.*

"Consider another angle: if your face swells up and you call in the doctor, he will look at you, ask you a few questions, and tell you that you have the mumps. Then he will prescribe for you, give you some advice, separate you from five to ten dollars, and be on his way. He does not go ahead and check out your lungs, heart, kidneys, liver, digestion, and metabolism. You are sick; he has found something wrong with you; and that is that.

"But when we come across a single bad tube in our testing, we don't immediately grab up a pad and start figuring the repair bill. We go right on testing the remainder of the tubes. Then we replace the defective tube with a new one and turn on the set. All the controls are operated; all the channels are checked out; and the TV set is watched closely and critically for any sign of faulty operation. We know if the owner tells us to repair the set, he will expect it to operate perfectly when he gets it back, no matter how sketchy his original complaint might have been. And if he doesn't want it fixed, we have to remove all the new parts we installed to make the set operate."

"Yeah, and if it's an average case and we do get the job, our total bill will be under $20," Barney interrupted.

"True," Mac agreed, "and you can see that all these things add up to a vast difference between the rough 'estimate' given free by many salesmen who gamble a small amount of time and no equipment on the possibility of securing a job running into hundreds or even thousands of dollars, and the careful and complete troubleshooting job performed by a radio and TV technician. Yet the latter often calls his time-consuming diagnosis an 'estimate,' too. Everyone should realize the difference. That's why I've had these new claim tickets printed," he said as he handed one to Barney.

"Notice the part that stays with the set says in easy-to-read type that a charge is made in every case for the labor, equipment, and knowledge used in locating the trouble. If the device is repaired, this charge becomes part of the total service charge; otherwise it will be collected when the set is surrendered. The ticket further states this charge will be $1.50 for a small radio or record player and $3.50 for a TV set, tape recorder, or hi-fi system delivered to the shop. If the equipment has been subjected to unusual damage by fire, water, lightning, or tampering, the charge will be higher. When the owner writes his name and address on

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this ticket, he cannot help but see the statement of policy immediately above; but we'll still have a sign prominently displayed that states a charge will be made for locating trouble and determining the cost of repair."

"Do you think that will protect us if some chiseler tries to get out of paying the charge?"

"I don't know for sure, but I do know that 'intent' carries a lot of weight in any court of law. If we can show we did everything we could to let the customer know he was going to have to pay for the time, equipment, and knowledge we used finding what was wrong with his set, that will certainly establish our intentions were honest and above-board. It will be pretty hard for him to deny knowing he was incurring this charge when his claim stub matches a ticket with his signature below a clear statement of our policy. Notice we do not use the word 'estimate' at all. We speak about work done, equipment used, and knowledge applied."

Mac paused and then concluded thoughtfully: "A long time ago, in the *Book of Luke*, if I remember rightly, a very wise Judge said, 'The labourer is worthy of his hire.' I doubt any modern day judge, when he clearly understands the circumstances, will try to reverse that decision." —30—

MIDWEST YL CONVENTION

THE annual Midwest YL Convention, sponsored this year by the LARKS (Ladies Amateur Radio Klub of Chicago) will be held Friday and Saturday, May 19 and 20, at Weller's Motor Lodge, 6150 W. Touhy Ave., Chicago.

The FCC has issued the call W9YL for use during the convention. Hallicrafters has loaned the group a complete SSB station for the convention. W9YL will operate all bands and a special commemorative QSL card will be sent to all stations worked. Station operators will be Roberta Kroulik, K9IVG and Eva Gudia, K9EMS.

As part of the convention, contact will be made with the YL German Anniversary Party being held at Dortmund, Germany on the same date.

Also planned is a Friday night supper to be held at the Classic Bowl and a Saturday luncheon and banquet at the Tam O'Shanter Country Club. Convention chairman is Bernice Schmidt, W9SJR. —30—

". . . about this 'check' you accepted on that last call . . ."

Reducing Interference To Hand-Held CB Transceivers

By HARTLAND B. SMITH

By operating between the assigned channels, QRM problems may be reduced.

TRANSISTORIZED 100-milliwatt transceivers have become extremely popular because they may be operated in the 27-mc. range without an FCC license. Unfortunately, in densely populated areas, these little rigs are subject to severe interference from the 5-watt Citizens Radio stations which use the same band.

What Can Be Done

Many owners of such units are unaware of the fact that this interference problem can be reduced, or even completely eliminated, by a proper choice of operating frequency. Low-power units, unlike conventional Citizens Radio equipment, are not required to transmit on specifically designated channels. An unlicensed 100-milliwatt transceiver, for example, may be operated on any frequency in the 26.970 mc. to 27.270 mc. band.

Since there is a relatively large gap between the 27.225 mc. and 27.255 mc. Citizens phone channels, any spot between these two frequencies will usually be free from local interference. The same can be said for the area from 27.255 mc. to 27.270 mc. Such 100 milliwatters may also be used on the Citizens radio control frequencies: 26.995, 27.045, 27.095, 27.145 and 27.195 mc. These assignments normally have fewer signals on them than the crowded phone channels.

When dodging interference, be sure to stay at least 5 kc. away from the band edges. Don't purchase a crystal for a frequency lower than 26.975 mc. or higher than 27.265 mc.

A Word of Caution

A word of caution is in order. The foregoing suggestions may only be followed if the input power to the transceiver does not exceed 100 milliwatts and then, only if it is used to communicate with similar unlicensed low-power devices. Whenever one of these units is employed in conjunction with a licensed Citizens Radio station, it, too, must be licensed and may only be operated on a channel allocated to the Citizens Radio Service.

Complete details regarding the operation of unlicensed low-power communication equipment will be found on page 82 of Volume II, FCC Rules and Regulations. A copy of Volume II may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. The price is $2.00. —30—

The Complementary Emitter-Follower

By **DONALD S. BELANGER**
Sangamo Electric Co.

Description of a useful transistor circuit with impedance transformation, isolation, unity gain, and low distortion.

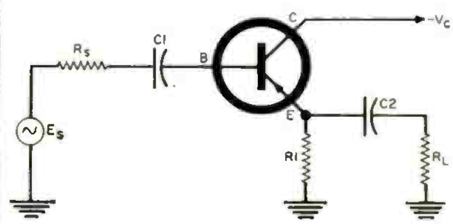

Fig. 1. Basic emitter-follower circuit.

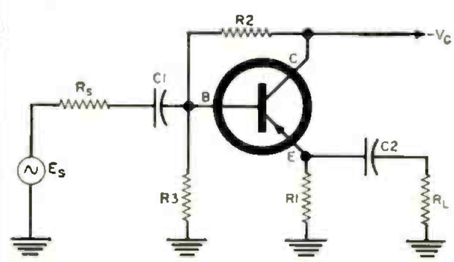

Fig. 2. In this emitter-follower, a large current flows through R_1 in order to satisfy the requirements of a small R_L value.

Of the three common transistor configurations, the common collector (or emitter-follower) is one of the most neglected by circuit designers. Common-collector stages offer several unique properties—impedance transformation, isolation, unity gain, and very little distortion.

An emitter-follower is shown in Fig. 1. When we add the biasing network (R_2 and R_3) shown in Fig. 2, the high input impedance of the transistor is shunted by these two resistors, operating effectively in parallel.

The emitter-follower shown in Fig. 2 has the disadvantage of requiring a large current through R_1 in order to satisfy the requirements of a small R_L. This leads to a high dissipation for the transistor as well as unnecessary drain on the power supply. A quick review of the emitter-follower's operation will show why.

A negative signal at the base of the transistor allows electron current to increase from collector to emitter. The increase in negative voltage across R_1 is coupled through C_2 to R_L. On the positive half of the cycle, the positive-going base decreases the current through the transistor and C_2 starts to discharge through R_1 and R_L. If R_1 is not small enough for C_2 to discharge rapidly through it, then C_2 will hold the emitter at a more negative voltage than the base. This reverse biasing of the emitter-base junction cuts off the transistor, causing clipping of the signal (Fig. 3). In order to eliminate this distortion, R_1 must pass at least twice the current as seen by R_L.

Fig. 4 shows a complementary emitter-follower which, except for a small forward bias that inhibits crossover distortion, draws from the power supply only the current required by the load. R_1, R_2, R_3, and R_4 provide the appropriate small forward bias. R_3 and R_4 are protective resistors. V_1 and V_2 should be selected to have roughly the same *betas*. Since only one transistor is conducting during each half cycle, the power dissipated by each is only one-half of the total power delivered to the load.

The complementary emitter-follower

Fig. 3. Reverse biasing of the emitter-base junction cuts off the transistor and produces this clipping of the signal.

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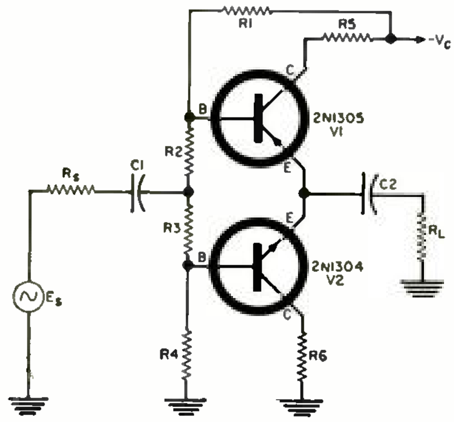


TYPICAL VALUES:
R1, R4 = 22K R5, R6 = 22Ω
R2, R3 = 220Ω V = -15V.

Fig. 4. A complementary emitter-follower that draws only the current required by the load from the power supply utilized.

is basically a power-output stage. To fully utilize its capability, it is sometimes desirable to drive this stage from a single-ended emitter-follower. The price of the extra components will be covered by improved circuit performance (Fig. 5).

Another advantage of the complementary emitter-follower is its use in circuits requiring d.c. response. By running the transistors between a positive and negative supply (Fig. 6), a d.c. output may be obtained which can have a steady-state value either side of ground.

—30—

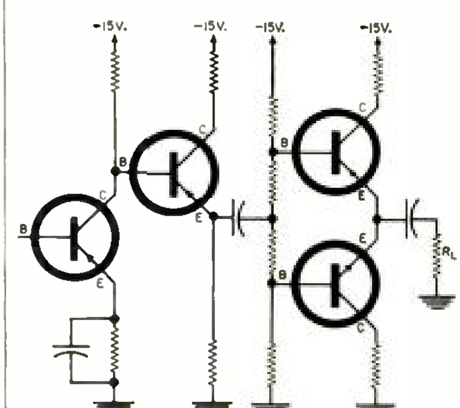
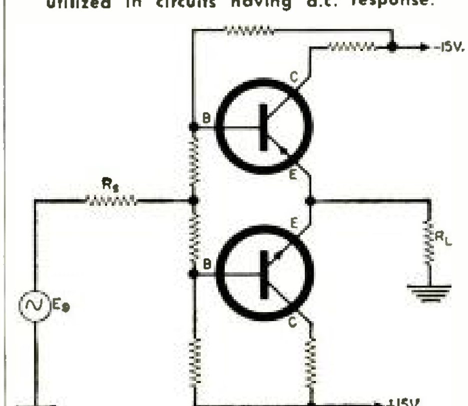


Fig. 5. The complementary emitter-follower is driven here from a conventional single-ended emitter-follower circuit.

Fig. 6. The complementary circuit may be utilized in circuits having d.c. response.



Auto Radios for 1961

(*Continued from page* 35)

shorted, resulting in low audio output.

Signal-seeker does not stop. Check to make certain that antenna is extended, "seeker" sensitivity control is turned up, and that stations are being received normally. Then try a new "trigger tube" (12AL8). Next check the 2nd i.f. transformer for alignment and continuity.

Receiver completely dead, no characteristic "thump" when turned on. There is no voltage between heat sink and chassis. This could be caused by an open fuse resistor in the transistor emitter circuit. Replace with another fuse resistor and match the value used. This will be either .33 or .47 ohm. (The .47-ohm resistor is used with a 1000-μf. bypass capacitor. The .33-ohm resistor is not bypassed for audio.) Check for cause of transistor overload.

Very distorted, little or no volume, output transistor is hot to the touch. This may be caused by an improperly adjusted bias control, a defective bias control, or an open or changed value 10-ohm bias resistor. See Fig. 1. If this condition is permitted to continue, it is only a matter of chance as to which goes first, the transistor or the fuse resistor.

Bias is adjusted by turning the bias control until the d.c. voltage from the heat sink to the chassis measures, with 12 volts at the set's power input, 1.5 volts for the following receivers: *Chevrolet, Corvair, Pontiac, Cadillac,* and *Oldsmobile.* The *Oldsmobile* 989383 requires 1.6 volts, as does the *Buick* Model 980135 and the *Pontiac* 989692. The *Oldsmobile* 989387, the *Pontiac* 989831, and the *Buick* 980132 require but 1.2 volts. When the bias voltage is being adjusted, be certain to connect the speaker or use a 4-ohm load in its place.

Receiver keeps burning out transistors. Transistors in the output stage will burn out for a number of reasons: if the bias control is improperly adjusted, if the bias resistor opens, and if the set is operated at more than half volume for any length of time with the speaker circuit open. An autotransformer-type output transformer is used in these receivers. If the speaker is not in the circuit or if the shorting switch fails to short when the speaker plug is removed, the back e.m.f. can ruin the transistor.

Check to make certain that none of the above has occurred and check to make certain that the car owner has not hooked up a rear-deck speaker with an improperly wired or defective switch.

Receiver dead, characteristic thump can be heard when set is turned on, but no other sound. This trouble holds true for the early-run radios used in 1961 *Cadillacs.* Before "pulling" the set, try backing the antenna plug out just a mite. On some units the antenna plug shorts internally against the tuner frame. A fiber washer and some insulating tape will cure this problem. See Fig. 5. —30—

New Tube Tester Data

Owners of RCA hole-card automatic testers: here are hole locations to be punched for new tubes.

RCA AUTOMATIC TESTER, WT-110A

TUBE TYPE	HOLE LOCATIONS TO BE PUNCHED	NOTES
2FS5	A3, B4, B6, B7, D2, G5, J2, K3, L1, L6, L7, M3, M6, N2, N6	
2FY5	A3, B4, B6, C1, C7, D2, G5, I6, I10, J2, K10, L1, L6, L9, M3, M6, N2, N6	For gas test, see instructions.
3ES5	A3, B4, B6, B7, D2, G5, J2, K3, L1, L6, L7, M4, M6, N2, N6	
3FY5	A3, B4, B6, C1, C7, D2, G5, I6, I10, J2, K10, L1, L6, L9, M4, M6, N2, N6	For gas test, see instructions.
6AR8	A4, B5, C7, G1, G2, G3, G6, G8, G9, K2, L3, M5, M10, N2, N9	Emission and short test only. Reject if below 4.
6DB6	A3, B4, C2, D1, D7, E6, G5, I6, I10, J3, K2, L1, M5, M10, N2, N9	For gas test, see instructions.
6EM7 Triode Unit #1	A7, B8, C6, D4, G5, I6, I10, J2, K6, K7, L1, M3, M10, N1, N9	For gas test, see instructions.
6EM7 Triode Unit #2	A7, B8, C3, D1, G2, I6, I10, J10, K4, L1, L6, L7, M3, M10, N1, N9	
6EZ5	A2, B7, C8, D5, E4, G3, I6, I10, J7, K5, L1, L6, L7, M3, M10, N1, N9	
6FY5	A3, B4, B6, C1, C7, D2, G5, I6, I10, J2, K10, L1, L6, L9, M5, M10, N2, N9	For gas test, see instructions.
6GK6	A4, B3, B5, B9, C1, D2, E8, G7, I6, I10, J5, K6, K7, L1, L6, L8, M3, M10, N1, N9	
6GN8 Triode Unit	A4, B5, C1, D2, G3, I6, I10, J2, K3, L1, M3, M10, N1, N9	For gas test, see instructions.
6GN8 Pentode Unit	A4, B5, C6, D7, E8, G9, I7, I9, J1, K7, L1, L6, L8, M3, M10, N1, N9	
6K4/EC70	A3, B6, C7, D1, G2, G4, G8, J1, K6, K7, L1, L6, L7, M5, M10, N2, N9	Use WG-339A adapter.
8GN8 Triode Unit	A4, B5, C1, D2, G3, I6, I10, J2, K3, L1, M5, M10, N3, N9	For gas test, see instructions.
8GN8 Pentode Unit	A4, B5, C6, D7, E8, G9, I7, I9, J1, K7, L1, L6, L8, M5, M10, N3, N9	
10EG7 Triode Unit #1	A7, B8, C6, D4, G5, I6, I10, J7, K6, L1, M5, M10, N5, N9	
10EG7 Triode Unit #2	A7, B8, C3, D1, G2, I6, I10, J10, K5, L1, L6, L7, M5, M10, N5, N9	
12DW7 Triode Unit #1	A4, B5, C8, D7, G6, I6, I10, J2, K6, L1, M2, M10, N4, N9	For gas test, see instructions.
12DW7 Triode Unit #2	A4, B5, C3, D2, G1, I6, I10, J4, K2, L1, M2, M10, N4, N9	
12S7/UAF 42 Diode Unit	A1, B8, C7, G3, K9, L3, M2, M10, N3, N9	Reject if below 3. Use special adapter.
12S7/UAF 42 Pentode Unit	A1, B8, C7, D6, E5, G2, I6, I10, J3, K3, L1, M2, M10, N3, N9	Use special adapter.
13EM7 Triode Unit #1	A7, B8, C6, D4, G5, I6, I10, J2, K6, K7, L1, M1, M10, N3, N9	For gas test, see instructions.
13EM7 Triode Unit #2	A7, B8, C3, D1, G2, I6, I10, J10, K4, L1, L6, L7, M1, M10, N3, N9	
19X3/PY 80	A4, B5, G3, G9, I6, I10, K4, K5, L4, L6, L10, M5, M9, N4, N8	Reject if below 4.
45A5/UL 41	A1, B8, C3, C7, D6, E5, G2, I6, I10, J6, K8, L1, L6, L8, M5, M7, N1, N6	Use special adapter.
45B5	A4, B5, C3, D2, E9, G7, I6, I10, J9, K6, L1, L6, L8, M5, M7, N1, N6	
50BM8/UCL 82 Triode Unit	A4, B5, C8, D1, G9, J2, K7, L1, M5, M7, N5, N6	For gas test, see instructions.
50BM8/UCL 82 Pentode Unit	A4, B5, C2, D3, E7, G6, I6, I7, J1, K4, L1, L6, L7, M5, M7, N5, N6	
6360/QQV03-10	A4, B5, C2, D1, D3, E7, F8, G6, I6, I10, J10, K5, L1, M2, M10, N4, N9	Test P1 - P2
6883	A2, B7, C1, D5, E3, G10, I9, I10, J1, K3, K4, L1, L6, L7, M2, M10, N4, N9	
7717	Use 6CY5 Card	
6074	Use 0B2 Card	
6099	Use 6J6 Card	
6132	Use 6CH6 Card	
6627	Use 0B2 Card	
7543	Use 6AU6 Card	

CORRECTION TO EARLIER CARD PUNCH DATA, 9-59:

1. EL822 should be EL821
2. 25GD6 should be 25CD6

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☐ **SOCKETS,** 7-pin shielded . . . . ea.	2¢
☐ **SOCKETS,** 7-pin unshielded . . . . ea.	2¢
☐ **SOCKETS,** 9-pin unshielded . . . . ea.	2¢
☐ **SOCKETS,** 9-pin, printed circuit . . . . ea.	2¢
☐ **SOCKETS,** 7-pin, printed circuit . . . . . ea.	2¢
☐ **SOCKETS,** 4-prong wafer . . . . ea.	4¢
☐ **SOCKETS,** 8-pin, ceramic . . . . ea.	7¢
☐ **SOCKETS,** 9-pin . . . . ea.	12¢
☐ **KNOBS,** channel selector, 1½" pointer . . . . ea.	16¢
☐ **POINTER KNOBS,** 1½" long ¼" shaft . . . . ea.	19¢
☐ **3-IN. INSTRUMENT KNOBS,** ¼" shaft . . . . ea.	29¢
☐ **2¼-IN. INSTRUMENT KNOBS,** ¼" shaft . . . . ea.	14¢
☐ **IRC RESISTORS,** 250Ω, 10W, 10% . . ea.	7¢
☐ **5W WIREWOUND** resistors, 93 ohms . . ea.	5¢
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☐ .1 @ 200V	☐ 1 mfd @ 100V	☐ .01 @ 400V
☐ .15 @ 200V	☐ .01 @ 200V	☐ .047 @ 400V
☐ .22 @ 200V	☐ .1 @ 300V	☐ .1 @ 400V
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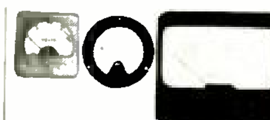

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Negative Resistance

(*Continued from page 57*)

negative-resistance region (BC), bounded on each side by a positive-resistance region (AB and CD), gives the type of curve shown earlier in Fig. 2B, which is valued for flip-flop applications. Viewed from emitter to ground, a point-contact transistor operated in this manner is a negative resistance.

Direct-Coupled Junction Transistor Duo. The junction transistor has a current gain of less than 1 when connected regeneratively (common-base circuit), so it cannot be used directly as a negative resistance in the way that the point-contact transistor can. However, *two* junction transistors may be connected in a manner such that a negative resistance is "seen" at the input terminals of the circuit. In Fig. 9A, the common emitter resistor, R_e, is analogous to the common cathode resistor in a cathode-

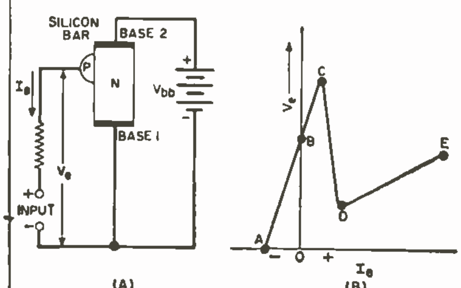


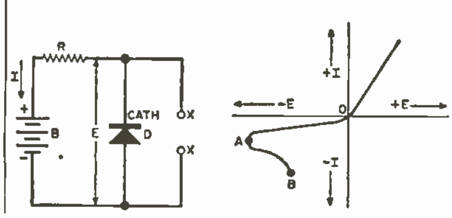
Fig. 10. Uni-junction transistor circuit.

coupled tube circuit. Positive feedback voltage is developed across this resistor by the second transistor, V_2. The plot of V_1 base voltage (V_b) *vs* base current (I_b) has the shape shown in Fig. 9B, a negative-resistance region appearing between B and C. Viewed from the V_1 base to ground, the circuit is a negative resistance when R_e has the proper value to place the operating point of V_1 along the negative slope (BC in Fig. 9B).

Uni-junction Transistor. This device, also called a double-based diode, consists of a bar of n-type silicon with an ohmic (non-rectifying) base contact at each end and a single p-n junction near the top end. Fig. 10A shows a uni-junction circuit. The junction is biased by the input voltage in such a way that its lower half is positive with respect to base 1 and acts as an emitter, whereas its upper half is negative with respect to base 2 and acts as a collector. This simultaneous emitter and collector action produces a negative-resistance characteristic (region CD in Fig. 10B).

Point-Contact Germanium Diode. The

Fig. 11. Point-contact germanium diode circuit.



point-contact germanium diode exhibits negative resistance when biased highly in the reverse direction. Fig. 11A shows the circuit. As the reverse current is increased from zero (Fig. 11B), the diode voltage drop increases to *A*, showing positive resistance. As the current is increased further, the diode voltage drop then decreases from *A* to *B*, revealing negative resistance which is available at terminals *X-X*. Unfortunately, the diode is overloaded when in the negative-resistance condition and is soon damaged by overheating. This has prevented exploitation of the effect, although the point-contact diode operated in this manner will oscillate, amplify, and provide bi-stable switching action.

Thermistor. The thermistor, a temperature-sensitive resistor, exhibits negative resistance over a portion of its *EI* characteristic, which seems to be dependent upon internal heating to some extent. The thermistor is not a rectifying device, therefore it has no polarity; current may be passed through it in either direction. Fig. 12A shows a thermistor circuit. Fig. 12B shows the response: as the voltage (*E*) is increased, the thermistor current (*I*) increases from zero to point *A*, a peak dependent upon internal and ambient temperatures and upon the composition of the thermistor material. As the voltage is increased further, the current decreases, as from *A* to *B*, revealing negative resistance. The latter is available for use at terminals *X-X*.

Because negative resistance in the thermistor depends upon heat effects

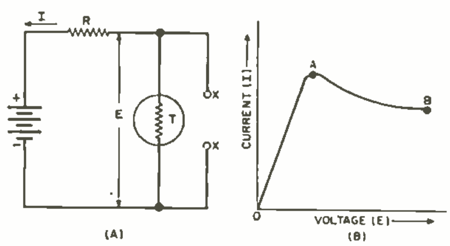


Fig. 12. Circuit showing use of thermistor.

and since there can be appreciable thermal inertia in the device, use of the thermistor in negative-resistance oscillators, amplifiers, and switching circuits is limited to very low frequencies.

Additional Devices

The devices chosen for review in this article are d.c.-operated, and they qualify as resistances. In addition to these, there are certain a.c.-operated devices which can be made to display a negative slope in their conduction characteristics. It would seem proper, however, to term these *negative-impedance* devices. In some applications, these devices are less flexible than their d.c. counterparts because they require a.c. power supply (either a.f. or r.f.).

Such devices include ferro-resonant elements (ferristors), ferro-electric capacitors, voltage-sensitive capacitors (silicon capacitors or varactors, and ceramic voltage-sensitive capacitors), and the several types of magnetic amplifier devices and saturable reactors. —30—

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The simple mechanical and electrical maladies which are the great majority of television set troubles — what you can do about them and what not to try. Covers tubes and testing, antennas, UGH converters, fringe-area reception, the set and the chassis. $2.50

2506. FUNDAMENTALS OF RADIO AND ELECTRONICS, Everitt, et al
All you need to know on electronics and radios is found in this book—including transistors and vacuum tube principles and circuits. A product of close collaboration among five radio authorities, it is perfect for self-study. 832 pp. $11.35

2402. PRACTICAL RADIO SERVICING, Marcus and Levy
Dealing with the common types of radios in use, a-c/d-c receivers, photograph players, and batter and three way portables. This book not only describes circuit fundamentals and servicing instruments and methods, but also gives graded job sheets giving valuable practical experience. Includes the indispensable Radio Detect-O-Scope. Illustrated. $8.95

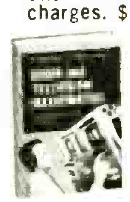
2403. ELEMENTS OF RADIO SERVICING, Marcus and Levy
Gives practical, step-by-step procedures for finding troubles in radio receivers and making repairs. Readers with a background of simple radio theory can easily understand the book. Emphasizes over-all servicing procedures. $7.25

2406. ESSENTIALS OF TELEVISION, Slurzberg, Osterheld and Voegtlin
Comprehensive study of basic TV circuits. The operation of a color set and three monochrome receivers is described in detail from the antenna to the picture tube and loudspeaker. Features the sound section, waveforms, the picture tube, etc. Complete with illustrations, examples, questions, problems. $8.95

2409. TELEVISION FOR RADIOMEN, Noll
Here are the principles and essential mathematics of television. Detailed studies of cascade tuners, new video amplifier techniques, large screen picture tubes, modern deflection systems, latest antenna detail. Covers U.H.F., color TV, transistors, some topics not dealt with before. Construction, operation and servicing of television. $10.00

2411. TELEVISION SERVICING, Levy and Frankel
Explains how to find the section in which the trouble occurs and then to find the defective component. From the circuits discussed, which are employed in over 95% of TV receivers now in use, the reader gains an understanding of the principles involved. A knowledge of basic electronics is essential. $7.75

2423. BE YOUR OWN TELEVISION REPAIRMAN, Guth
Seventy-five percent of the time the only trouble with your TV set is a faulty tube. With this complete book, covering all manufacturers' models, you can easily replace the tube yourself. One dollar saves big repair charges. $1.00



2804. RADIO AND TELEVISION MATHEMATICS, Fischer
Whenever you need to look up the use of a formula or the correct substitution of numbers, you can find it here—rapidly. More than 700 step-by-step solutions of the usual problems encountered in radio, television and industrial electronics, including all those needed for FCC exams. $6.95

2419. BASIC TELEVISION, Grob
The basic book for training television servicemen and technicians. No mathematics other than simple arithmetic and algebra is needed. 660 pages with illustrations. $9.25

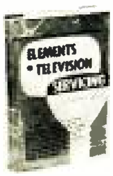
2420. TELEVISION FUNDAMENTALS, Fowler and Lippert
A simple nonmathematical presentation of the basic principles the radiotechnician must know in order to install and service television receivers. Sound treatment of each element of the system—from the antenna to the picture tube. $8.50

2424. TELEVISION SERVICING, 3rd Edition, Buchsbaum
Complete, most recent information on the design, construction, and servicing of both black-and-white and color sets. Shows how to locate and repair every conceivable trouble. $7.15

2427. COLOR TELEVISION FUNDAMENTALS, Kiver
This book can teach anyone familiar with monochrome television how to install and service color TV sets. All circuit discussions employ highly successful step-by-step approach. $7.25

2006. THE ELECTRONIC EXPERIMENTER'S MANUAL, David A. Findlay
With a few dollars worth of basic tools and this book to guide you, you can explore the wonderworld of electronics experimentation more completely than ever before. 10 big sections, including exciting projects you'll build and use. $4.95

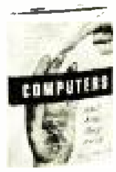
2412. TELEVISION AND FM ANTENNA GUIDE, Noll and Mandl
Two antenna experts tell you their secrets of antenna choice for best reception everywhere, including fringe and difficult areas. Discusses general characteristics, lengths spacings, and principles including impedance matching and loss factors. Several new types of antennae based on author's own experimentation included. $5.95



2425. ELEMENTS OF TELEVISION SERVICING FOR BENCH AND FIELD, Marcus and Gendler
An up to date discussion of installation, servicing, and repair of TV receivers. An ample, practical guide designed for the serviceman familiar with radio reception. $8.15

2017. ELECTRONIC EXPERIMENTER'S HANDBOOK, 1961
A do-it-yourself goldmine! Includes 40 all-new projects — 20 data charts and tables on circuits, resistors, transformers, capacitors, ham and citizens band radio, sound levels—and more. Projects for your shop, for your hi-fi and audio systems, for the ham and SWL and for fun. $1.00

2413. CLOSED-CIRCUIT AND INDUSTRIAL TELEVISION, Noll
This text exhaustively studies theory and practice of closed-circuit and industrial television, present and potential. The technical section of the book covers TV transmission and its application to specific commercial equipment. $4.95



2007. COMPUTERS AND HOW THEY WORK, James Fahnestock
A fact-filled guidebook to electronic computers. Covers the history of computers and explains the workings of every major computer system ever used. Must reading for career-minded students and electronics pros who want a more complete knowledge of this important field. $4.95

2358. MECHANICS VEST POCKET REFERENCE BOOK
Over 200 fact-filled pages including tables, charts, formulas, for every aspect of mechanical work. Also includes logarithm table, conversion factors on gears, U. S. versus foreign measurements, etc. $2.50

2012. JOBS & CAREERS IN ELECTRONICS, 1961
Your key to a top-paying position in electronics! Describes interesting jobs for engineers, technicians, technical writers. Includes five big sections on opportunities in electronics, planning a career, testing your aptitude, case histories of careers and spare time electronics. $1.00

2408. ESSENTIALS OF ELECTRICITY FOR RADIO AND TELEVISION, 2nd Edition, Slurzberg and Osterheld
This book provides the necessary background of electronics principles for an understanding of television, frequency modulation, and radio circuits. Electrical principles are explained in terms of electron flow. $8.25

2008. CLASS D CITIZENS RADIO, Leo G. Sands
Now, with more than a million vehicles equipped for its use, Citizens Radio is a major phase of the electronics field. Here's the story on the whole field—its history, rules, and everything about how it works. Learn exactly what Citizens Radio is, its applications, what you need, FCC rulings, etc. $4.95

2415. MANDL'S TELEVISION SERVICING, Mandl
This standard textbook of television servicing includes recent information on transistor circuits, color TV, UGH and VGH receivers, cascade tuners, automatically focused tubes. A master table lists over 100 trouble symptoms, with possible causes and page number for full servicing instructions for that fault. $7.50

2502. ELEMENTS OF RADIO, 4th Edition, Marcus & Marcus
This excellent one-volume course on the essentials of radio has sold over a million copies! It employs the unique "spiral" method of instruction and is profusely illustrated. $7.00

2011. STEREO & HI-FI DIRECTORY, 1961, Ziff-Davis
New! Over 1200 component listings, 800 photos; latest models, prices! Entire sections on every phase of stereo and monaural high fidelity. $1.00

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Service Notes

INTERMITTENT FILAMENT

Westinghouse chassis V-2366-1 (VHF) and V-2366-2 (VHF-UHF). The set may go completely dead (tubes will not light) and after an indefinite time the set will return to operation. Preliminary observation will uncover the fact that the defect is in the filament string. A check of all the tubes will not reveal a defective tube. The trouble may be caused by the filament dropping resistor *R*-425. The VHF chassis uses a 33-ohm resistor rated at 15 watts. The VHF-UHF chassis uses a 29-ohm resistor also rated at 15 watts. This resistor is wirewound and uses crimped tabs to make contact with the ends of the resistance wire. Poor contact at these points results in varying resistance and sometimes in an arc that quickly opens the resistor. This resistor may be found "up front" under the chassis near the 1B3GT (high-voltage rectifier).

It is suggested that when replacing this resistor a 50-watt wirewound ceramic with a resistance of 40 or 50 ohms and an adjustable tap be used. In many locations it is possible to drop the filament voltage without detriment to the picture and thus extend the life of the tubes.

The replacement resistor can be fastened by its mounting clips to one of the internal support bars for better heat dissipation.

STEELMAN PHONOGRAPHS

The *Steelman Co.'s* console phonographs and radio-phonographs manufactured during the 1960-61 period, Models 603, 703, and others, include two speaker jacks placed in each rear lower corner of the back of the cabinet and, depending upon the particular model, a switch plate. This plate was fastened to the rear of the cabinet and mounted a third speaker jack and a slide switch marked: "stereo," "internal," "external." It may be found that when a speaker is plugged into a corner jack there is no sound from that speaker, or when the speaker is plugged into the jack on the plate and the switch moved, the entire set goes dead. It may also be found that when the external speaker does operate its volume is very low.

A number of these sets were improperly wired at the factory. The correct circuit places the corner jacks across a corresponding right- or left-channel speaker system. Speakers plugged into these jacks merely connect in parallel to the existing circuit. When the jack on the plate is used and the switch moved to "external stereo," the correct circuit places all the internal speakers on one channel and the external speaker on the other.

Low volume from the external speaker may be due to incorrect wiring or to speaker mismatch. Most of the *Steelman* sets use speakers with 3.2-ohm voice coils. Using a conventional 8-ohm speaker will of course result in lowered output from the 8-ohm loudspeaker.

ACCESS TO PHONO CHASSIS

Technicians attempting to gain access to the chassis in a number of *Steelman* portable phonographs and portable radio-phono combinations may find that one or more of the horizontal fabric-covered plates directly above the chassis cannot be moved. These plates have been nailed in place with one nail to each side. These nails were necessary in order to secure *UL* approval. *Do not force.* The chassis may be reached by first removing all the knobs, then the escutcheon, and then the perforated vent plate. In some models the nail heads will now be exposed; in others, the nail heads may be countersunk beneath the top of the fabric. A pair of diagonal pliers may be used to get them started. If the nails cannot be found, pry the plate gently upwards and towards the rear. *UL* requirements are that the nails be replaced when the set is re-assembled.

HOFFMAN: PICTURE WIDTH

The *Hoffman* 23" television receiver sometimes suffers from excessive picture width. This can be cured as follows. (Fig. 1.) Connect either a .1-μf. or a .15-μf., 600-volt capacitor across C_{416}. Later production runs of this receiver incorporate a width switch for this purpose. The switch varies the capacity of C_{416} from .05 μf. to .22 μf.

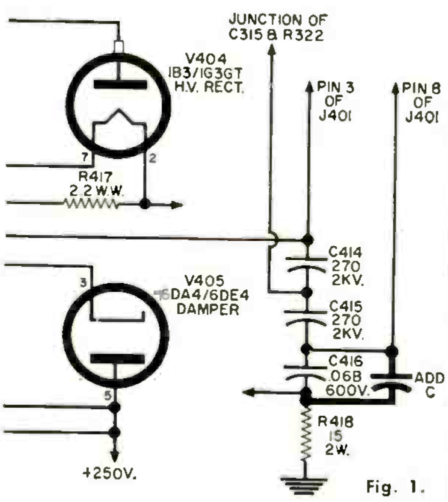


Fig. 1.

MOTOROLA: RASTER DISTORTION

Before making any extensive tests to determine the possible cause of raster distortion in any of the *Motorola* 17P6 series receivers, check the position of the deflection yoke. Loosen the screw holding the yoke clamp, push the yoke firmly up against the flare of the picture tube, rotate the yoke, and then tighten the clamp. —30—

New Products and Literature for the Electronics Technician

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

AUTOMATIC V.O.M.

1 **B&K** is currently offering a new automatic v.o.m. which features a burn-out proof meter

in addition to providing increased simplicity and versatility.

Designed to speed testing in TV, radio, and hi-fi service work, the "V O Matic 360" offers direct reading on all scales. The meter covers d.c. volts in six ranges, a.c. volts in six ranges, a.f. (output) in four ranges, d.c. current in five ranges, and resistance in four ranges. Supplemental ranges are also provided on 18 separate external overlay meter scales for 0-250 mv. d.c., capacitance in three ranges, audio power output in seven ranges, dbm in five ranges, and peak-to-peak a.c. volts (sine-wave only) in two separate ranges.

Sensitivity is 20,000 ohms-per-volt d.c. and 5000 ohms-per-volt a.c.

ALL-WAVE GENERATOR

2 **Radio Shack Corporation** has added a new item to its line of "Realistic" test equipment,

an all-wave generator, designated as the Model 100.

The instrument combines in one cabinet a Wien-bridge audio generator and a ± 1% Colpitts r.f. generator. Special features include a.f. from 20 to 20,000 cps and r.f. from 100 kc. to 330 mc. The circuit incorporates cathode-follower outputs, has provision for crystal marker, and vernier tuning.

The unit measures 12" x 5-3/16" x 8½". The Model 100 is available in both kit and wired versions.

REPLACEMENT FLYBACKS

3 **Chicago Standard Transformer Corp.** has announced the availability of four new exact replacement flyback transformers used in **RCA**, **Sylvania**, **Meck**, **Magnavox**, **Mirrortone**, and **Scott** TV sets.

The HO-320 is an exact replacement for the **RCA** 103839 and **Sylvania** 211-0016/18 while the HO-326 replaces **Meck** THC-10021. The HO-332 replaces **Magnavox** Nos. 360580-1 and 360604-1 with the HO-333 serving as an exact replacement for **Magnavox** No. 360700-1/-2.

The company has an extensive line of replacements for other makes and models.

POWER-SUPPLY KIT

4 **Paco Electronics Co., Inc.** is now offering its Model B-12 regulated, variable-voltage power

supply as a kit for the electronic experimenter.

Featuring fully variable and regulated d.c. plate voltages from 0-400 volts at 150 ma. maximum, the instrument also provides bias voltages from 0-150 volts at 2 ma. and three 3-amp. a.c. filament outputs: two at 6.3 volts plus a 12-volt filament output.

The B-12 is enclosed in a rugged metal case which has a grey crackle finish and top-mounted carrying handle. It weighs 20 pounds and measures 13" x 8½" x 7". It is available in kit form or completely factory wired.

R.F. POWER METER

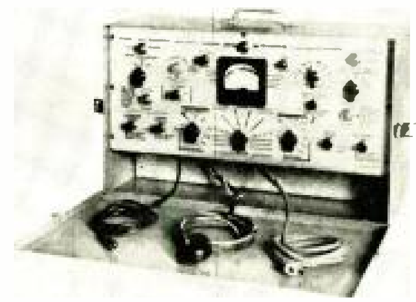
5 **Electro Impulse Laboratory, Inc.** has made available a new line of r.f. power meters covering the frequency range of 100 kc. to 200 mc.

The power meters, both feedthrough and terminative type, are similar to the firm's regular line of power meters but since they have a limited frequency range are less expensive.

Ten models from 1½ watts full-scale to 1500 watts full-scale are available. Two models are available in the feedthrough power monitor type from 15 watts up to 150 watts.

PORTABLE CRT TESTER

6 **The Teletronics Co.** is now offering a new and improved version of its portable "Beamer"



which has been designed especially for use in TV service departments for testing and rejuvenating faulty and weak TV tubes.

The new instrument will test all current models as to filament condition, element continuity by mutual conductance method, shorts, leakage up to 20 megohms, emission, grid cut-off and grid control, and cathode test.

The same unit is used to restore brightness by cathode sweeping, bringing up old tubes by grid expansion, burns off low-resistance grid-cathode shorts, burns off high-resistance inter-element shorts, and welds open cathode tabs.

TV/FM AMPLIFIER

7 **Blonder-Tongue Laboratories, Inc.** is marketing a new mast-mounted broadband amplifier which incorporates a remote power supply and may be used up to a full mile from an a.c. power supply.

The amplifier unit has been designated Model AB-3 while the remote power supply is Model RP-3 and the entire unit is the AM-3 mast-mounted broadband TV/FM amplifier.

The unit provides a 22 db gain on FM and TV when used either to improve home TV reception in fringe areas or as a preamplifier in master TV system installations.

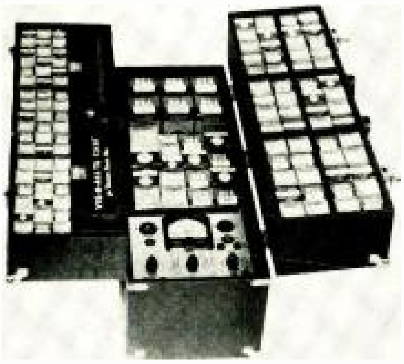
Input is matched to a 300-ohm antenna while outputs are provided for both 75- and 300-ohm cables. The device uses a total of three tubes.

TUBE TESTER/CADDY

8 **GC Electronics Co.** has come out with a completely portable tube tester and caddy for the radio-TV technician who makes home service calls.

Tradenamed "Vis-U-All," the tester in the new caddy has an unusual circuit design with only four sockets that simplifies the test panel for fast, easy tube checking. It provides for a dynamic check of tube emission, filament voltage, and current leakage in addition to indicating general operating conditions of CR tubes.

Measuring 20" x 14" x 8" and weighing 22



pounds empty, the tester is covered with a durable material and further protected with metal-clad corners. Space is provided for approximately 150 tubes in addition to tools.

REPLACEMENT CAPACITOR KIT

9 **Sprague Products Company** has available two new assortments of "Isolarad" capacitors which have been specifically selected for electronic service technicians.

Assortment IK-22 contains 11 of the capacitors in the seven most frequently used ratings while the IK-8 includes 17 capacitors in the seven most popular ratings. The assortments are packaged in clear, hinged-lid compartmented plastic cases with each compartment clearly identified by catalogue number and rating for easy selection.

3-INCH SCOPE KIT

10 **Heath Company** has added a compact, 3-inch d.c. oscilloscope to its line of electronic instruments in kit form.

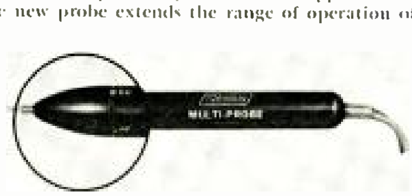
The Model 10-10, which measures 7⅜"x 4⅝"x11", may be used as an inexpensive readout for computers, for waveform observation, and for voltage, frequency, and phase-shift measurements in addition to more conventional service work.

Features include identical vertical and horizontal d.c.-coupled amplifiers with low relative phase-shift characteristics and transformer-operated power supply.

SERVICE "MULTI-PROBE"

11 **Mercury Electronics Corporation** is marketing its new Model MP-1 "Multi-Probe" which the company claims does the work of four different probes.

Designed specifically for service applications, the new probe extends the range of operation of



any v.t.v.m., oscilloscope, or signal tracer. The instrument includes a d.c. probe, a.c./ohms probe, r.f. probe, and low-capacity probe. An exclusive rotating probe head with detent action enables the service technician to select the probe function desired with a quick quarter turn of the probe head.

"IN-CIRCUIT" TESTER

12 **Sierra Electronic Corporation** has a new transistor tester, Model 219B, which provides convenient measurement of the transistor beta parameter while the transistor remains in the circuit. Betas from 1 to 120 are measured in four overlapping ranges.

With the transistor removed, Model 219B not only reads beta but also indicates leakage current (I_{co}) in two ranges: 0-50 and 0-500 μa. Typical measuring accuracy is ±5%, depending on circuit impedances.

The instrument is housed in a high-strength plastic case with convenient carrying handle. Power is provided by an internal battery with an average life of about 600 hours.

RELAY FOR REMOTE CONTROL

13 **The Lionel Corporation** has announced the availability of a new bi-directional, twelve-position sequence relay for remote operation of television controls, hi-fi, radios, appliances, and lighting circuits.

Designated series No. 4175, the a.c.-d.c. unit assures a minimum operating speed of 40 milliseconds. Other coil ratings include: 5000 ohms impedance, drop-out current of .003 amp., and d.c. input current of .020 amp. minimum. The relay is being offered in both horizontal and vertical mounting versions. A built-in disconnect switch is standard.

SUBMINIATURE TRIMMERS

14 **International Resistance Co.** has developed two new types of subminiature precision trimming potentiometers for printed circuit and other high stability applications, as the first in its "Circuitrim" line.

One of the units—Type CT-100—has a "tap adjust" feature which eliminates the need for expensive mechanical components with no sacrifice of electrical characteristics.

Type CT-200 is a ½x½-inch square precision trimmer available with printed circuit terminals or Teflon-coated wire leads.

SEMI-SOLID CONTACT CLEANER

15 **Caig Laboratories, Inc.** has added "Cramolin-Paste" to its line of contact cleaners.

This new contact cleaner is in semi-solid form and is especially useful in applications where high current and/or high voltages are involved. According to the company, the new product is free from mineral acids, alkalies, sulphur, or any other harmful contents which might attack metal. It is a combined cleaner, preservative, lubricant, and anti-corrosive. It comes in half-pound cans.

G-E INSTRUCTION KITS

16 **General Electric Company** has entered a new product field with the design and merchandising of a line of educational electronic science kits.

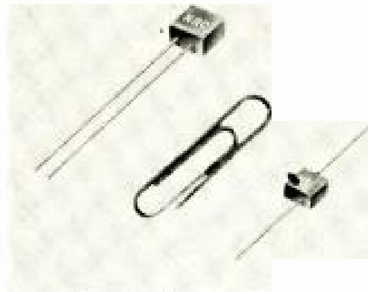
The first group of "Educational Projects" divides into two categories: three are experimental laboratories, use of which leads to a basic knowledge of electricity, electronics or transistors; while four of the kits provide similar educational advantages but result in a product which can be enjoyed for many years.

Currently available units are the transistor lab, basic electricity lab, advanced electronics lab, transistor radio project, transmitter project, intercom project, and analogue computer project. Complete manuals and all the requisite tools are included in each kit.

PRECISION RESISTORS

17 **National Resistance Corporation** has developed a new precision resistor which features a unique strain-free bobbin construction and winding technique which minimizes stress.

According to the manufacturer, the new construction technique greatly increases the mechanical strength of the component. The resistor wire termination is at the opposite end from the lead terminations, isolating the terminal from solder



heat when installed on a printed circuit. A flanged terminal securely anchors the termination, preventing pull-out during assembly and under severe environmental conditions.

Available in sizes 1/4"x 1/4"x 1/8" and 3/16"x 3/16"x 1/8", the units will operate over a temperature range of −65 to +125 degrees C.

SERVICE CAPACITOR KIT

18 **Aerovox Corporation** has packaged six of its Type PRS "Dandee" capacitors in a handy reusable box which is being marketed as Kit AK-500.

Designed for the service fraternity, the electrolytics are those most often required in the repair of series-string TV sets and a.c.-d.c. table radios.

CONNECTION AID

19 **Twirl-Con** is now offering a handy service tool which is designed to produce quick, neat, and secure connections on printed-circuit

boards as well as conventionally wired chassis.

The device permits defective components to be replaced neatly and rapidly by utilizing the ¼" lead wire stub and twirling the ends of the new part over them. Both hands are left free for the soldering operation.

The unit is available in three sizes: No. 1 (for most radio and TV work) will wind a twirl that slips over 18-gauge wire; No. 2 for 16-gauge wire; and No. 3 for 13-gauge wire.

FLEXIBLE PRINTED CIRCUITS

20 **Garlock Electronic Products** has announced the development of flexible printed circuits which are said to provide greater freedom of design, increased reliability, lower installation costs, and reduced size and weight.

The new units can be bent or twisted into any desired shape to allow maximum design freedom. The outstanding electrical, physical, and thermal properties of the "Teflon FEP" encapsulation is responsible for the flexibility of the design, according to the manufacturer. The etched copper circuit is completely encapsulated between two layers of the material.

HEAT SINKS

21 **Navigation Computer Corp.** has announced a new line of patented felt discs pierced with holes for transistor leads. Sandwiched between the semiconductor and the etched circuit board, the discs serve as heat sinks for soldering operation.

The felt is injected with a volatile fluid which evaporates during soldering and absorbs heat from transistor leads so that temperatures do not rise to dangerous levels.

PLUG-IN TV ANTENNA

22 **Snyder Manufacturing Company** has added a new plug-in indoor antenna to its line of TV antennas.

Utilizing the complete wiring system of the home, the Model UL-500 can be plugged into any electrical socket out-of-sight and attached to the rear of the TV set. It is said to be effective with both black-and-white and color receivers as well as with AM and FM radio receivers. It uses no current and plugs into any a.c. or d.c. outlet.

The antenna comes with a 9-foot heavy duty cable and is housed in a black molded plastic enclosure. The device carries UL approval.

EDUCATIONAL KITS

23 **Heath Company** is currently introducing two new items in its "Educational Kit" series, the EK-2A and EK-2B.

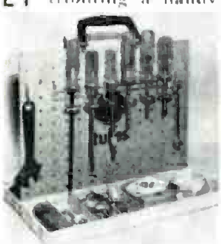
The kits comprise a two-part course in basic radio. EK-2A, entitled "Basic Radio—Part 1,"

teaches the basic parts and functions of a simple crystal radio circuit and leads to the construction of a regenerative tube-type receiver. EK-2B, "Basic Radio—Part 2," advances radio theory knowledge and, with additional parts, enables the builder to up-grade the EK-2A radio until he has completed a two-band superhet.

The kits come with companion text-workbooks.

HANDY "TOOL TOTER"

24 **General Electric Company** is currently distributing a handy "tool toter" which has been specifically designed for the electronic service technician.



Designed to organize and ease the carrying of tools and other equipment used during service calls, the toter has a two-sided rack for tools as well as trays for components, small tools, and most-used parts. In addition to its portable applications, the unit can also be used on the service-shop workbench.

HI-FI—AUDIO PRODUCTS

TRANSISTORIZED TAPE RECORDER

25 **GBC America Corp.** is handling the distribution of a subminiature transistorized tape recorder which is being marketed as the "Transi-voice."

Made in Italy, the recorder will operate in any position, run up to 100 hours on four standard 4.5-volt batteries, and record up to 1½ hours on a single 3½-inch reel of tape at 1⅞ ips or a shorter period at 3¾ ips.

Total weight of the unit is slightly over 4 pounds. The push-button controls are accessible

even when the unit is carried in its leather shoulder-strap bag. The sensitive dynamic microphone, coupled with the high-gain transistor amplifier, is said to provide good recording sensitivity.

A complete line of accessories is available for use with this instrument.

PLASTIC SPEAKER BAFFLES

26 **Lowell Manufacturing Co.** has introduced a series of molded plastic speaker baffles. Made of **Monsanto** "Lustrex Hi-Test 88" high-impact styrene, the new baffles—called "Coloramic"—are claimed to be easy to work with and easy to paint with any good Latex paint.

Two of the baffles, Models AD880-P and CR80-P, are 8-inch speaker units for recessed mountings. The third, Model L35-P, is a wall intercom plate that accommodates a 3½-inch speaker. Model AD880 is designed primarily as a ceiling baffle; Model CR80-P for either ceiling or wall mounting.

BULK DEGAUSSER

27 **Amplifier Corp. of America** has developed a new degausser which functions both as a bulk tape eraser and as a demagnetizer for record-playback and erase heads.

According to the company, the "Magneraser" will produce complete erasure of recorded signal on all brands of tape and ¼", ½", or 16 and 35 mm. magnetic sound film on either plastic or metal reels from 3" to 15".

The unit operates on any alternating 50- or 60-cycle current and furnishes the necessary gradually diminishing cyclic magnetization field which the tape normally encounters during supersonic erasure. Features include a momentary push-button control safety "on-off" switch; small size (2½" × 1"); and light weight (2½ pounds). It comes equipped with an 8-foot line cord, molded rubber plug, and operating instructions.

NEW E-V MICROPHONES

28 **Electro-Voice, Inc.** has introduced a new low-cost dynamic microphone designed specifically for "language laboratory" applications. Designated as Model 624LL, the unit features high-level, wide-range response, adaptability for use in different positions, and rugged design.

The manufacturer is also offering other microphones, said to be as handy as the 624LL, but which are adaptable to a variety of language lab and classroom uses.

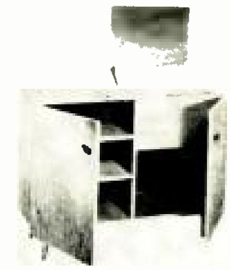
TAPE MARKING SYSTEM

29 **PRS System, Inc.** has announced a pressure-sensitive, self-adhesive marking tape which may be written on and then applied directly to the shiny (non-magnetic) surface of recording tape.

Because of its white background, the **PRS** tape can be spotted readily and thus help identify a particular section of the recorded reel. The company also markets pressure-sensitive labeling strips to be applied to the plastic reel for identification purposes.

EQUIPMENT CABINET

30 **Homewood Industries** has added an equipment cabinet to its line of unfinished "hi-fi furniture." Designated as the Model 9, the new cabinet comes completely assembled and smooth-sanded, ready for finishing by the owner. It features a lift-up top compartment for housing a record-changer or turntable, as well as ample shelf space for a tuner, amplifier, and record storage. The cabinet's back is vented to provide air circulation for ventilation of components.



FM TUNER/AMPLIFIER

31 **Grommes** has announced the current availability of the Model 510 FM tuner/amplifier which has been specifically designed to provide **background music for offices and homes.**

The Model 510 is a complete FM tuner, pre-

amplifier, and 20-watt amplifier housed in a compact enclosure. The amplifier features phono, tape, and microphone inputs. The microphone input enables the unit to function as a p.a. system without interrupting the background music.

The circuit includes loudness, bass, and treble controls while the FM tuner section employs a 3-gang capacitor with flywheel drive and tuning eye. There are two broadband i.f. stages, a dual limiter, and ratio detector.

STEREO RECEIVER

32 **Crosby Electronics, Inc.** is now on the market with what it claims is the most powerful stereo receiver ever produced.

The R80 provides 80 watts of undistorted power, push-button source selection, and ganged push-pull knobs. Also featured are: two-channel indicator for tuning and program level; variable

mono-stereo blend lights; speaker/headset selector on front panel; special volume control for third speaker installation; concurved tuning dial; and a multiplex dimension control with powering facilities for a non-powered accessory multiplex adapter.

PORTABLE ECHO CHAMBER

33 **Ecco-Fonic, Inc.** has added a new unit to its line of portable echo chambers. The "Encore" model has been especially engineered for musicians so that guitars, accordions, banjos,

Now you can build almost any kind of electronic device!

Here are the ABC's of 50 vacuum-tube circuits for electronics experimentation and project construction— all fully diagramed, complete with parts list.

HOW many times have you wanted a diagram of a basic vacuum-tube circuit which you could use as a guide in building hi-fi components, receivers, transmitters, intercom systems, test equipment and other electronic gear? At last, in one book, you can find all the basic diagrams, schematics, and other vital information on vacuum tubes and their circuits essential for such projects!

Beginning with the Edison effect (the birth of the diode), Julian M. Sienkiewicz, Managing Editor of Popular Electronics, leads you right up to the multi-element vacuum tubes used in everyday circuits. Vacuum-tube circuit design is described in understandable, down-to-earth language. Plate resistance, transconductance, gain, load lines, characteristic curves and the like will no longer be mysterious terms but useful tools for your work or hobby.

You'll Become An Expert On All Types Of Vacuum Tubes

The first four chapters are devoted to the operation of diodes, triodes, tetrodes, and pentode and beam-power tubes. Chapter five covers construction practices, tools, and test equipment, along with workshop hints that will be a real boon to all who want to get the most out of their equipment. Chapter six contains *a collection of fifty vacuum-tube circuits* that gives you a basic library of useful circuits for quick and trouble-free reference.

One hundred vacuum-tube schematics, plate-characteristic curves, simplified diagrams, test circuits and other selected illustrations supplement the informative text to make this book one of the most useful and invaluable manuals for your electronic experiments and hobby projects.

192 pages, 100 illustrations $4.95

PARTIAL CONTENTS:

DIODE VACUUM TUBES. Emission—Diode Operation—Diode Characteristics—Rectification Power—Supply Filters—Detection (AM and FM).

TRIODE VACUUM TUBES. Triode Operation—The Triode Test Circuit—Control-Grid Effect—Triode Characteristics—Plate Characteristic Curves—Plate Resistance—Transconductance—Amplification Factor—Interelectrode Capacitance. **TRIODE AMPLIFIERS.** Load Lines—Operating Point—Cathode Bias—Cathode Load Lines—Signal Amplification—Signal Inversion—Voltage Gain—Computing Voltage Gain—Cathode Bypass Capacitor—Distortion—Summary.

MULTI-ELEMENT TUBES. Miller Effect—Tetrodes—Tetrode Plate Characteristic Curves—Output Signal vs. Secondary Emission—Pentodes—Suppressor Grid-Pentode Plate Characteristic Curves—Tetrode and Pentode Characteristics—A. C. Plate Resistance—Transconductance—Amplification Factor—The Pentode Voltage Amplifier—Operating Point—Cathode Bias—Cathode Bypass Capacitor—Distortion—Beam-Power Vacuum Tubes—Audio Output Stages.

CIRCUIT CONSTRUCTION HINTS. Checking Components—Fixed Resistors—Potentiometers—Capacitors—Transformers and Coils—Vacuum Tubes—Where to Buy—Test Equipment—Multimeter—Vacuum Tube Voltmeter—Oscilloscope—Signal Generators—Other Test Equipment—Tools—Tools You Will Need—Soldering—Chassis Construction.

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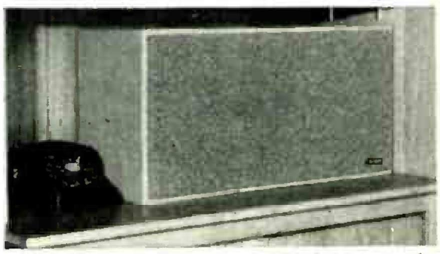
harps, harmonicas, violins, electric organs, etc. can acquire new "presence" and "dimension."

Designed for easy installation and operation, the unit has four main controls and a special switch. The variable delay control varies the delay time before the echo begins, from .01 to .8 of a second. The echo control adjusts the volume and intensity of the echo while the reverberation control adjusts the number of times the echo repeats—from 0 to a multitude of repeats. The volume control adjusts the level of the original sound from the voice of the instrument.

NEW BOOKSHELF ENCLOSURE

34 Argos Products Co. has developed a new three-speaker bookshelf enclosure which can be used for either stereo or mono audio systems.



The "Eldorado" uses one 12" Jensen woofer and two 3½" Jensen tweeters to provide an over-all coverage from 40 to 17,000 cps. The bass response is obtained by means of a ducted port system, which features the firm's tuning tube, to exactly match the cabinet to the 12" woofer. The three speakers are wired in a crossover network to 8-ohm terminals on the back, phased for stereo use.

The cabinet is finished in wood-grained pyroxylin fabric and is available in either walnut or blonde color. It measures 27" wide, 14¼" high, and 10" deep.

NEW ITEMS FROM CBS

35 CBS Electronics has announced two new items of interest to audiophiles: a new series of stereo, twin-stylus turret cartridges for phonographs and a "do-it-yourself" microphone kit.

The HF series of cartridges utilize the constant displacement principle. They can be matched to the RIAA response curve over the entire recorded frequency range. Separation between channels exceeds 25 db. Low stylus mass permits tracking at 2 grams, resulting in negligible record wear.

The "Mark III" microphone kit permits the enthusiast to construct a 30-10,000 cps ceramic microphone which provides a 1000-cps sensitivity of 52 db below 1 volt/microbar. Recommended load for this unit is 5 megohms. It is suitable for application in audio systems, amateur, CB, sound laboratories, etc.

ELECTROSTATIC TWEETER

36 Allied Radio Corporation is offering a new electrostatic tweeter for extending the treble range of any high-fidelity speaker system.

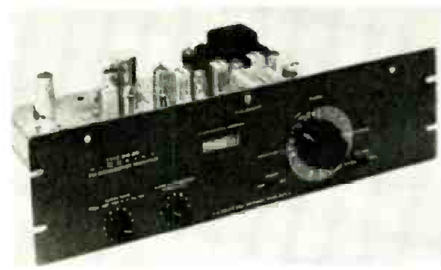
Complete with built-in crossover network, balance control, and power supply, the "Knight" KN-825 tweeter is designed to supplement existing speaker systems and provide high-frequency response from 1000 cps to the limits of audibility. Employing a curved, sound-radiating element, the unit is claimed to provide a full 90-degree dispersion of high-frequency tones without blank spots.

The tweeter measures 8" x 10" x 3" and has a contoured, perforated plastic grille, decorator-styled in ivory. Its wood top and bottom are oiled walnut.

PROFESSIONAL FM TUNER

37 H. H. Scott Inc. has put a professional FM tuner on the market as its Model 310-DR.

The new unit has a 2 μv. sensitivity, measured by IHFM standards. Distortion is less than .5% and frequency response is ± .75 db from 20 to

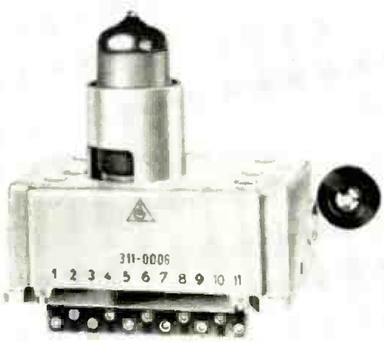


75,000 cps. The Model 310-DR has a 2.2 db capture ratio. Selectivity is 50 db and crossmodulation rejection is 85 db. The unit may be rack mounted in only 5¼" of panel space.

The circuit features dynamic interstation noise suppression and an exclusive electronic relay which makes possible a simple, yet effective, diversity reception system for high signal quality under extremely difficult conditions.

WIDE-BAND FM TUNER

38 **Waller Corporation** is now offering a new wide-band FM radio tuner that is compatible with any system of multiplex stereo broadcasting under consideration by the FCC.



The Model 311-006 tuner incorporates a.f.c., a.g.c. in the r.f. stage, and an i.f. bandwidth of approximately 150 kc. at 6 db down.

MINIATURE TAPE RECORDER

39 **Lafayette Radio** has recently introduced a miniature, all-transistor, battery-operated tape recorder which weighs only 4 pounds and measures 7⅝" x 5¾" x 2½".

The Model RK-120 uses five transistors and 1 thermistor and is completely self contained with

its own built-in speaker and amplifier. A single function lever provides for rewind, stop, play, and record with a special safety record button to prevent accidental erasure. A visual indication of correct recording level and battery condition is shown by a built-in level meter.

The unit will operate at either 1⅞ or 3¾ ips.

CB-HAM-COMMUNICATIONS

CB MOBILE WHIP

40 **Marina Communications** has developed a mobile whip exclusively for class D CB radio operations.

Known as the "Buddy Whip," the unit is claimed to give up to a 10-db gain over bumper mounted antennas. The whip lowers from the driver's seat to permit easy entrance into garages or filling stations. Its all-fiber-glass construction eliminates corrosion problems while its special insulation avoids short circuits from overhead.

Over-all length is 96 inches. It is designed to be used with 52-ohm coax. Installation requires only two small screws in the car's gutter.

GRID-DIP METER KIT

41 **Paco Electronics Co., Inc.** is now offering a new all-purpose grid-dip meter kit, the Model G-15.

The unit's major functions are as a variable frequency oscillator covering 400 kc. to 250 mc. in eight bands, with no skipping, and as an absorption wavemeter over these frequencies. The kit includes a modulation indicator which gives both a visual and aural check on "on the air" operation.

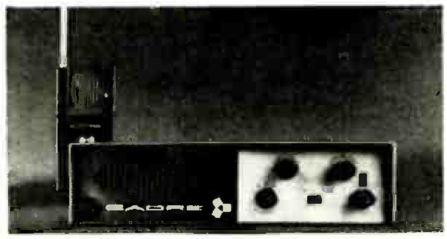
The G-15 can be operated in one hand. It has a large, easy-to-read thumb-actuated dial and comes in a convenient case which measures 2¾" x 7½" x 2½". The grid-dip meter is available factory wired as well as in kit form.

CB TRANSCEIVERS

42 **Cadre Industries Corporation** has entered the CB equipment field with two fully transistorized, portable CB transceivers, the Model 500 and the Model 100.

The Model 500 is a 5-watt portable transceiver incorporating 15 transistors and 7 diodes. Its unusually low power drain makes it ideal for mobile as well as fixed operation. The transceiver operates on five crystal-controlled transmit and receive channels while the receiver is tuneable to all CB channels. This model weighs 6 pounds and measures 11⅝" x 3" x 5⅝". It comes complete with dynamic microphone, cables, mounting brackets, and hardware for car or boat installation.

(*Continued on page* 122)



The Model 100 is a 100 mw. transceiver designed to operate over a ½ to 1 mile range. Operating on one crystal-controlled transmit-receive channel, it can be used on any one of the 23 CB frequencies. Using 7 transistors and 1 diode, the unit measures 6¼"x 2¾"x 1½" and weighs only 20 ounces. It is powered by a standard 12-volt mercury cell.

DUMMY LOAD

43 **Collins Radio Company** is now offering its DL-1 dummy load which may be switched instantly into or out of an amateur radio station circuit for transmitter tuning and testing operations.

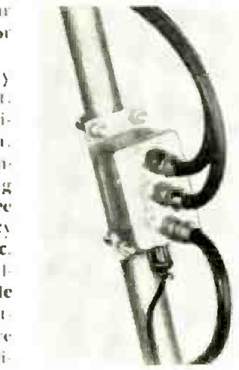
The 100-watt resistive load may be used with transmitters of 100-watt output power and may also be used for brief tuning periods with higher powered amplifiers.

This new unit permits switching the dummy load with the ease of actuating a toggle switch. RCA and Type N connectors are located at the transmitter input and the antenna output at the rear of the DL-1. A position at the rear of the unit also provides connections for remote control of the switching operation. A 6.3-volt a.c. source is required for relay operation.

The unit measures $5^{11}/_{16}$" x 3½" x $7^{3}/_{16}$". It comes with four removable rubber feet.

COAXIAL RELAY

44 **Bay-Roy Electronics, Inc.** has designed an all-weather coaxial relay to meet the needs of the radio amateur for a low-cost outdoor coaxial unit.



This s.p.d.t. relay features lightweight, gold anodized aluminum construction. Gasket sealing is incorporated for long life and trouble-free service. Frequency range is 0 to 225 mc. Five models are available to cover a wide range of actuator voltages. All models are available with a variety of r.f. connectors.

Technical specifications are available on request.

WIRELESS PAGING SYSTEM

45 **Multitone Electronics, Ltd.** is marketing a new personal call system which features a battery-operated transmitter weighing only 3 pounds.

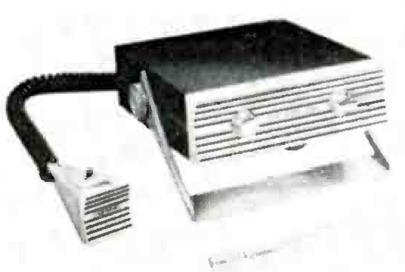
Fully transistorized and completely independent of the power supply, coverage varies from 40,000 to 300,000 square feet depending on the layout of the premises. The 15-channel setup pro-

vides either speech or private coded signal for a total of 15 persons carrying the companion 5-ounce pocket receivers.

TRANSISTORIZED CB UNIT

46 **Osborne Electronics Corp.** is currently introducing an all-transistor CB transceiver as its Model 300.

The 9-transistor circuit will operate on any of



the 23 CB channels. It features a 4-channel selector with plug-in crystals. The rugged, all-metal die-cast case measures only 1⅞"x 6"x 7". The circuit includes squelch control and a noise limiter.

The unit comes with a push-to-talk microphone equipped with a 3-foot coil cord.

MANUFACTURERS' LITERATURE

MOTOROLA REPLACEMENTS

47 **Motorola Inc.** has announced the availability of a replacement parts catalogue which is designed especially for service technicians.

This 151-page catalogue, available through local **Motorola** distributors, contains complete listings of the firm's universal-type components, including mechanical and electrical specifications, as well as cross-reference charts and complete price lists of major parts used in the company's TV receivers, home and car radios, and record changers dating as far back as 1919.

"SOLDERING SIMPLIFIED"

48 **Kester Solder Co.** has just published a revised edition of its popular instruction manual, "Soldering Simplified."

Particularly valuable to trainees and apprentices, the manual begins with a brief reference to the historical importance of solder and then details in a concise, easily understood manner, the basic principles of soldering.

Different types of solders and fluxes and their composition are discussed, along with soldering techniques, proper heat application, and pre- and post-soldering metal-treating procedures. Equipment types, their use and care, are also covered in this free booklet.

"MATHEMATICS"

49 **Canadian Institute of Science & Technology Limited** has issued an informative 12-page booklet entitled "Mathematics."

The booklet outlines many different types of home-study mathematics courses being offered by the school—ranging from elementary arithmetic to the more advanced aspects of calculus. Prof.

(Continued on page 124)

E. A. Allcut has written the opening pages of the booklet and makes interesting comments on how mathematics has evolved and how it has now become one of the greatest tools in engineering, science, and business.

"STAN COR'S CORNER"

50 **Chicago Standard Transformer Corporation** has announced publication of the fifth issue of its popular "Stan Cor's Corner"—a handy compilation of tips for service technicians.

Issue No. 5 describes and illustrates almost thirty service shop gadgets, ideas, and shortcuts all designed to save time for the technician. Also included in this issue is a page showing EIA color codes for power, audio, and i.f. transformers and for speaker lead and plug connections.

TV-FM RECEPTION AIDS

51 **Jerrold Electronics Corporation** has just issued a fully illustrated, 12-page catalogue which covers a broad range of equipment, including TV-FM reception products, master antenna system components, accessories, and test instruments for such equipment.

Equipment is listed under the following categories: TV reception aids for the home, TV distribution systems, TV system accessories, and systems test equipment. The publication is designated DSD-179.

CB PRODUCT CATALOGUE

52 **GC Electronics Company** has announced the availability of a new 16-page catalogue covering communications and Citizens Band products.

Featured are such items as new base-station and mobile antennas, auto antennas, mounting hardware of all kinds, as well as related miscellaneous items. Catalogue FR-61-B is free on request.

"STOCKING CATALOGUE"

53 **Tru-Ohm Products** is now offering copies of its Catalogue D-61, known as the "Stocking Distributor Catalogue."

This new publication is said to be ideal for checking stock, ordering, reference, as an inventory control, and other uses. The publication is being offered without charge on request.

INDUSTRIAL TUBE REPLACEMENTS

54 **Sylvania Electric Products Inc.** is making available a new industrial tube replacement guide which contains complete, up-to-date listings for a wide variety of industrial tubes including backward wave oscillators, counter tubes, gas switching tubes, klystrons, magnetrons, strobotrons, thyratrons, trigger tubes, and traveling wave tubes.

Copies of this 8-page brochure are being offered without charge.

NEW PRODUCT CATALOGUE

55 **Audiotex Mfg. Co.** has published an 8-page new products catalogue to introduce the latest audio-stereo items in its line.

Featured additions are a pocket size test meter, an album of phono record accessories, volume and speaker controls, and a complete series of exact replacement record changer knobs. The catalogue is designated as FR-61-A.

HI-FI EQUIPMENT

56 **Sound Foyer**, a division of **Radio Products Sales, Inc.** has issued a 90-page catalogue covering an extensive line of stereo and mono high-fidelity equipment.

The new publication, Catalogue No. 1160, contains up-to-date product specifications and price information on amplifiers, recorders, microphones, and other audio equipment and accessories.

TRANSISTOR AMPLIFIER DATA

57 **Centralab** is offering copies of its descriptive bulletin, No. 42-870, which provides complete electrical and physical specifications on the company's 4-stage transistor amplifier, TA-12-B.

The tiny ultraminiature audio amplifier measures .531" in diameter and is .228" high. It contains 4 transistors, 8 fixed resistors, and 6 capacitors and provides a gain of 73 db at 1000 cps and has a nominal input impedance of 2500 ohms. Frequency response is ±5 db from 300 to 20,000 cps. —30—

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.

Answer to Puzzle Appearing on Page 93

B	U	G	■	S	P	A	D	E	■	R	P	M
A	N	A	■	P	A	N	E	L	■	I	R	E
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X	I	S	■	■	T	A	X	■	■	E	R	S

BREEZESHOOTERS MEET

THE Seventh Annual Hamfest of the Breezeshooters will be held on Sunday, May 28 at The Lodge, North Park, near Pittsburgh, Pa.

As in previous years, the Club expects a large attendance from the area. Registration was 928 in 1960 and the group hopes to top 1000 this year.

The Club has planned an interesting and varied program for hams, YL's, and XYL's.

For details, contact W3FSF, Daniel Davies, Box 226, Silver Lane, R.D. 1, McKees Rocks, Pa. —30—

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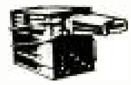
LETTER SYMBOL QUIZ

(From page 8)

1. D	6. H	11. E
2. G	7. F	12. L
3. K	8. O	13. N
4. A	9. B	14. C
5. M	10. I	15. J

'RAN 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
28 Volt Inverter Power Supply, New .... P.U.R.
12-Volt Inverter Power Supply, Like New .... P.U.R.
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
28V Inverter Power Supply, New .... P.U.R.
12-Volt Inverter Power Supply, Like New .... P.U.R.
Shock Mount for above $2.95
We carry a complete line of spare parts for above.

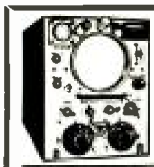
FAMOUS BC-645 TRANSCEIVER
15 Tubes 435 to 500 MC

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 APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.

Completely Assembled
LIKE NEW! Supplied with 5" Scope, type 5CP1 only $14.50

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
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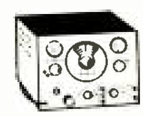

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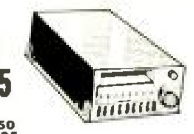

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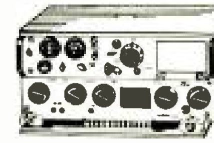

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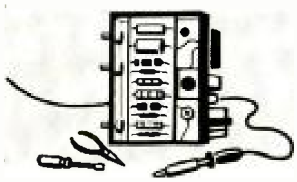

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Using the BC-221 for CB

(Continued from page 50)

and the audio oscillator to the horizontal amplifier with the scope sweep turned off. Then you adjust the audio oscillator for a 1:1 Lissajous figure (usually a circular pattern). The reading of the audio oscillator will tell you how many cycles you are off. To determine which direction you are off, vary the BC-221 dial. If the beat note decreases as the dial setting is lowered, it means the transmitter frequency is lower than the channel center frequency. While this method is quite accurate, it is not practical when more than one beat note is present.

The additive method has been found quite practical for most models of the BC-221. It should work with any model employing the 6K8 tube. In some cases, it has not worked with certain models of the surplus Navy LM meter and very early models of the BC-221. If you have such an instrument, you will have to rely on the conventional method of operation. However, you can improve performance by using a voltage-regulated power supply and also by employing the tenth harmonic of the "High" band which will make interpolation of correct settings much easier.

Using Other Frequency Meters

The author has also tried both the TS/174 and TS/175 frequency meters for CB use. The former has a frequency range of 20 to 40 mc. on fundamentals, but because of the large frequency coverage for a given spread of the dial, it is more difficult to use and certainly not as accurate as the BC-221. The TS/175 has a range of 40 to 80 mc. on fundamentals. Since CB units have little harmonic output, no success was experienced with the TS/175.

Some Additional Hints

The tuning capacitor of the BC-221 is gear driven. There is always a certain amount of backlash in these gears. Consequently, all final settings should be made with the dial turning clockwise.

Leave your BC-221 in the same room and turned on at all times. This makes for most stable operation. Let the transmitter to be checked come to you. Don't carry your BC-221 to the transmitter.

Don't make any attempt to repair or alter a BC-221 other than changing tubes and making "Corrector" internal adjustments as described in this article. Moving internal leads, changing internal parts, or altering the circuitry will throw the calibration off and make the instrument useless.

Remember, the additive method described in this article is ideal for direct measurement of CB transmitter frequencies, but the output is too low for off-the-air checks. For such purposes, the direct method, as described in the August 1960 issue of ELECTRONICS WORLD must be employed. —30—

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___6AX7	.64	___6U8	.78	___12DB5	.69
___6BA6	.49	___6V6GT	.54	___12DE8	.75
___6BC5	.54	___6W4	.54	___12DL8	.85
___6BC7	.94	___6W6	.69	___12DM7	.67
___6BC8	.97	___6X4	.39	___12DQ6	1.04
___6BD6	.51	___6X5GT	.53	___12DS7	.79
___6BE6	.55	___6X8	.77	___12DZ6	.56
___6BF6	.44	___7AU7	.61	___12EL6	.50
___6BG6	1.66	___7A8	.68	___12EG6	.54
___6BH6	.65	___7B6	.69	___12EZ6	.53
___6BH8	.87	___7Y4	.69	___12F8	.66
___6BJ6	.62	___8AU8	.83	___12FM6	.45
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___6BN4	.57	___8CG7	.62	___12SK7GT	.74
___6BN6	.74	___8CM7	.68	___12SN7	.67
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___6BQ6GT	1.05	___8CX8	.93	___12U7	.62
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___6BR8	.78	___11CY7	.75	___12W6	.69
___6BU8	.70	___12A4	.60	___12X4	.38
___6BY6	.54	___12AB5	.55	___17AX4	.67
___6BZ6	.54	___12AC6	.49	___17BQ6	1.09
___6BZ7	.97	___12AD6	.57	___17C5	.58
___6C4	.43	___12AE6	.43	___17CA5	.62

Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price
___0Z4M	.79	___5CL8	.76	___6CB6	.54	___12AF3	.73	___17D4	.69
___1AX2	.62	___5EA8	.80	___6CD6	1.42	___12AF6	.49	___17DQ6	1.06
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___1DN5	.55	___5J6	.68	___6CG7	.60	___12AL5	.45	___17W6	.70
___1G3	.79	___5T8	.81	___6CG8	.77	___12AL8	.95	___19AU4	.83
___1J3	.79	___5U4	.60	___6CM7	.66	___12AQ5	.52	___19BG6	1.39
___1K3	.79	___5U8	.81	___6CN7	.65	___12AT6	.43	___19T8	.80
___1LN5	.59	___5V6	.56	___6CR6	.51	___12AT7	.76	___21EX6	1.49
___1R5	.62	___5X8	.78	___6CS6	.57	___12AU6	.50	___25BQ6	1.11
___1S5	.51	___5Y3	.46	___6CU5	.58	___12AU7	.60	___25C5	.53
___1T4	.58	___6AB4	.46	___6CU6	1.08	___12AV5	.97	___25CA5	.59
___1U4	.57	___6AC7	.96	___6CY7	.71	___12AV6	.41	___25CD6	1.44
___1U5	.50			___6DA4	.68	___12AV7	.75	___25CU6	1.11

RAD-TEL TUBE CO. **NOT AFFILIATED WITH ANY OTHER MAIL ORDER TUBE COMPANY**

Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price	Qty. Type	Price
___1X2B	.82	___3CS6	.52	___4CS6	.61	___6AF3	.73	___6DB5	.69	___12AX4	.67	___25DN6	1.42
___2AF4	.96	___3DK6	.60	___4DE6	.62	___6AF4	.97	___6DE6	.58	___12AX7	.63	___25EH5	.55
___3AL5	.42	___3DT6	.50	___4DK6	.60	___6AG5	.65	___6DG6	.59	___12AZ7	.86	___25L6	.57
___3AU6	.51	___3Q5	.80	___4DT6	.55	___6AH6	.99	___6DQ6	1.10	___12B4	.63	___25W4	.68
___3AV6	.41	___3S4	.61	___5AM8	.79	___6AK5	.95	___6DT5	.76	___12BA6	.50	___25Z6	.66
___3BA6	.51	___3V4	.58	___5AN8	.86	___6AL5	.47	___6DT6	.53	___12BD6	.50	___35C5	.51
___3BC5	.54	___4BC8	.96	___5AQ5	.52	___6AM8	.78	___6EU8	.79	___12BE6	.53	___35L6	.57
___3BE6	.52	___4BN6	.75	___5AT8	.80	___6AQ5	.50	___6EA8	.79	___12BF6	.44	___35W4	.52
___3BN6	.76	___4BQ7	.96	___5BK7A	.82	___6AR5	.55	___6H6GT	.58	___12BH7	.73	___35Z5GT	.60
___3BU8	.78	___4BS8	.98	___5BQ7	.97	___6AS5	.60	___6J5GT	.51	___12BL6	.56	___50B5	.60
___3BY6	.55	___4BU8	.71	___5BR8	.79	___6AT6	.43	___6J6	.67	___12BQ6	1.06	___50C5	.53
___3BZ6	.55	___4BZ6	.58	___5CG8	.76	___6AT8	.79	___6K6	.63	___12BY7	.74	___50DC4	.37
___3CB6	.54	___4BZ7	.96			___6AU4	.82	___6S4	.48	___12BZ7	.75	___50EH5	.55
___3CF6	.60					___6AU6	.50	___6SA7GT	.76	___12C5	.56	___50L6	.61
												___117Z3	.61

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RAD-TEL TUBE CO.

DEPT. EW561 **55 CHAMBERS STREET, NEWARK 5, N. J.**

TERMS: 25% deposit must accompany all orders, balance COD. Orders under $5: add $1 handling charge plus postage. Orders over $5: plus postage. Approx. 8 tubes per 1 lb. Subject to prior sale. No COD's outside continental USA.

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ADVERTISERS' INDEX MAY, 1961

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N VOID AFTER MAY 31, 1961 1

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SERVICE & MAINTENANCE TECHNICIAN YES ☐ NO ☐

CONSUMER PRODUCTS FULL TIME ☐ PART TIME ☐ INDUSTRIAL FULL TIME ☐ PART TIME ☐

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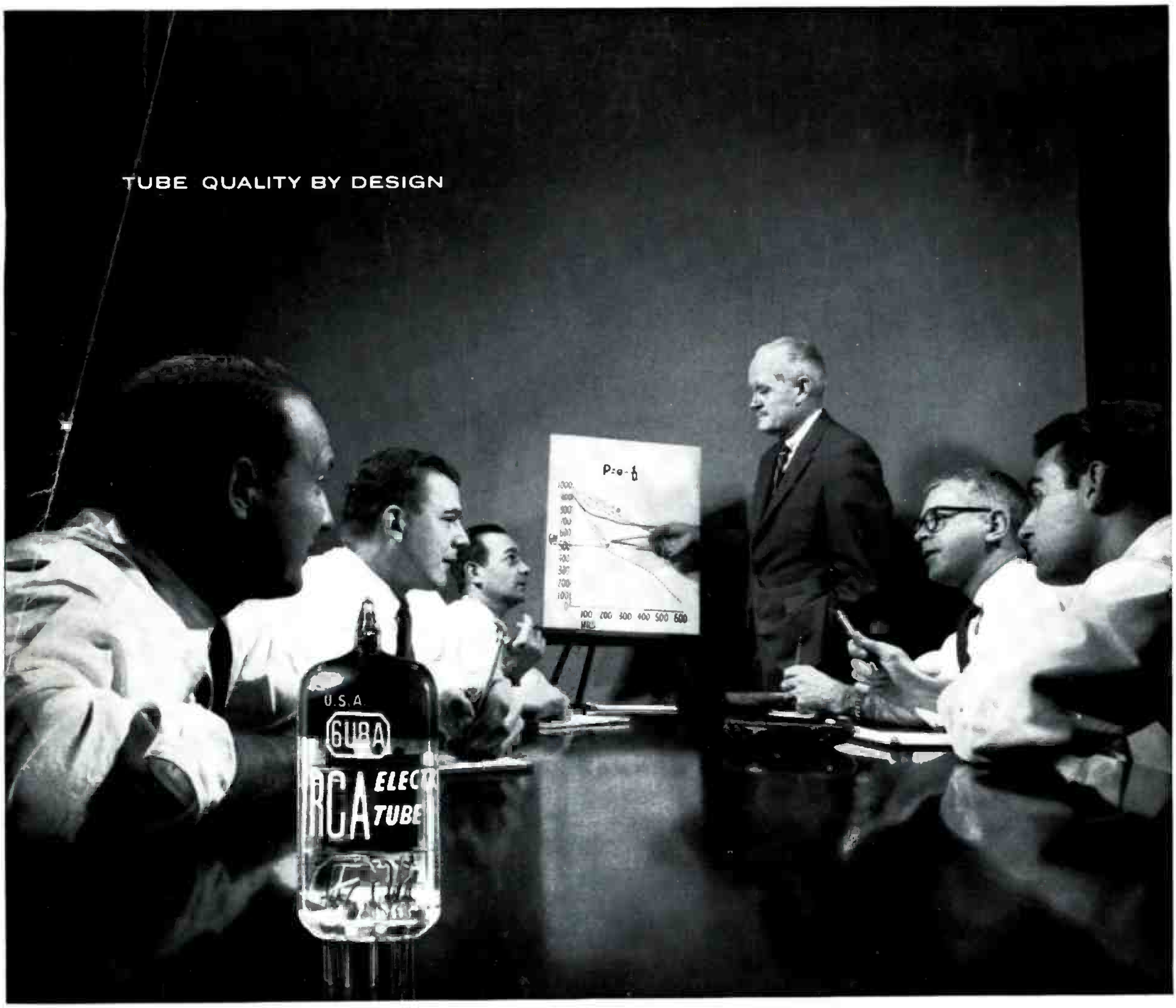
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