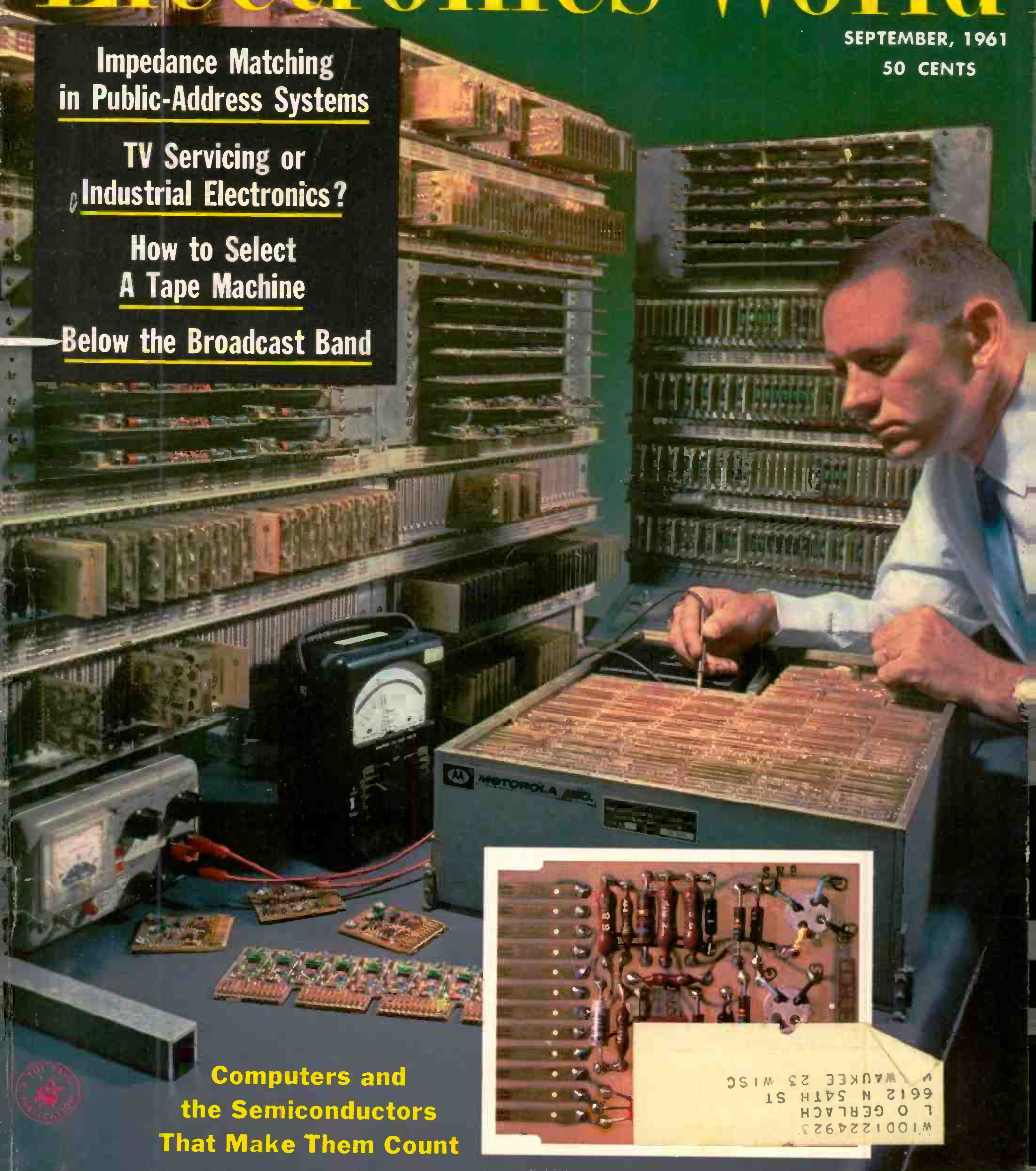
Electronics World

SEPTEMBER, 1961

50 CENTS



Impedance Matching in Public-Address Systems

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How to Select A Tape Machine

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SYLVANIA'S BIG 9 covers the line!

New Sylvania 9-transistor kit provides replacement for over 300 NPN and PNP types.

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TYPE NUMBER	JOB DESCRIPTION	REPLACEMENT FOR
SYL 101	NPN, conv., mixer, osc.	18 types
SYL 102	NPN, if-amplifier	24 types
SYL 103	NPN, af-amplifier driver	21 types
SYL 104	NPN, af-power amplifier	12 types
SYL 105	PNP, conv., mixer, osc.	30 types
SYL 106	PNP, if-amplifier	40 types
SYL 107	PNP, af-amplifier driver	60 types
SYL 108	PNP, af-amplifier output	65 types
SYL 109	PNP, af-amplifier pwr output (popular auto radio type)	54 types

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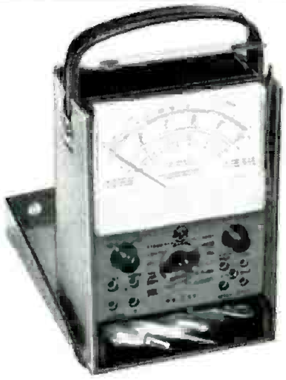
GENERAL SYSTEM

ELECTRONICS WORLD is published monthly by Ziff-Davis Publishing Company at 434 South Wabash Avenue, Chicago 5, Illinois. Subscription rates: one year United States including possessions and Canada $5.00; Pan American Union Countries $5.50; all other foreign countries $6.00. Second Class postage paid at Chicago, Illinois and additional mailing offices. Authorized by Post Office Department, Ottawa, Canada as Second-Class matter. September 1961, Vol. 66, No. 3.

RCA ELECTRONIC INSTRUMENTS
"PREFERRED BY PROFESSIONALS"

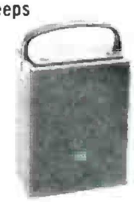
METERS and TUBE TESTERS



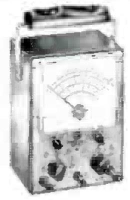
WV-38A VOLT-OHM-MILLIAMMETER
THE V-O-M WITH THE EXTRAS!

Compare this superlative RCA V-O-M against the model you may have been thinking of buying. See if it doesn't check out better in these extra features:

- EXTRA! 1.0 volt and 0.25 volt ranges DC!
- EXTRA! Big easy-to-read 5¼" meter!
- EXTRA! Non-breakable plastic case; no glass to crack or shatter!
- EXTRA! Smart attractive modern styling—the V-O-M of the future!
- EXTRA! Red test lead has probe and slip-on alligator clip for added versatility!
- EXTRA! Orderly location of jacks below switches keeps leads out of the way!
- EXTRA! Spring clips on handle to hold test leads!
- EXTRA! DB scales clearly marked: no squinting!
- EXTRA! Rugged, scuff-proof, stain-resistant laminated vinyl carrying case, only $4.95* extra!



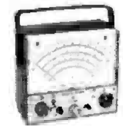
Only $43.95* complete with batteries, instruction book and all probes, clips and cables. (RCA V-O-M Kit only $29.95*).



NEW! WV-77E VOLTOHMYST®

Measures AC and DC voltages to 1500 volts; resistance from 0.2 ohm to 1,000 megohms. Separate scales, 1½ volts rms and 4 volts peak-to-peak for low AC measurements.

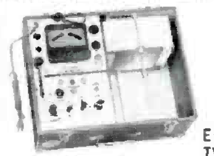
Only $43.95* complete with probes, leads, instructions. (RCA VoltOhmyst Kit only $29.95*).



NEW! WV-98B SENIOR VOLTOHMYST®

Measures AC and DC voltages (3% accuracy); resistance from 0 to 1,000 megohms. Measures peak-to-peak values of complex waveforms. Rugged cast aluminum case, big 6½" meter.

Only $79.50* with leads, clips, instructions. Also available in economical kit form.



WT-110A AUTOMATIC ELECTRON TUBE TESTER

Especially designed for TV and general service testing of electron tubes. Uses automatic punched-card selection of correct test conditions on wide variety of tubes. Checks vacuum-tube rectifiers under high-current conditions.

$199.50* complete with 263 punched cards, 24 blank cards, card punch, instruction book.

SCOPES

WO-91A 5-INCH COLOR-TV OSCILLOSCOPE

High-performance, wide-band oscilloscope ideally suited for color-TV, black-and-white TV, and other electronic applications. Dual bandwidth (4.5 Mc, 0.053 volts rms/in. and 1.5 Mc, 0.018 volts rms/in.). Internal calibrating voltage and calibrated graph screen. Includes special direct/low-cap shielded probe and cable.

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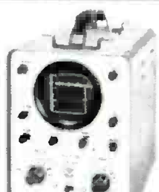
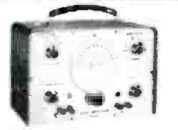


NEW! WO-33A SUPER-PORTABLE OSCILLOSCOPE

A low-cost all-purpose scope you can carry anywhere—only 14 pounds—ideal for in-the-home servicing of black-and-white and color-TV, audio and ultrasonic equipment. High gain and wide bandwidth to handle the tough jobs! Rugged and compact—scaled 3" graph screen.

Only $129.95* complete with low-cap direct input probe, cable, power cord, cord-carrying brackets, instructions. (RCA Super-Portable Oscilloscope Kit, only $79.95*).

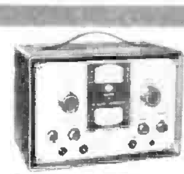
GENERATORS



NEW! WA-44C AUDIO GENERATOR

Generates sine and square wave signals for testing audio systems. Frequency range: 20 cps to 200 Kc. Used to measure intermodulation distortion, frequency response, input and output impedances, speaker resonance, speed of recording and playback mechanisms, transient response and phase shift.

Only $98.50* with cable and instructions.



WR-49B SIGNAL GENERATOR

For alignment and signal tracing of AM/FM receivers, low-frequency signal tracing and alignment of TV vf/if amplifiers. Six ranges—85 Kc to 30 Mc. Internal 400 cps modulation. Low rf signal leakage!

Only $79.50* complete with shielded cable for rf and af output, instruction book.

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To supply a fundamental frequency rf carrier of crystal accuracy for aligning and troubleshooting color-TV, black-and-white TV, FM receivers and other electronic equipment operating in 19 Mc to 260 Mc range.

Only $242.50* complete with output cable, two phone tips, instruction book.

There's an RCA test instrument to help you do every job better, and easier—and to save you valuable time. A comprehensive line of test accessories: video multi-markers, TV isotaps and bias supplies, probes and cables. See your Authorized RCA Electronic Instrument Distributor for complete information.

RCA Electron Tube Division, Harrison, N.J.

*User Price (Optional)

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RADIO CORPORATION OF AMERICA

SEPTEMBER 1961 / VOL. 66 NO. 3 **Electronics World**

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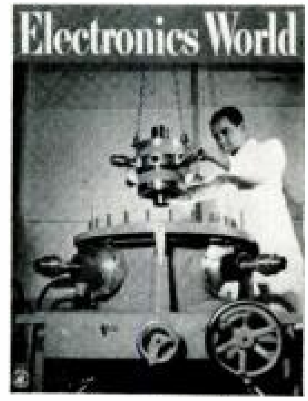

COMING NEXT MONTH

NEW BATTERIES—PROGRESS OR CONFUSION
Characteristics and applications of the new alkaline-manganese and sealed nickel cadmium batteries and how to determine which of the many types currently available will do the best job in given equipment.

ION GENERATOR & ELECTROSTATIC AIR FILTER FOR THE HOME
Design and construction of a precipitation filter-ionizer for installation in warm-air furnace. The unit cleans the air and generates ions which some persons feel are advantageous.

ELECTRO-MECHANICAL SWITCHING IN AUTOMATION
How multi-position switches are replacing human operators in performing tasks that involve many steps in specific sequences.

LOUDSPEAKER TESTING & MEASUREMENT
While speakers can be tested objectively and such tests are meaningful, these measurements must be done properly and interpreted correctly. This article tells how it is done.

PARALLEL-RESISTOR CHART
A useful nomogram for electronics technicians and others who have to deal with parallel-R and series-C circuit problems.

TV MUSIC & THE BROADCAST TECHNICIAN
The job and equipment of the technician who tapes the background music for network television shows.

IMPEDANCE MATCHING IN P.A. SYSTEMS
The second article in this series for the audio technician covers the installation of more complex sound systems, involving high-impedance speaker lines.

CIRCUIT DIAGRAMS OF MULTIPLEX ADAPTERS
We plan to include schematics and technical explanations on four or five commercially available versions of multiplex adapters which are currently on the market or due to be released in the near future.

TRANSISTORIZED CB CONVERTER
Details for building a two-transistor converter for the car's broadcast radio that permits it to pick up Citizens Band signals.

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

September 14th

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...for the Record

By **W. A. STOCKLIN**
Editor

AUTOMATION

RELIABILITY is a theme that seems to be emphasized more and more in the electronics industry as time goes on. One hears, for example, of one failure in 60,000 hours of operation and although this is impressive, it actually falls short of our future requirements. When we consider that the success or failure of a satellite launching can hinge on a 20-cent resistor, the need for maximum reliability from every one of the thousands of components comprising the package is self evident.

On a recent visit to Winston-Salem, North Carolina we had the privilege of inspecting a completely automated production line. This 110-foot line was designed and is being operated by *Western Electric Company*. It is being used to produce film strip carbon resistors for military applications. The production line is a highly coordinated system in which a digital computer calls all the signals. Automated equipment deposits a carbon coating on a ceramic core, sputters on gold terminations, attaches caps and leads, spirals the carbon to value, encapsulates the resistor in a protective shell, tests at three different points for quality, marks appropriate values on the resistor, and finally packs the components for shipping. At no point in this entire process is a human operator involved. Human error, poor judgment, inattention, and fatigue have been eliminated as possible causes of defective components.

While the cost of the finished product is considerable, it is not of primary importance. The entire concept is based on improving the reliability of the finished item. Theoretically, since the line has just gone into operation, reliability can be increased from one failure in 60,000 hours to one failure in 200,000 hours of operation.

After years of study, it has been found that most resistor failures can be attributed to dust, dirt, or oil from the fingers of production line workers—deposited in the course of the manufacturing process. These inherent problems, along with the possibility of human error in testing and checking performance, have heretofore restricted any meaningful increase in the reliability ratio.

One of the most interesting performance tests we witnessed was that designed to check each resistor for leakage of its protective shell. The units were immersed in a hot bath and any leakage, indicated by air bubbles, was detected by a photoelectric cell. Should the resistor fail this leakage test, the component was automatically discarded by the machine.

Although the electronics industry is still in its infancy when it comes to developing completely automated production equipment, there is no doubt that because of the increasing emphasis on reliability, other automated lines will be developed to handle others of the hundreds of components which make up every piece of electronic equipment.

THE "NEW LOOK"

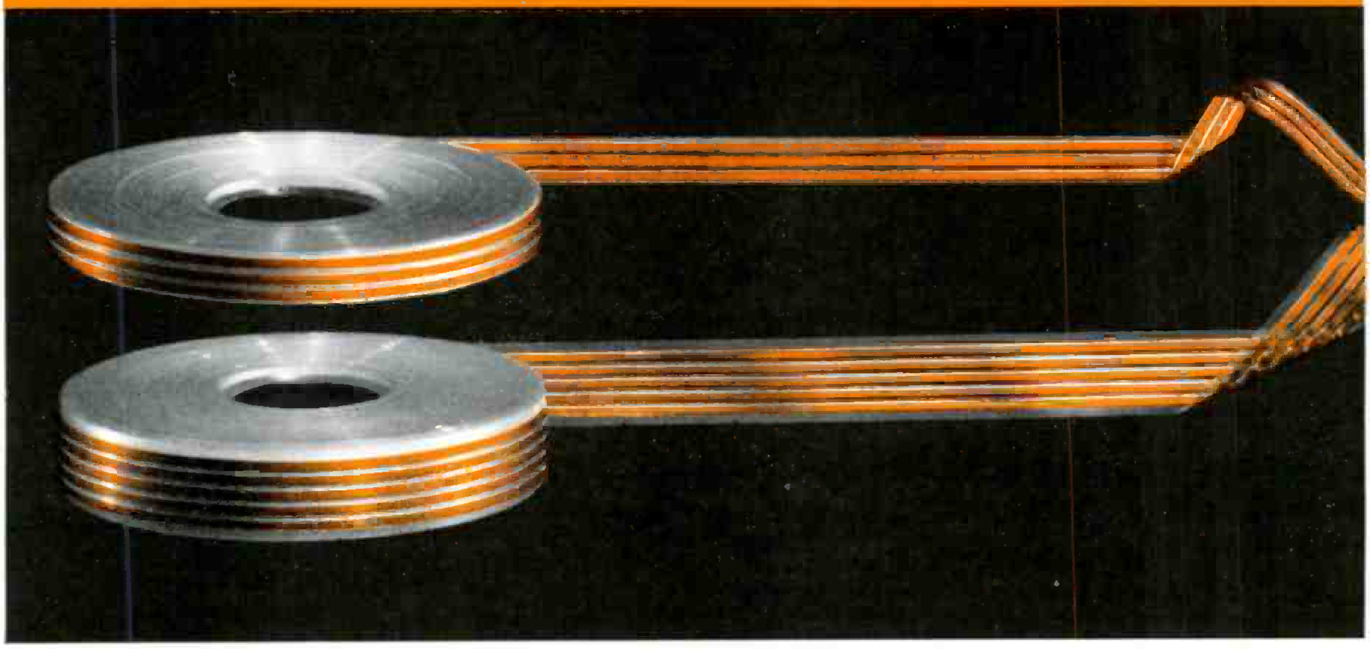
AS we pointed out in last month's editorial, starting with this issue the ELECTRONICS WORLD logo on the cover has been changed. We believe that you will find the new upper and lower case type more readable and make the magazine easier to spot—even at a distance. We would also like to call your attention to the changes on our Contents page. We have tried to make it more attractive, easier to read, and more helpful by adding subheadings under the titles of some of the feature articles, when space permits. This will help in further clarifying the subject of the article instead of having to refer to the pages themselves for more detailed explanation.

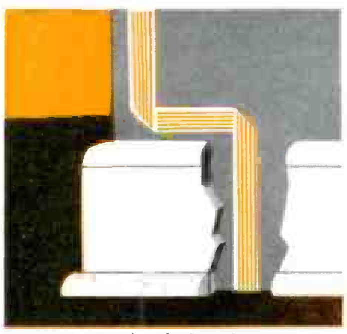
We are also experimenting with various type faces. (For those interested in the "mechanics" of publishing, we refer you to pages 42, 52, 58, and 62.) Again, our goal is to develop a presentation that is not only attractive but easier to read. Some readers may feel that the answer is to just go to a larger type face, but we dislike the idea of offering less than complete coverage of a given subject and fewer articles per issue. We believe most readers would rather have more and better material than larger type—but since this is an experiment—we will appreciate any comments pro or con regarding this point.

Basically, we plan no changes in the editorial policies of ELECTRONICS WORLD. We will still cover the same areas and continue to bring you the same authoritative material as we have during the past years.

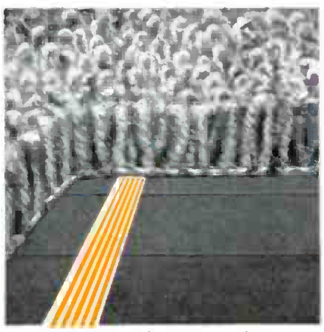
For those of you who may have missed last month's issue, we would like to mention again the fact that, starting with the October issue, all of the EW Lab Tested Reports involving hi-fi equipment will be handled by the *Hirsch-Houck Laboratories*. Julian Hirsch and Gladden Houck will do the testing and, in our opinion, their facilities and knowledge of high-fidelity equipment cannot be topped. We hope our readers will agree. ▲

In ELECTRONIC COMPONENTS if it's news, expect it first from IRC



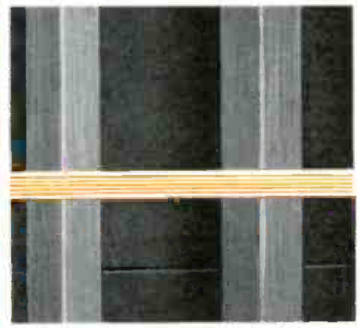


Installs behind surbases



Lies under floor coverings

Conceals easily behind wallpaper



Saves drilling in walls and wood

Use POLYSTRIP®... the new, easier way to make low-voltage interconnections

Users find POLYSTRIP a time, money, and headache-saver. The speed of installing this flat cable results in substantial savings. POLYSTRIP lies under floor coverings without causing bulges; slips between wallboard seams, behind moldings, through openings, thus eliminating drilling or cutting walls and woodwork. It fastens to finished walls, ceilings and baseboards with double-backed tape, doing away with conduit and plaster-cracking hardware. The many features of this new concept in cabling make POLYSTRIP equally valuable for new construction or renovation.

POLYSTRIP consists of uniformly spaced flat copper conductors laminated with transparent plastics into a very thin, flexible, flat cable. Already proved in industrial electronics, it is now applicable for hi-fi, paging, signalling and alarm systems, programming, wired remote TV control.

INSTALLER'S KIT SAVES 47%

Assortment #205 saves 47% over the separate prices of items it includes. Contains 75-foot rolls of both 3- and 5-conductor cable; 6 splicing and 2 wire lead type connectors* for both 3- and 5-conductor cable; 50-foot roll of double-backed adhesive tape and 1 Stripping Tool.

International Resistance Company, 414 North 13th Street, Philadelphia 8, Pa.

*POS-E-FLEX Connectors by The Thomas & Betts Co., Inc., Elizabeth 1, N.J.

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Executive

for SUPERIOR Citizens band communication . . .

MODEL 100

The ultimate in Executive Citizens transceivers. Advanced features and design make the Model 100 an exceptional value. **New** crystal filter which minimizes adjacent channel interference in the receiver. **New** built-in receiver calibration circuit. **New** International NR squelch. **New** 12 position crystal control transmit channel selector. **New** front panel microphone jack. **New** provision for connecting external speaker and S/meter. Dual conversion superheterodyne receiver. Push-to-talk operation. Three way power supply for 6/12 vdc, and 115 vac. Handsomely packaged with new attractive control panel. Full five watts plate input. Certified tolerance .005%. Size 5½" x 8½"- x 9" deep. Engineered to provide maximum operating efficiency. **Complete with 1 transmit crystal, 1 receive crystal, new style ceramic microphone and coil cord.**

$199.50*

MODEL 10

International's exciting **New** Compact transceiver for the Citizens licensee who desires quality workmanship and engineering plus the best possible circuit for the money invested. Field tested full 5 watt transmitter contained in the higher price Executives. Certified tolerance .005%. Tunable superheterodyne receiver covering all 23 channels. Three position crystal control transmit channel selector. Manual transmit-receive control. Noise limiter. Available accessories include four separate power supplies — 6 vdc, 12 vdc, 24 vdc or 115 vac, push-to-talk relay kit, squelch kit, and 12 position transmit channel selector. **Complete with 1 transmit crystal, matching microphone and external speaker, but less power supply.**

$59.50*

MODEL 50

A precision engineered transceiver featuring push-to-talk operation. Three position crystal control transmit channel selector. Dual conversion superheterodyne receiver tuning all 23 channels. Full five watts plate input. Crisp and clear modulation. Certified tolerance .005%. Series Gated automatic noise limiter. **New** International NR squelch. Three way power supply for 6/12 vdc, and 115 vac. The Model 50 Executive is a rugged yet handsome piece of communication gear equally at home in the office, service truck or field. Inside the Model 50 and every International Executive you'll find the latest circuitry, careful craftsmanship and quality components. Additional features of the Model 100 Executive may be added at any time. **Complete with 1 transmit crystal and matching microphone.**

$149.50*

*Suggested Price

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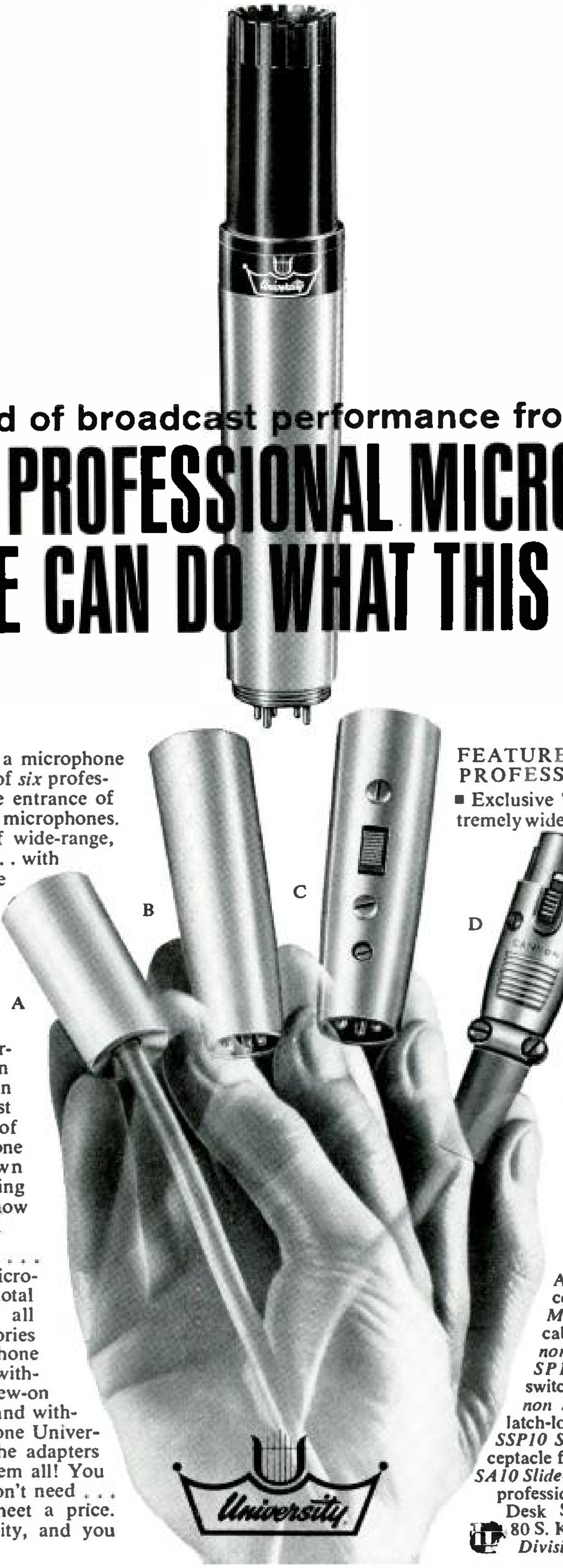

Never before has there been a microphone like this . . . and it's just one of *six* professional models that herald the entrance of University into the field of microphones. Each sets a new standard of wide-range, distortion-free performance . . . with frequency response available as low as 30 cps, as high as 20,000 cps. Each offers the years-ahead-of-its-time concept of modular flexibility. Each is styled with clean, uncluttered lines totally adapttable to every environment.

To accomplish all this, University drew upon its more than two decades of leadership in sound, and applied all this vast experience to the challenge of producing a better microphone than had ever been known before. University — the leading manufacturer of speakers — now sets the pace in microphones.

MODULAR FLEXIBILITY . . . a major breakthrough in microphone design . . . gives you total interchangeability between all microphones and all accessories at all times. Need a microphone with a switch and another without . . . or for slide-on and screw-on stands . . . or for cables with and without cannon plugs? Buy just one University microphone plus only the adapters you need, and you've got them all! You don't pay for features you don't need . . . you don't compromise to meet a price. That's *true* modular flexibility, and you get it only from University.

FEATURES OF THE UNIVERSITY PROFESSIONAL MICROPHONES

■ Exclusive "Unilar" diaphragm assures extremely wide response range . . . from as low as 30 cps to as high as 20,000 cps. ■ Rugged generating element is indestructible in normal use. Internal elements of shock-mounted models float in vibration-free foam insulations. ■ Impedance matching simplicity (choice of two low, one high) with press-on connectors built into every accessory. No tools, soldering, or rewiring. ■ Trend-setting exterior design with smart modern finishes . . . just right for every application.

All these accessories available for complete modular flexibility: [A] *Model CC10 Cable Adapter* with 18' cable, $6.00. [B] *Model PA10 Cannon Plug Adapter*, $6.30. [C] *Model SP10 Cannon Plug Adapter* with switch, $6.90. [D] *Model CA10 Cannon Plug and Cable* with push/action latch-lock and 18' cable, $6.00. [E] *Model SSP10 Stand Adapter* with switch and receptacle for cannon plug, $11.10. [F] *Model SA10 Slide-on Stand Adapter* $4.20. All prices professional net. For further details, write Desk S-9 University Loudspeakers, Inc. 80 S. Kensico Ave., White Plains, N.Y. *A Division of Ling-Temco Electronics, Inc.*

LETTERS FROM OUR READERS

CB CHANNEL NUMBERS

To the Editors:

I have noticed many businesses listing their CB call sign on their service vehicles and business places but, in my opinion, there is one thing missing. This missing part is especially important at marinas and other service points.

I think that the CB channel number should be a part of the call sign when the call sign is displayed on vehicles and places of business showing they monitor the CB band.

This would assist anyone desiring to call for service. If they monitor on one frequency and transmit on another, then these should be listed. This would not take up any more room on advertising in newspapers or vehicles and would be very helpful.

B. B. Landry, Jr.
Research Technician
American Optical Company
Southbridge, Mass.

This is certainly a good idea, as is the use of a standard calling frequency for the Citizens Band.—Editors.

* * *

FOUR-CHANNEL STEREO

To the Editors:

I should like to compliment you on an interesting May issue. I find, however, that I must take exception to your article "Four-Channel Stereo Adds Depth to Tapes" by John W. Hogan. I feel that the article is misleading in that it would have the reader believe that conventional or "single dimension (X-X) stereo" is incapable of properly producing or rather reproducing the illusion of depth. This is simply not true. The fact is that we listen to music with two ears, and they are perfectly capable of conveying all necessary intelligence to produce the depth illusion physiologically. Mr. Hogan's indication that increasing the amplitude of a conventional stereo signal will only serve to increase the loudness is perfectly true but irrelevant to his argument. The purpose of all reproduction is to reproduce *reality* or as close to reality as possible, not to alter it at the whim of the listener and the twist of the "Y dimension" knob.

If Mr. Hogan is trying to indicate that additional channels will *enhance* the three dimensional effect he has a point, but has failed to state it clearly. The difficulty with today's stereo recording, be it record or tape, is not the medium on which the recording is made, nor the amount of available channels, but rather, curious microphone placement. For reproduction of sound in the home as it appears in the studio or concert hall, it is generally true that microphones should be placed approximately the same distance apart as the spacing of the average human ears. At the "other end of things" the listener should wear headphones. The binaural system *does* very closely approximate the reality of performance. Unfortunately because of crosstalk problems, the quest for commercial appeal, and the reluctance of the listener to wear headphones, microphones are commonly placed yards apart and are listened to with loudspeakers. Hence the same type of distortion one might expect to hear with the variable "Y-Y dimension" control.

While it is true that every additional parameter of information more closely yields reality, I would suggest that there is a very practical limit to such thought, and I would further suggest that with responsible microphone placement and recording technique in general, today's conventional two-channel stereo is a logical compromise.

Steve Young
Staff Announcer, WBCN
Boston, Massachusetts

Perhaps our author tried to make his case for four-channel stereo a little too strongly in the article. Many have discovered that an illusion of depth is possible with the two presently used stereo channels. There is no doubt, though, that more channels can convey more information. We do agree that for the present, at least, two-channel stereo is the logical compromise.—Editors.

* * *

MEASURING CONDUCTIVITY OF SOLUTIONS

To the Editors:

I enjoyed reading your article "Measuring Conductivity of Solutions" which appeared in a recent issue of Electronics World magazine. More articles of this type are needed in this fast moving electronics age to familiarize people with the basic theory and equipment involved in electrochemical measurements.

One point aroused my curiosity, however, and I would appreciate receiving more information about it. You say in the article: "A 60-cycle source . . . is preferred for high resistance electrolytes. . . ." Why is 60-cycles preferred for low conductivities? From a theoretical standpoint, it would appear that an instrument utilizing a 1000-cycle source would operate as well, if not better than a 60-cycle unit at the high resistances. Other than from an economic standpoint (60-cycle units tend to be less expensive than those for 1000-cycles) I can see no justification for limiting yourself to low range measurements by using 60 cycles, when commercial units

(*Continued on page* 14)

are available for 1000-cycle operation which will accurately cover all ranges of conductivity.

ALEX C. PAPAIOANNOU
Foxboro, Massachusetts

Here is a copy of Author Collins' remarks in answer to the above question.—Editors.

Dear Mr. Papaioannou:

Your question is certainly a good one, and perhaps I should have taken the space to cover the point in the article. While the economic aspect is always important, there is another and even more important reason for using a 60-cycle source for low conductivity solutions. Since a conductivity cell consists of two electrodes separated by a relatively high resistance medium, it resembles a capacitor and exhibits some of the same properties. When in use, the equivalent circuit of a conductivity cell is actually a resistor with a shunting capacitor. In the case of conductivity cells for *high conductivity* measurements, the capacitance is quite small since, as pointed out in the article, the electrodes are small and spaced far apart. Since the resistance of the solution is low, the shunting effect is negligible.

The circumstances are different, however, in the case of cells for *low conductivity* measurements. The electrodes are large and closely spaced, so the capacitance between them is no longer negligible, especially since it shunts a high resistance. It is desirable, of course, to minimize the shunting effect by making the capacitive reactance as great as possible. The easiest way to do this without disturbing the rest of the circuit is to reduce the frequency. You can readily see that the capacitive reactance at 60 cycles will be 16½ times as great as the value at 1000 cycles. Because of the small electrolytic content of low conductivity solutions, reducing the frequency does not introduce polarization errors. The chief advantage of the higher frequency, therefore, does not apply in these circumstances.

I do not mean to imply that accurate measurements of low conductivity solutions cannot be made at 1000 cycles. I mean simply that the use of the lower frequency serves to minimize one source of error. Some wide-range conductivity bridges are equipped with both a 60-cycle and a 1000-cycle source, to permit the operator to select the frequency best suited for the test. An example of such a bridge is Model RC-16B2, manufactured by *Industrial Instruments, Inc.*

JOHN R. COLLINS
Wheaton, Maryland

* * *

NEGATIVE RESISTANCE

To the Editors:

In going through the May 1961 issue of your magazine I came across an article on "Negative Resistance" by Rufus P. Turner.

In Fig. 4 is a diagram of an arc transmitter, inductively coupled to the antenna circuit. Arc transmitters are inherently direct-coupled to the antenna.

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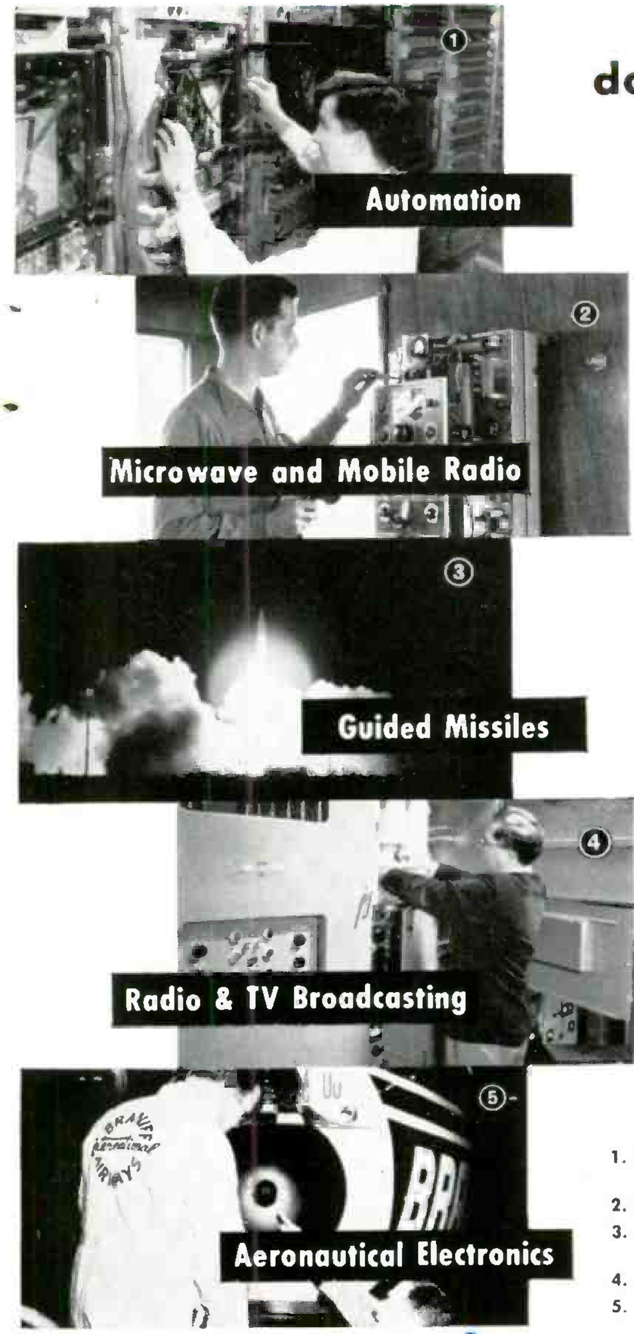

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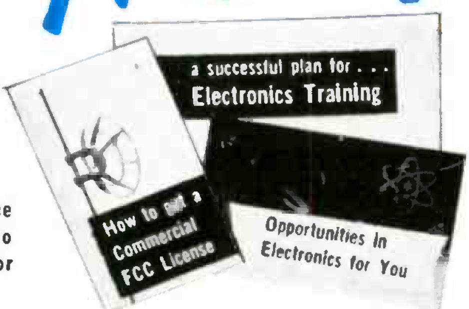

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Further, the essential element to oscillation of the arc is not mentioned in that the arc must be struck in a strong magnetic field, and this in the hydrocarbon atmosphere described by Mr. Turner.

Mention is also made of a "dynatron" tube together with the date 1918. A tetrode tube is indicated in the text and the diagram. I don't recall screen-grid tubes being around in 1918.

A DeForest Pioneer
West Chester, Pa.

Thanks to the above reader for his comments. The article in question simply used an arc transmitter and dynatron oscillator as examples of the use of negative resistance. The author did not intend to go very deeply into all the details of these two devices other than to show that both operated under principles of negative resistance described in the article.

It is true that the tetrode tube was not commercialized in the United States until 1927 or 1928. However, experimental models were available much earlier. An article by Albert W. Hull entitled "The Dynatron—a Vacuum Tube Possessing Negative Resistance" appeared in the "Proceedings of the I.R.E." (Volume 6, page 5) in 1918.—Editors.

* * *

DUAL 35-WATT AMPLIFIER

To the Editors:

Here is a photograph of the dual 35-watt amplifier which I constructed, as described by you in your March issue.

I am more than pleased with the results I have obtained. This is the third one I have wired for myself and friends,

and everyone that has heard them is amazed at the quality of the reproduction.

J. N. Mann
Elizabeth, New Jersey

Reader Mann's photo shown above certainly looks as though he did a very fine job in constructing the amplifier described.—Editors.

* * *

AN ECONOMY HI-FI AMPLIFIER

To the Editors:

In Mr. Arthur Glaser's article, "An Economy Hi-Fi Amplifier" in your July, 1961 issue, there appeared to be an error in the value of R_m, the cathode resistor of V_2. It would seem that 470,000 ohms is far too large for this particular resistor.

John Neal
Cleveland, Ohio

Reader Neal is, of course, correct in that the value given is much too large. The correct value is actually 470 ohms.—Editors. ▲

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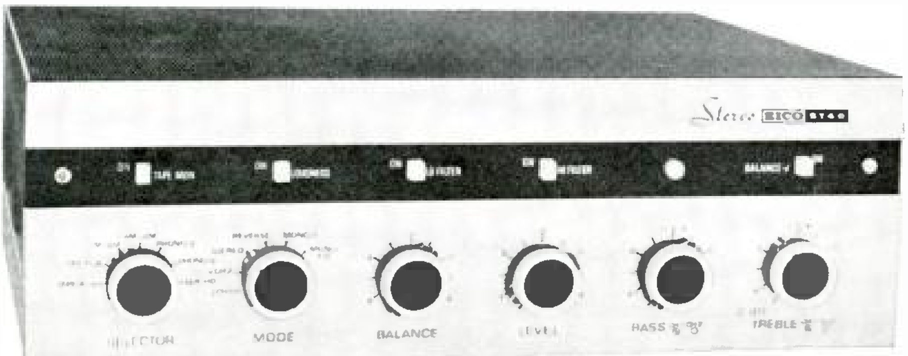
New Audio Test Report

Eico ST40 Integrated Stereo Amplifier
Sonotone 9T Ceramic Stereo Cartridge
Dynaco "Dynatuner" FM-1



Eico ST40 Integrated Stereo Amplifier

For copy of manufacturer's brochure, circle No. 58 on coupon (page 120).

ONE OF the most attractively priced integrated stereo amplifiers on the market is *Eico's* Model ST40. It is a dual 20-watt (continuous sine-wave power) per channel design. One of the first things that attracted our attention is the new cabinet styling which, apparently, will become standard packaging for the new *Eico* "Medalist" series. The panel is a combination of black and gold, attractively styled, and the equipment cover is completely perforated, providing excellent ventilation. The appearance of present-day kits is a far cry from that of their predecessors.

The circuit is fairly conventional, employing push-pull 7591 output tubes using cathode bias. These are the very same tube types used in the circuit described in our article "Dual 35-Watt Stereo Amplifier" (March 1961 issue). It is interesting to note that with an additional 80 volts of "B+" and fixed bias, the amplifier described then easily puts out 35 watts per channel at only .3 percent harmonic distortion. This gives some idea of the sound, conservative design of the Model ST40.

A total of 10 tubes plus one rectifier make up the entire circuit. The unit incorporates all the necessary function controls and permits the reproduction of any possible source of program. It has such features as tape-monitor switch, high and low filters, loudness control, conventional bass and treble tone controls, and provision for center-channel speaker. Another feature is the balancing slide switch which works on the null principle. Two similar programs (mono or stereo) are passed through one channel out-of-phase and the balance control is adjusted for minimum output (null). Note that this balancing method results in exactly equal gains in both of the amplifier channels. In order to obtain a balanced sound output, the two speakers used must have equal sensitivities.

Performance of this unit proved to be good, with many of its characteristics being equal to some of the best designs available. The following results were obtained on a kit which we assembled:

Sensitivity for 20-watts output: tape-head input, 1.85 mv.; both magnetic phono inputs, 3.2 mv.; and all other high-level inputs, .34 v.

Frequency response at 2 watts: ±.8 db from 30 to 15,000 cps (the limits of our test).

RIAA equalization: within ±1.5 db from 30 to 15,000 cps.

Rumble filter: −11.2 db at 30 cps in relation to 1000 cps. This filter is of the sharp cut-off type, response dropping rapidly below 100 cps.

High-frequency filter has a response dropping off to −13 db at 15,000 cps in relation to 1000 cps.

The bass and treble tone controls and loudness (contour) control proved to be extremely effective.

All of the following hum and noise measurements were made with the volume control adjusted to provide 2 watts output with a 6-mv. signal into the magnetic phono jack. High-level inputs: −69.1 db; magnetic phono input: −54.4 db; tape-head input: −38.2 db. All of these are in relation to 2 watts output.

Harmonic distortion at 2 watts output: .85% at 30 cps, .21% at 100 cps, .19% at 1000 cps, .06% at 15 kc. For 2% harmonic distortion: 11.7 watts at 30 cps, 23.4 watts at 50 cps, 24 watts at 100 cps, 24.2 watts at 1000 cps, 23.8 watts at 15 kc. We consider a figure of 2% harmonic distortion as just detectable by the most critical ear. With this thought in mind, this amplifier could have been rated at 23.4 watts from 30 cps to beyond 15 kc., according to the IHFM standards for power response (−3 db points). It is interesting to note that the manufacturer is inclined to be conservative in his published specifications in this regard.

We have spent many enjoyable hours listening to recorded programs using this amplifier and we were extremely pleased with its performance. There were no indications of ringing or coloration of the original material. The design is such that one should be able to use the amplifier for a long while without encountering maintenance problems.

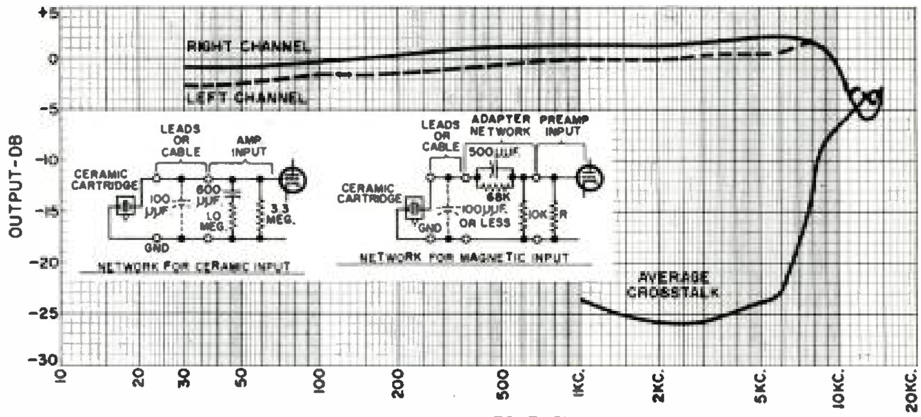
As with all kits produced by this manufacturer, the construction manual is so detailed and well illustrated that it is hard to conceive that anyone would have difficulty with the construction, although it is time-consuming. No special test equipment is required for the unit. It is available for $79.95 as a kit, which required this reviewer approximately 15 hours to build, or completely factory-wired at $129.95. ▲

Sonotone 9T Ceramic Stereo Cartridge

For copy of manufacturer's brochure, circle No. 59 on coupon (page 120).

IN view of the fact that the manufacturer's claims emphasize that there are no audible differences between their new "Velocitone" 9T cartridge and even the best magnetics of any of their competitors, we looked forward with considerable interest to testing one of their units. The 9T is a ceramic stereo cartridge using an easily replaceable dual "turnover" stylus with .7-mil and 3-mil tips, or with dual .7-mil tips. The cartridge may be connected into any ceramic input of a stereo preamp, although for precise equalization the manufacturer suggests the use of an *RC* network having values specified in the data sheet. The cartridge is also supplied with a pair of equalizers (see circuit) to convert it to magnetic input. Since we have tested most stereo cartridges through the magnetic-input circuit of our preamp and since the adapters were so convenient to use, all our tests on this cartridge were made using the magnetic-input adapters.

The results of our tests, using a *Westrex* 1A record, are shown in the accompanying graph. We tried several different load resistors (*R*) and we



found that an 18,000-ohm load gave us the smoothest response. The value of this resistor may be changed to alter the output level of the cartridge.

We spent several hours listening to the best records available and, without a doubt, the cartridge proved to be smooth in response and was able to handle extremely loud passages without breakup. We were not troubled at all with listening fatigue. Our listening was done at a stylus force of 3 grams. (The manufacturer recommends 2 to 4 grams for professional arms and 3 to 5 grams for changers.)

The most interesting part of our tests was performed at the *Sonotone* plant using their equipment. We were extremely pleased to note that there was only a slight difference in their results on frequency response and channel separation compared to our own measurements. Their frequency response differed only between 11,000 and 15,000 cps, being 3 db higher than our curves. Channel separation was slightly greater, being 30 db instead of the 26 db we measured around 3000 cps. These differences could simply have been the result of using another pressing of the *Westrex* 1A test record, or different lead lengths.

An A-B test, using one of the best magnetic cartridges available, proved conclusively that there was no difference in the audible quality of sound reproduction between the two, at least on the particular musical selections listened to. It is possible that an auditor with very good high-frequency listening response could have heard a difference, but this reviewer found it impossible to distinguish between the two cartridges. One fact was apparent, however, the ceramic cartridge had less groove noise, "clicks," and "pops." Obviously, this was the result of the slightly lower response of the ceramic cartridge at the extreme high-frequency end between 11,000 and 15,000 cps. Our A-B tests indicated that none of the records had very much program content in this frequency range (and yet they were the best available).

Without debating what is, or is not, recorded above 10 kc., it can be stated that frequency-response measurements are only *one* indication of cartridge quality. There are many other performance criteria, such as transient performance, harmonic and IM distortion, that enter into the picture and determine what a cartridge sounds like. The best over-all judgments can be made by careful comparative listening tests, using a wide variety of program sources.

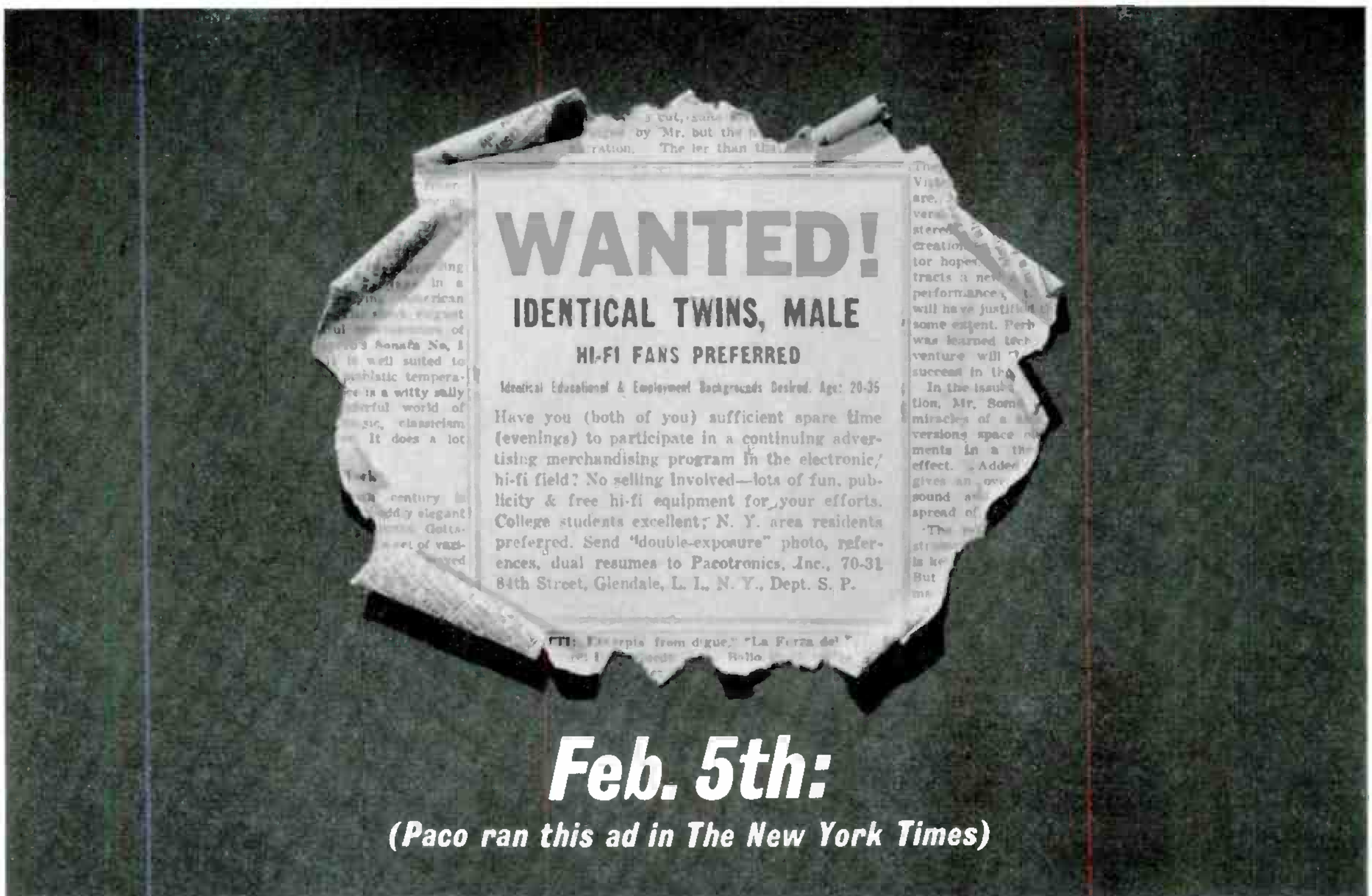
The 9T cartridge is available at a *list* price of $20.50 with sapphire tips and at $23.50 with diamond-sapphire tips. A unit is also available with dual .7-mil diamond tips at $26.50 list. Prices include a pair of equalizers for magnetic input and mounting hardware. ▲

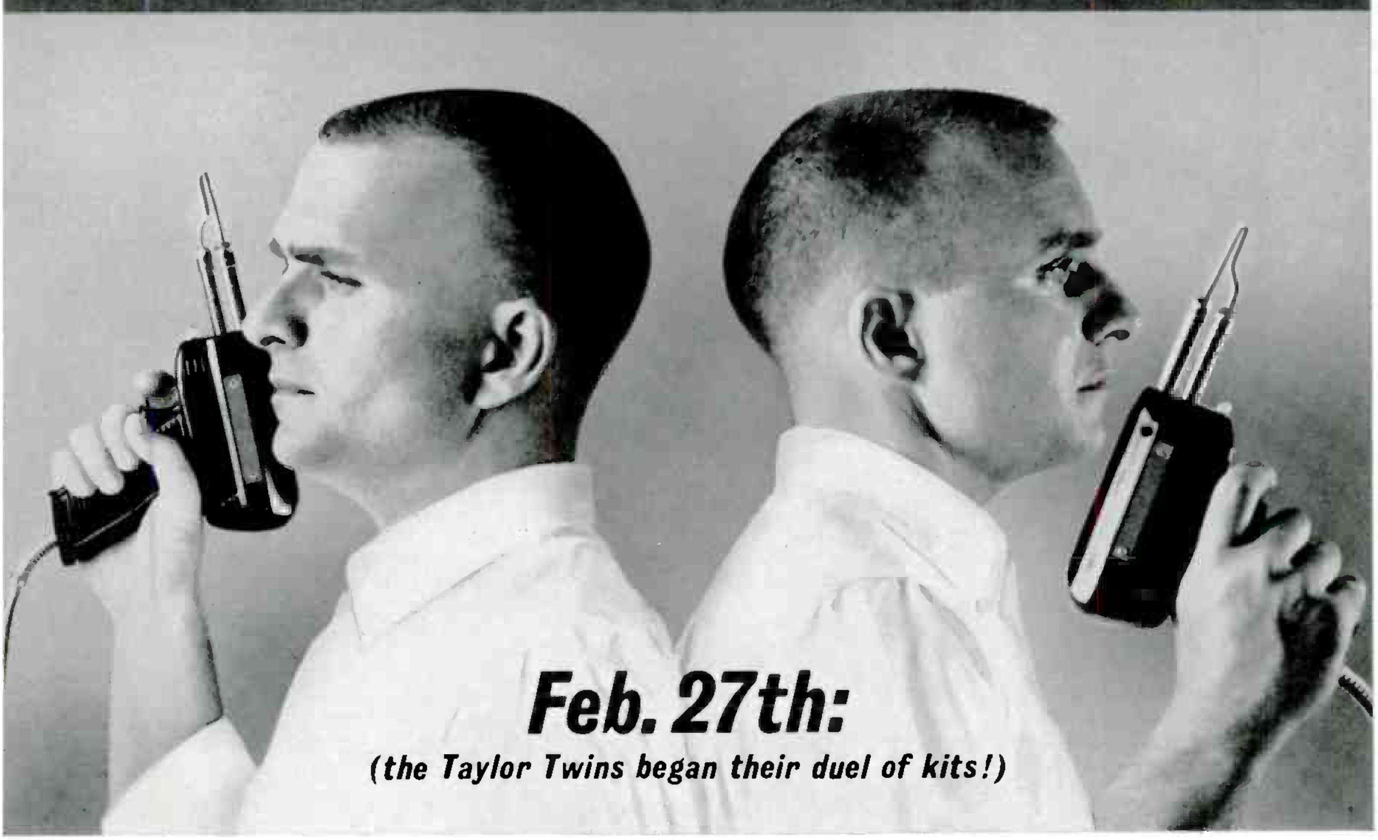
Dynaco "Dynatuner" FM-1

For copy of manufacturer's brochure, circle No. 60 on coupon (page 120).

NOT too long ago, it would not have made too much sense to suggest that a novice try to build an FM tuner, even from a kit. The construction of a basic amplifier has always been fairly simple, but building circuits that would have to operate properly at the very high r.f.

(*Continued on page* 24)





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

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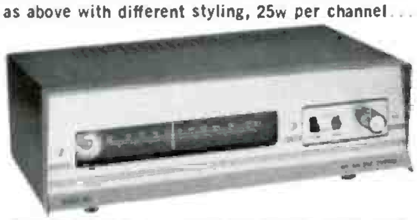
SA-40 Kit with enclosure, "Twin-Tested" operating assembly manual..... $79.95 net

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

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



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

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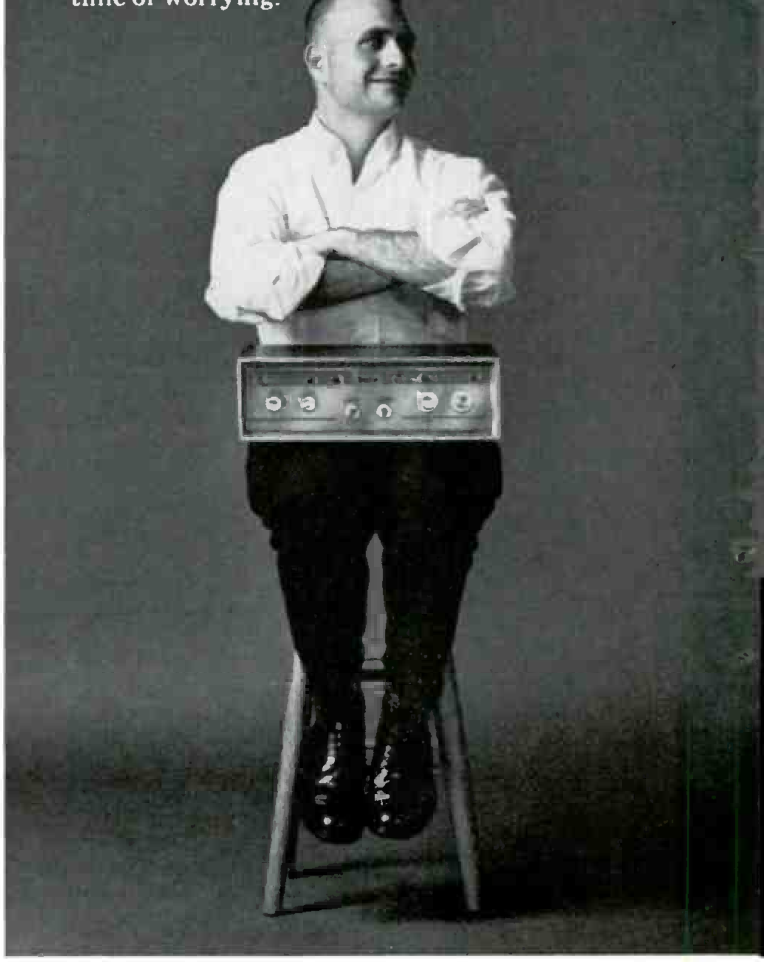
"I built the Paco SA-40 Stereo Preamp Amplifier."

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



"I built a competing Stereo Preamp Amplifier."

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

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Lexington Radio Electronic Equip. Co.
Louisville P. I. Burks Co.
LOUISIANA
Baton Rouge Davis Electronic Supply†
Lake Charles Television Radio Supply†
New Orleans Crescent Radio & Sup. Inc.†
Epcor†
Southern Radio Supply†

Shreveport Koelemay Sales Co., Inc.†
MARYLAND
Baltimore Hi-Fi Shops*
Revacto of Maryland†
Hagerstown Zimmerman Wholesalers
Salisbury Standard Electronics Supply†
Towson Baynesville Electronics†
Wheaton Key Electronics
MASSACHUSETTS
Brockton Tee Vee Supply Co.
Chelsea Lektron, Inc.
Holyoke Kathleen Smith Music Shop Inc.
Jamaica Plain Tee Vee Supply Co.
Lynn Land Electronics Supply Inc.†
Milford Tee Vee Supply Co.
Peabody Tee Vee Supply Co.
Springfield Del Padre Music Shop Inc.
Del Padre Supply of Springfield
MICHIGAN
Battle Creek Electronic Supply Corp.
Dearborn Hi-Fi Studios, Inc.*
Detroit Hi Fidelity Workshop*
Hi-Fi Studios, Inc.*
Radio Specialties Co.
Grosse Point Hi Fidelity Workshop*
Kalamazoo Electronic Supply Corp.
Muskegon Western Elec. Supply Co.†
Pontiac Hi Fidelity Workshop*
Wyandotte Hi Fidelity Workshop*
Radio Specialties Co.
MINNESOTA
Minneapolis Ken Craft Hi-Fi*
St. Paul Electronic Market*
MISSOURI
Joplin Four State Radio Supply†
Kansas City McGee Radio Co.
Manhattan Radio & Equipment Inc.†
St. Louis Deltronics Distributing Co.†
Olive Electronic Supply
MONTANA
Billings Electronic Supply Co.†
NEBRASKA
Omaha Omaha Electronics Co.†
Scotts Bluff Tri State Electronics Inc.
NEW HAMPSHIRE
Concord Evans Radio
NEW JERSEY
Bergenfield Arnco T. V. Parts Corp.*
Hackensack Emsco Electronics Inc.*
Morris Plains Park Electronic Corp.
Newark Terminal-Hudson
North Bergen Arnco T. V. Parts Corp.*
Passaic Ed's Electronics Inc.
Princeton Sun Radio & Electronics Co.
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Westwood Arnco T. V. Parts Corp.*

Parts Unlimited Stores
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Albuquerque Electronic Parts Co.†
Yucca Wholesaler†
Los Alamos Valley Engineering Co.

NEW YORK
Albany Greylock Electronics†
Seiden Sound, Inc.†
Bayside Snyder Electronic Distrs. Inc.*
Binghamton Stack Electronics†
Brooklyn Witmal Electronics*
Benray Electronic Distributors
Bronx Adamson Electronic Corp.*
Buffalo Radio Equipment Corp.†
Standard Electronics, Inc.†
East Northport Arena Electronics, Inc.†
Elmont Great Eastern Mills-Electronics*
Hempstead Newmark & Lewis*
Jamaica Harrison Radio Corp.
Peerless Radio Dist. Inc.
Kingston Greylock Electronics†
Long Island City Electronics Supply Corp.
Middletown Artec Distributors Inc.†
Certified Electronics Inc.†
Mineola Arrow Electronics Inc.
New Hyde Park Dressner Audio Sales Co.*
New York City Adson Electronics
Arrow Electronics
Consolidated Radio Sales Inc.†
Dale Electronics Co.
Grand Central Radio
Harrison Radio Corp.
Hi Fidelity Center*
Magic Vue Television Corp.*
Magna Electronics Co.
Sun Radio & Electronics Co.
Terminal-Hudson
Wilmar Distributors Corp.*
Zalytron Tube Corp.
Poughkeepsie Greylock Electronics†
Rochester Rochester Radio Supply Co.
Rome Rome Electronics, Inc.†
Schenectady Grimmers Elec. Parts Sup.
Syracuse L. Gordon Dist. Co.†
Syracuse Radio Supply Co.
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NORTH CAROLINA
Concord Mac Victor Electr. Supply Inc.

(Continued on next page) →

BUILD A HI-FI MUSIC WALL! Don Brann's new book **How to Build a Hi-Fi Music Wall** gives you step-by-step instructions for building a decorator styled cabinet or an entire music wall. Send 50c and your name and address to: PACOTRONICS, INC., Dept. EW-9, 70-31 84th Street, Glendale 27, New York.

frequencies used for FM has always been fraught with problems for the inexperienced. This has all been changed by the generally excellent engineering and design that have gone into many of the more recent FM tuner kits. The "Dynatuner" FM-1, which we have just built and tested, is a good example of this type. Even though not even the r.f. front-end has been pre-assembled, the entire construction required only 5½ hours for this reviewer. A less experienced person would require a little more time, but he certainly should encounter no difficulty at all. Two printed-circuit boards, to which components must be mounted and soldered, simplify the builder's task and make the final performance quite uniform from kit to kit. Even with a full complement of nine tubes (including rectifier and tuning-indicator tube), there is an empty space of 5" x 4" on the chassis for a multiplex adapter.

A special alignment procedure is prescribed which requires no test equipment and uses the tuning eye in place of a d.c. v.t.v.m. for the r.f., i.f., and discriminator alignment. This latter feature makes it possible to tune the discriminator accurately for minimum distortion, directly on a station. To test the validity of this alignment procedure the completed kit was first aligned without instruments according to the manufacturer's instructions and the following test results were obtained:

Usable sensitivity (for −30 db noise and distortion): at 90 mc., 6.5 μv.; at 98 mc., 4.0 μv.; at 106 mc., 5.0 μv.

Detector peak-to-peak separation: 920 kc.

Detector linear portion: 465 kc.

Total harmonic distortion (at 400 cps): 0.3% or less (limit of measurement).

Once these tests were completed, the tuner was re-aligned using precision laboratory test instruments and conventional FM alignment procedures. Repetition of the above measurements showed a slight improvement in sensitivity, mostly because the r.f. section was more precisely tuned, especially at the high and low ends of the band. The discriminator tuning and distortion were the same as before, validating the manufacturer's claim that his alignment procedure permits accurate detector alignment. The slight difference in sensitivity will not be noticeable in most signal areas, since normally signal strengths range from about 20 to 10,000 microvolts per meter in all but the weakest fringe areas.

Usable sensitivity (as above): at 90 mc., 2.5 μv.; at 98 mc., 2.0 μv.; at 106 mc., 2.0 μv.

Over-all i.f. bandwidth: 480 kc.

Detector peak-to-peak separation: 900 kc.

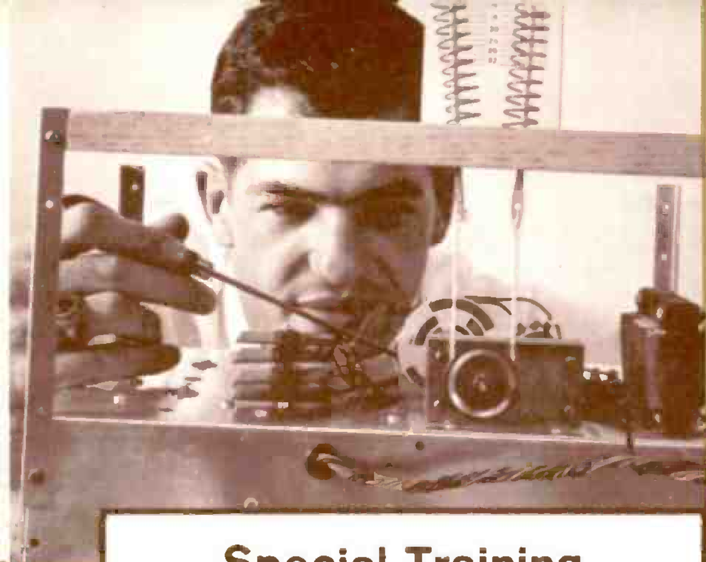
Detector linear portion: 460 kc.

Warm-up drift (after 15 minutes): 65 kc. at 98 mc.

Maximum audio output: 2.2 volts r.m.s.

Audio frequency response: ± 1 db of standard de-emphasis curve from 40

(*Continued on page* 88)



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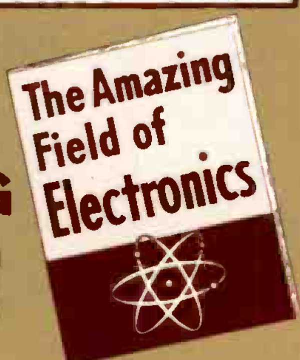

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Training for men who want to operate and maintain radio and TV stations; police, marine, aviation, mobile radio, etc. Includes FM Stereo broadcasting. Course also prepares you for your FCC license exam.

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Learn to service and maintain AM-FM Radios, TV sets, Stereo Hi-Fi, PA systems, etc. A profitable, interesting field for a spare-time or full-time business of your own.

SEE OTHER SIDE

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

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

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

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

FROM FACTORY LABORER TO HIS OWN BUSINESS that rang up sales of $158,000 in one year. That's the success William F. Kline of Cincinnati, Ohio, has had since taking NRI training. "The course got me started on the road," he says.

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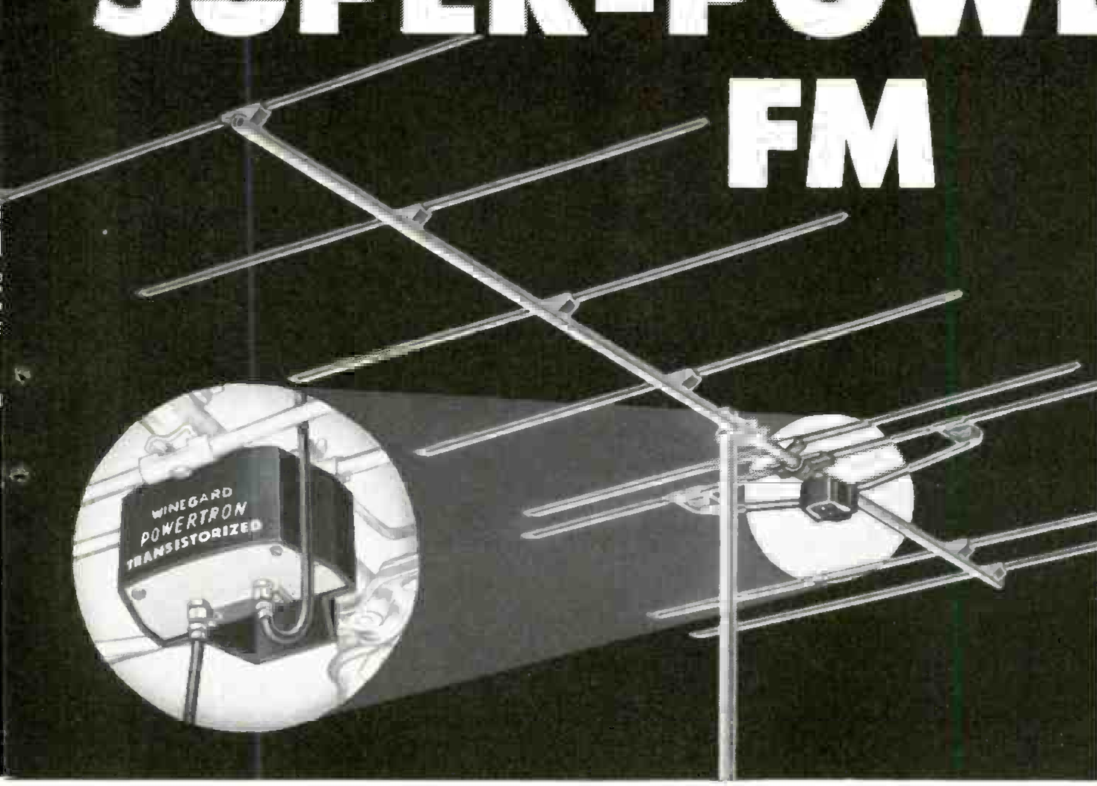


MODEL PF-8 FM STEREO-TRON YAGI — GOLD ANODIZED

This is the world's most powerful FM antenna. Because Multiplex requires an antenna with greater sensitivity and gain to offset the power loss of the carrier and subcarrier, Winegard's PF-8 is the best antenna you can install for Multiplex. When you hook up a PF-8, weak signals come in like "locals".

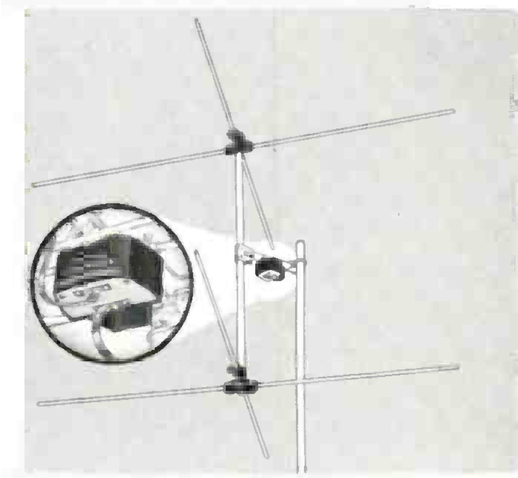
The PF-8 has a minimum gain of 26 DB over a folded dipole with a flat frequency response of ± ¼ DB from 88 to 108 m.c. It features a built-in TV-FM coupler and has eight elements with EXCLUSIVE "TAPERED T" driven element engineered perfectly to match the powerful transistorized, direct coupled, *built-in* amplifier. It is *available two ways* — Model PF-8 for 300 ohm twin lead or Model PF-8C for 75 ohm coax.

2 NEW TRANSISTORIZED WINEGARD ELECTRONIC FM ANTENNAS FOR LONG DISTANCE FM AND MULTIPLEX

Now WINEGARD brings you super-powerful FM antennas with *BUILT-IN* transistorized amplifiers for L-O-N-G range FM and multiplex reception. You can offer your customers the PF-8 FM STEREO-TRON Yagi (directional) or the PF-4 FM ELECTRONIC Turnstile (omni-directional). Both models deliver unexcelled performance far beyond ordinary FM antennas—open a new field of opportunity in the fast growing FM and Multiplex market.

Here Are Some Important Features of Winegard Electronic FM Antennas

1. Transistorized amplifier is designed as *part of* the "Tapered T" driven element (model PF-8) for unprecedented efficiency and signal-to-noise ratio.
2. Built-In FM-TV coupler allows you to use one power supply and down lead when used with a WINEGARD POWERTRON TV antenna.
3. Gold anodized finish—100% corrosion-proofed—all hardware irridized. This is the finest finish of any antenna—meets U.S. Navy specifications.
4. The quality of craftsmanship and materials in these antennas tell their own story—perfect mechanical balance—100 m.p.h. wind tested.



MODEL PF-4 FM ELECTRONIC TURNSTILE — GOLD ANODIZED

Most powerful non-directional FM antenna with 16 DB gain in all directions over a folded dipole. Has Winegard offset mount and transistorized amplifier with TV-FM coupler. Model PF-4 has 300 ohm output.

MODEL FM-8—Non-Electronic Yagi — Gold Anodized. The FM-8 is the finest non-electronic FM antenna available. It features the same Winegard "Tapered T" driven element and construction as our super-powerful PF-8.

MODEL FM-3T — Non-Electronic FM Turnstile — Gold Anodized. Very popular WINEGARD omni-directional FM antenna. Has WINEGARD'S offset mount and is gold anodized. Easy to install — can be mounted on same mast as TV antenna.

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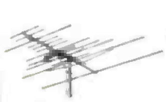
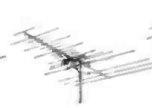
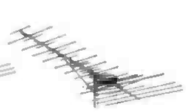
Watch Winegard go in '61 National Consumer Advertising this Fall in LIFE, LOOK, SUCCESSFUL FARMING, FIELD AND STREAM, SUNSET.



POWERTRON MODEL P-55 14 Elements



POWERTRON MODEL P-55X 21 Elements



SUPER POWERTRON MODEL SP-55X 30 Elements

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ELECTRONICS

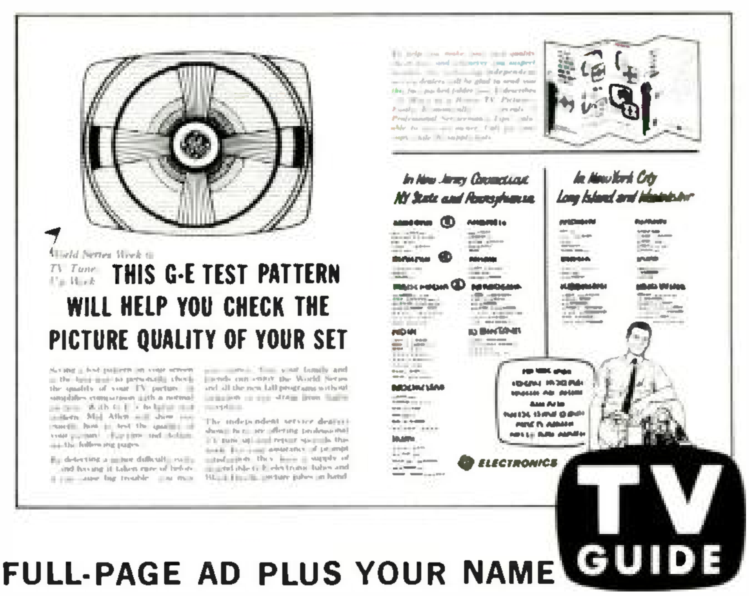
WORLD SERIES WEEK

G. E. in Cooperation with Independent TV Servicemen Launches Unique National Campaign— Sells Immediate Need for Your Service to Millions of Set Owners.

Never before a sales-building campaign like this—combining the power, coverage and prestige of World Series television with the flexibility of actual business-building emphasis *to your customers in your own local area.* It is aimed at those set owners—your customers—who put up with sub-standard TV performance. *This is your campaign.* It sells the immediate need for your professional service right when demand hits its peak—World Series Time!

Plan now to tie-in with TV TUNE-UP WEEK. It's easy, effective—no red tape. Get full details from your General Electric tube distributor. HE MUST RECEIVE NAMES OF PARTICIPATING DEALERS BY SEPTEMBER 8. General Electric Company, Distributor Sales, Electronic Components Division, Room 7244A, Owensboro, Kentucky.

Complete sales package helps you cash in on TV TUNE-UP WEEK

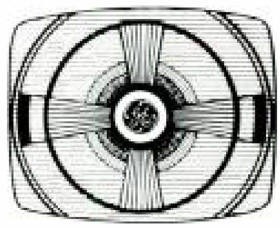


FULL-PAGE AD PLUS YOUR NAME IN SEPTEMBER 30 ISSUE OF TV GUIDE

This hard-hitting message launches TV TUNE-UP WEEK to 8 million television families . . . alerts your customers to the World Series TV Tune-Up commercial and sells your professional repair and maintenance service. Your name-and-address listing here ties you in directly—in your local edition of TV Guide—with this nationwide campaign.

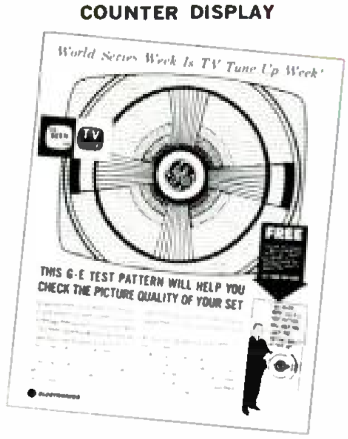
Here's a TV first! Commercials on your local station that feature an actual test pattern with which your customers can check the picture quality of their sets. You, the independent serviceman, are tied in directly through your listing in TV Guide.

IS TV TUNE-UP WEEK!



MOBILE WALL BANNER DISPLAY

COUNTER DISPLAY



AD MATS

SET REPAIR STICKERS

MAILERS

BUILDS BUSINESS FOR YOU 3 WAYS

1. TV Tune-Up Week builds an awareness of picture-quality deterioration—helps your customers prove to themselves the need for TV check-ups and preventive maintenance by you, their independent TV serviceman.

2. You, the independent service dealer, are the hero of TV TUNE-UP WEEK. On World Series television and in your regional edition of TV Guide, *your customers are urged to see you for prompt, professional service.*

3. As a participating dealer, you benefit from this national campaign at the local level *—in your city, in your neighborhood, with your customers.*

Progress Is Our Most Important Product

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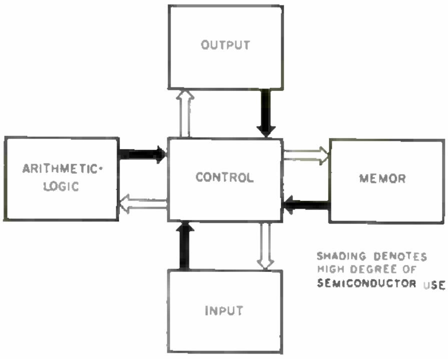


Fig. 1. Basic computer sections showing those that may employ many semiconductors.

WHETHER or not computers "think" is a moot question. Regardless, they are with us in ever-increasing number, and our lives will be influenced more and more by these electronic brains. One major reason for this ubiquitousness is the amazing transistor and its semiconductor "cousin," the diode. Scarcely 10 years old, these devices have successfully revolutionized many an industry, including that of computers.

Computer designers have pushed the state of the art to the point where a machine with the logical capability of the brain is at least in the talking stage. So complex is such circuitry that using vacuum tubes and conventional methods of early computers would result in an electronic monster the size of the Pentagon, and requiring Niagara Falls for electricity and cooling. Semiconductor devices, happily, were tiny to begin with and by "thinking small," designers have shrunk them to a size where a major handling problem is their virtual invisibility. This results in component densities of millions per cubic foot (in theory), with computers already on the market using as many as 10,000 transistors. This fact augurs well for a continued increase in semiconductor sales. With computers a billion-dollar market, semiconductors are million-dollar babies for sure.

Advantages of Semiconductors

Heat is a problem in computers, both as waste energy and as it affects performance. Many computer circuits are normally "on" rather than off, so the low heat generation of semiconductor devices is a desirable feature.

The more complex a device, the more important is the reliability of each of its parts. This fact is obvious, but an example is needed to bring out its implications. Using five hundred 99% reliable devices in series, a computer would have an over-all reliability of only about 1%! Thus reliability is more than just desirable, it becomes a necessity. Present transistors and diodes have reliability levels as high as 99.999%, and can thus provide a fairly high level of over-all reliability in associated equipment.

Because it lends itself well to "throw-away" modules, the semiconductor device also affords fast, economical repair and replacement.

Having established the reasons for

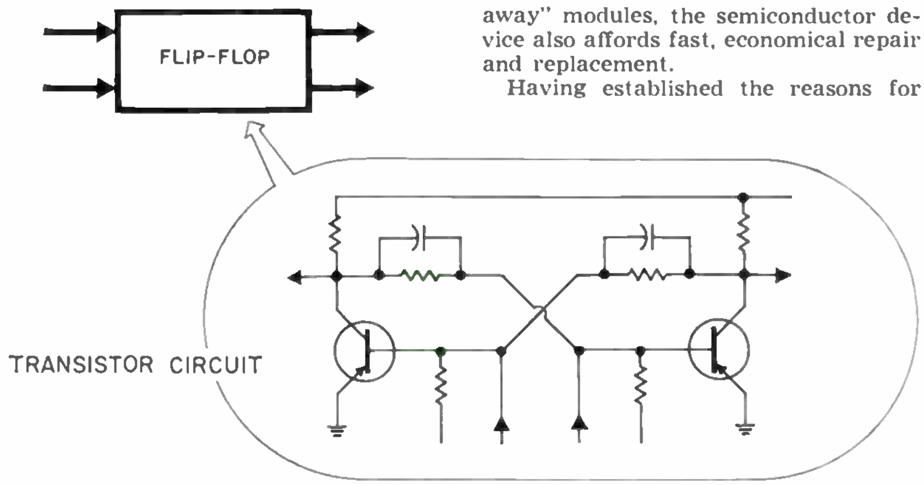


Fig. 2. A transistorized version of the important computer flip-flop multivibrator.

A second powerful argument for the transistor and diode is their inherent reliability. While life tests to date indicate about 8-year reliability, this is only because the devices have been tested for only that length of time. In theory, the transistor will not wear out —ever—short of being melted by heat, damaged by radiation, or struck forcefully with a hammer.

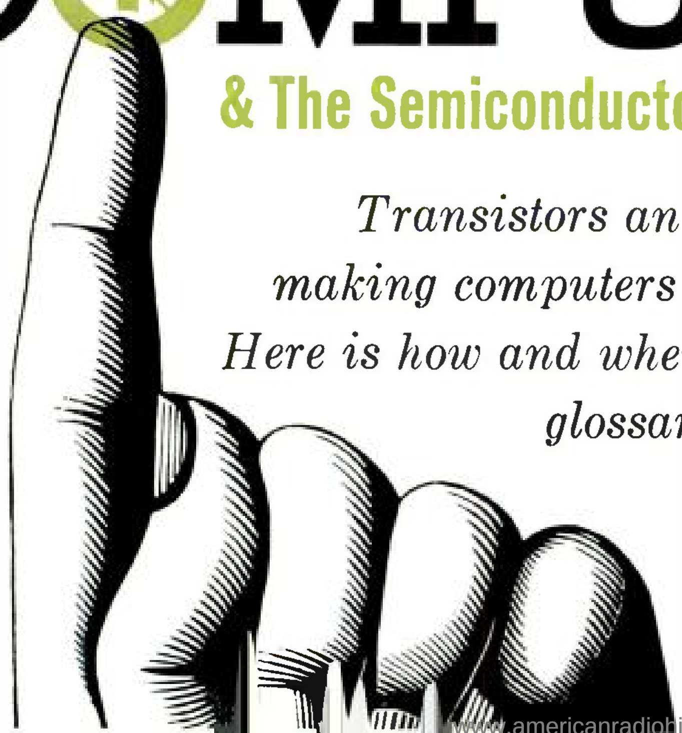
transistors being used in computers, let's see just where they are used, and what they do.

Computers are either analogue or digital, or a hybrid combination. The analogue type is actually a simulator, or scale model; the digital type can be more accurately described as a computer. Computers in general are composed of four parts, (1) an input-

COMPUTERS

& The Semiconductors That Make Them Count

Transistors and semiconductor diodes are making computers smaller and more efficient. Here is how and where they are used. Computer glossary for the technician is included.



By D. S. HALACY
Motorola Semiconductor Products Inc.

output, (2) a control unit, (3) an arithmetic unit, and (4) a memory. For the most part, we will find our semiconductors in (2), (3), and (4), as parts of flip-flops, "and," "or," "nor" gates, shift registers, Schmitt triggers, and so on. (See Fig. 1.)

Input and output functions are simple, in principle at least. Information is fed to the computer as a punched card, tape, film, electrical impulse, etc. At the output end, the results of computation are presented in a form intelligible to man.

The control unit puts the "program" into effect, seeing to it that the arithmetic and memory units do what they are supposed to do.

In the arithmetic unit, pulses are counted, added, multiplied, squared, or otherwise manipulated toward the desired result. While the digital computer is only a finger-counting machine, it is a very sophisticated one, with many rapidly moving fingers.

Just as we carry figures in our heads when working a problem, so the computer has a "memory" and stores information to be used as needed. Again, our basic flip-flop multivibrator circuit can perform this storage task; however, many complex memories are now ferrimagnetic devices driven by transistors.

The digital computer is basically a wired collection of "on-off" switches with the ability to add 1 and 1, rapidly. It is a well-known fact that the transistor is a nearly perfect switch, in which a tiny amount of control current can pass or stop a larger flow. By means of binary counting systems, these transistor "switches" can handle astronomical figures, performing all sorts of mathematical gymnastics involving addition, subtraction, multiplication, division, roots, and powers.

Semiconductor diodes of course take the place of vacuum tubes as rectifiers, reference units, regulators and so on, and complete computer circuits can be made using only diodes. Generally, computers incorporate both transistors and diodes, together with resistors, capacitors, magnetic cores, and so on. In many cases the semiconductor devices are smaller than these associated components.

Since the digital computer depends upon "on-off" devices, or more exactly, 1-0 devices, it is understandable that the basic component is the old reliable "flip-flop." Adapted from the early Eccles-Jordan vacuum-tube circuit, the flip-flop is a bi-stable switch that finds many computer applications (Fig. 2). The components of this circuit may be diodes, transistors, or a combination of both. Flip-flops are used throughout the computer for counting, frequency divi-

SOME IMPORTANT COMPUTER TERMS

Access Time — Time required for computer to locate data and transfer it from one computer element to another.

Adder — Device for forming sums in computer.

Address — Specific location of information in computer memory.

Analogue Computer — A physical or electrical simulator which produces an analogy of the mathematical problem to be solved.

Arithmetic Unit — Unit that performs arithmetical and logical operations.

Binary Code — Representation of numbers or other information using only 1 and 0 to take advantage of open and closed circuits.

Bit — Binary digit, either 1 or 0. Used to make binary numbers.

Block — Group of words handled as a unit, particularly with reference to input and output.

Carry — Signal resulting when sum of digits exceeds system base; also, the digit to be added to next column or the process of adding it.

Clear — Restore or reset, usually to zero.

Clock Rate — The speed of transfer of bits or words from one computer element to another.

Control Unit — Portion of computer that controls arithmetic and logical operations and transfer of information.

Delay Line — Memory device to store and later re-insert information; uses physical, mechanical, or electrical techniques.

Digital Computer — A computer that uses discrete numbers to represent information.

Flip-Flop — A circuit or device which remains in either of two states until the application of a signal.

Gate — A circuit with more than one input, and an output dependent on these inputs. An "and" gate's output is energized only when all inputs are energized. An "or" gate's output is energized only when one or more inputs are energized. There are also "not-and" gates, "exclusive or" gates, etc.

Logical Operation — A non-arithmetical operation. Decision making, data sorting, searching, etc. are included in this category.

Magnetic Drum — Rotating cylinder storage device for memory unit; stores data in coded form.

Matrix — Circuitry for transformation of digital codes from one type to another; uses wires, diodes, relays, etc.

Memory Unit — That part of the computer that stores information in machine language, using electrical or magnetic techniques.

Parallel Operation — Digital computer operation in which all digits are handled simultaneously.

Random Access — A memory system that permits more nearly equal access time to all memory locations than does a non-random system. Magnetic-core memory is a random type, compared with a tape-reel memory.

Register — Storage device for small amount of information while, or until, it is needed.

Serial Operation — Digital computer operation in which all digits are handled serially.

Storage — Use of drums, tapes, cards, and so on to store data outside the computer proper.

COVER STORY

FOR THE FIRST TIME in the history of airborne military electronics a digital computer is being used as the active, real-time element for navigation, guidance, and control of unmanned aerial vehicles. Shown on the cover is the feasibility test version of the computer, which is fully transistorized and utilizes high reliability type printed wiring board modules. In final operational form the unit will occupy only half the volume shown. The computer is a key component in the Navigation and Control System which Motorola designed, developed and is now testing for the U.S. Army Signal Research and Development Agency. Computer functions include coordinate conversion, continuous and optimum data combination from multiple sources, range correction and flight path control.

The computer is a general purpose, two-address, serial, binary data type, utilizing a 12,000-rpm memory drum with a 2048 word capacity (21 bits per word). Clock speed in the order of 260 kc. permits 78-microsecond multiplication.

The computer makes a significant contribution toward providing a capability with an inherent operational accuracy significantly greater than any present system for the same mission. This accuracy is achieved by a hybrid guidance system providing two principal outputs: Present position data furnished to the surveillance system aboard the aerial vehicle; steering signals furnished to the airframe autopilot. This accuracy allows surveillance data acquired during flight to be used for target positioning. There are no limitations to the number of aerial vehicles that may be operational at any given time.

The ground system includes three transmitters that generate the ground radio reference grid used for aerial vehicle control. The airborne system includes the digital computer shown on the cover, three receivers, a vehicle-contained velocity data source, and auxiliary sensory devices which are combined to give navigational control. System error is minimized by the optimum data combination technique which combines sensor outputs in the computer and provides an accuracy far superior to that of any individual sensor.

All research, development, and feasibility testing of the airborne digital computer is being done in the Data Systems Laboratory of Motorola's Military Electronics Division in Scottsdale, Arizona. ▲

(Photo: Courtesy Motorola Military Electronics Division)

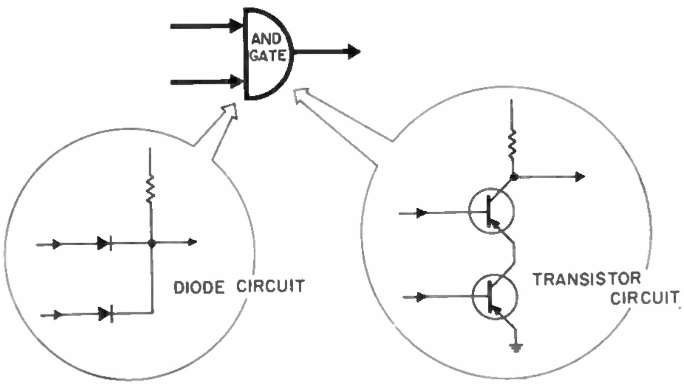


Fig. 3. Sample semiconductors circuits utilized as "and" gates.

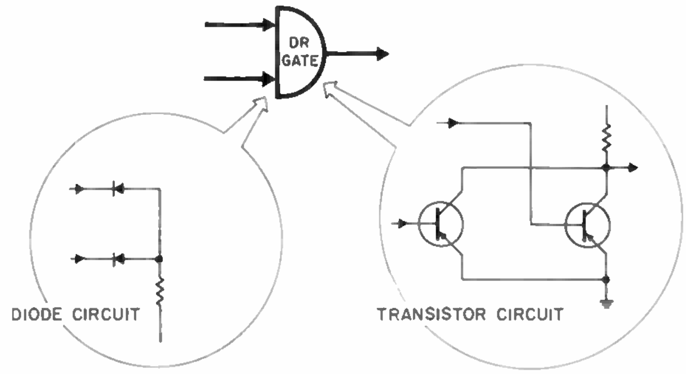


Fig. 4. The "or" gate circuit in its semiconductor arrangement.

sion, storage, and for time selection.

In addition to flip-flops, a computer uses amplifiers, oscillators, multivibrators, triggers, inverters, buffers, and the like. These, in turn, form circuits including shift registers, adders and half-adders, and delay lines. Although many memory devices now use magnetic cores for information storage, these cores need transistor drivers to set them and so the transistor finds wide use in this section as well.

To bear out the conclusion that the transistor is the "logical" choice, there is a complete computer philosophy labeled "transistor logic." This embraces the usual "and" gates and "or" gates, and extends to "nor" gates, which have no vacuum-tube counterparts. (See Figs. 3, 4, and 5.) Also, since the transistor is available in both *p-n-p* and *n-p-n* configurations, it permits greater flexibility, as for example in complementary circuitry.

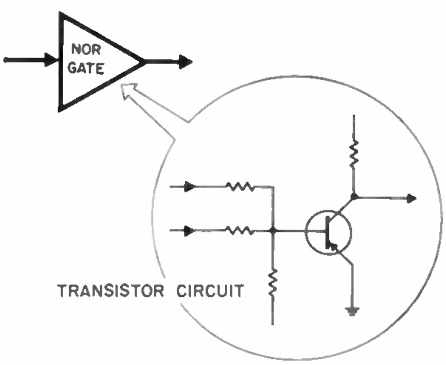


Fig. 5. Transistorized "nor" gate circuit.

Because the computer is just a binary adding machine, the most important semiconductor characteristic, beyond the ability to handle required current and voltage, is obviously speed. Computer diodes and transistors must be capable of switching in a matter of a few "nanoseconds." One nanosecond is 0.000000001 of a second, the time it takes light to travel about 1 foot!

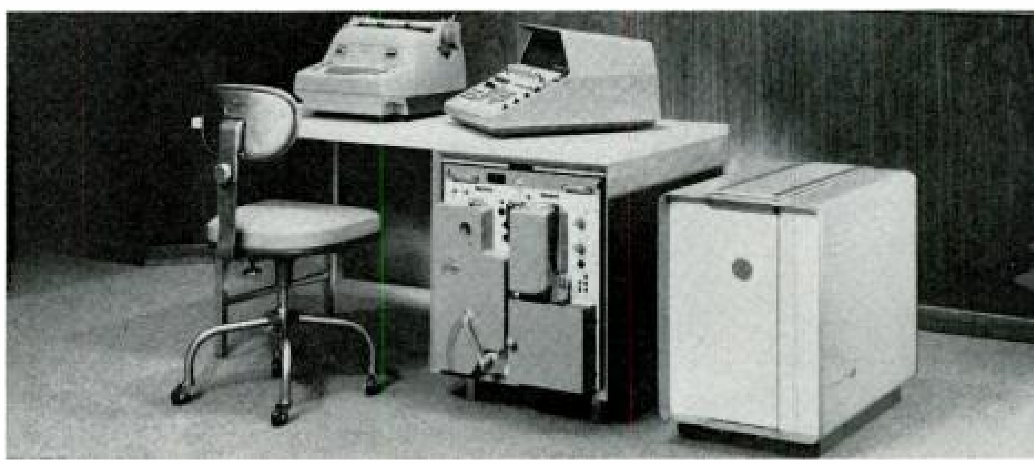
Germanium transistors are suitable for all computer applications except those requiring operation at high ambient temperatures; for example, in some military applications like missiles. In these cases, silicon devices may be desirable.

The Coming Generation

It is certain that computers will increase in number and complexity. Strong factors pointing in this direction are improved techniques for making better transistors, including the epitaxial process that has already been adapted to the manufacturing of mesa transistors. In addition, the price of transistors is dropping to make them economically feasible in applications other than defense and space research projects. Standardization and high-volume production will result in prices of transistors approaching those of vacuum tubes.

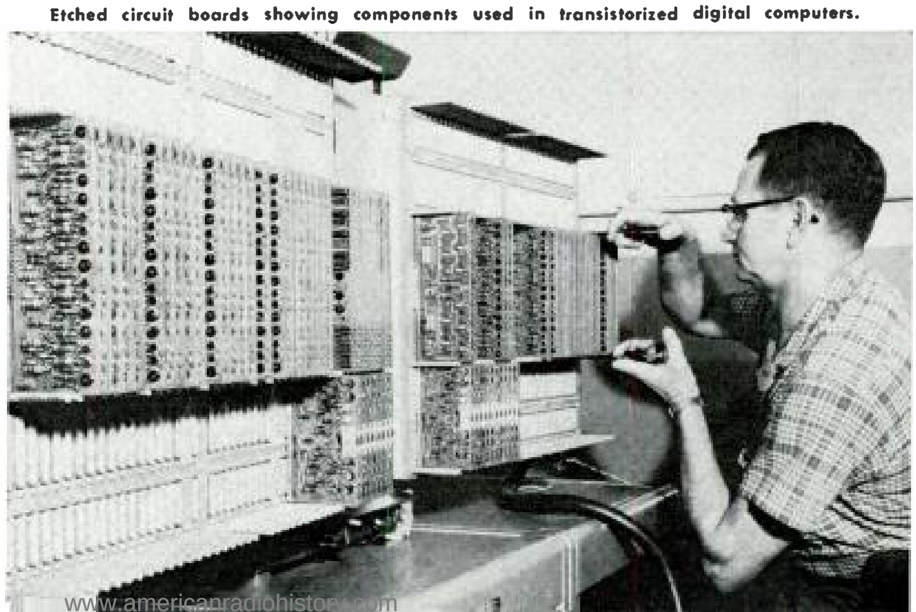
Also sure is the fact that in spite of this increasing complexity the physical size of the computer will undergo further shrinkage. Integrated circuitry, the ultra-miniaturization of components and circuits, has already produced multivibrators, "nor" gates, flip-flops, shift registers, and the like in a tiny fraction of the volume of conventional transistorized components. A current military project is a complete computer in a package 4 inches square and 1 inch thick. "Blue-sky designs" approach a packaging density comparable to that of our own brains.

We can look forward, then, to an even more "computerized" world, with the devices running our defenses, our industry, invading our homes and schools. And helping run the computers will be transistors and diodes, the semiconductor devices which seem to have come along at just about the right time to advance the state of the art. ▲



Semiconductors make possible computers like this compact Autonetics "Recomp" model.

Etched circuit boards showing components used in transistorized digital computers.



By JAMES T. MENDEL

From TV Service to

Is an experienced and capable TV service technician better off where he is, or should he try for a career in some other area of electronics?

EDITOR'S INTRODUCTION: We deal here with a question that is very much in the minds of very many technicians engaged in servicing consumer electronic equipment, whether they have their own shops or work for others. As did the author, they wonder whether they have not reached a dead end. "Is the grass really greener elsewhere? If it is, can I make the switch successfully? Do I have the right kind of background? Are prospective employers just waiting for me, or will I have to sell myself? How will my work differ? How far can I go? Will there be more pressure or less? All in all, will I be better off or worse?"

The author, who admits to strong prejudices in favor of the change, presents only one side of the argument: a former shop owner, he has fared well in industrial electronics. Yet we know of others in like situations who have refused to make the switch, even in the face of tempting offers. Some of them are eminently well qualified in the broad sense, to the extent that they do not bring into play all of their capabilities in service work. Nevertheless, they believe that they are better off where they are.

How do *you* feel about this matter? Stalwarts of the service industry, does James Mendel's viewpoint go against the grain? Is what you have, now and potentially, too important to be dismissed with the wave of a hand? Let us hear from you. In fact, let us hear from you whichever side of the argument you take.

MENTION the term "Industrial Electronics Technician" to the average television serviceman and he instantly visualizes bright, young, college-trained men working at giant computers, with slide rules and radio engineering handbooks never more than an arm's length away. This seems to be a common misconception held by those in consumer electronics about the "glamorous," highly technical field of industrial electronics. While confident of mastery in his own field, the TV man has serious doubts of his ability to break into the elite ranks of the industrial electronics technician.

Speaking as a former TV service technician who did make the big switch, I say, "You TV men who long for a change, hear this! If you can sit at a bench day in and day out, and manage somehow to fix all those dogs (well, almost all) that pass through your shop, then you're in!"

Hold on for just a few minutes while I qualify myself with a little personal history. My electronic background consists of eleven years (1948 through 1959) in the TV servicing business, with a little technical training before 1948. Ability? About average. (I used to think above average, but don't we all?)

I operated my own shop for most of those eleven years but, for the last two or three, I had become more and more discontented with my lot. True, it gave me a fairly decent income and a respected standing in my community, but there was no challenge in the work any more. More and more of the jobs could be repaired without any real thought or concentration. I was getting to the point of not even bothering to learn the inner workings of the never-ending string of new circuits. After all, a few minutes of analyzing the available information would eliminate from consideration over four-fifths of the circuitry of most TV sets. Then voltage checks, resistance checks, and sometimes waveform analysis would pinpoint the trouble. Why bother to really learn the circuitry? It wasn't actually necessary in most cases. Sound familiar?

Then, in 1959, by a fortunate circumstance, I was given an opportunity to make the change to industrial electronics, if I desired. Realizing that my ability was concentrated in a narrow, highly specialized slot in the electronics spectrum, I hesitatingly decided to try the switch.

My wavering resolve wasn't helped any by the reaction of the first few personnel directors I met. I could see their pleasant smiles dim as they found that my experience was limited to radio and television servicing. In fact, one company wouldn't even permit me to take its technical ability test after noting my background! Nevertheless, this attitude is neither universal nor insurmountable. Obviously, I did get a job.

Where You Will Stand

Now the comparison. How will you stack up against those highly trained industrial electronics technicians? Well,

Industrial Electronics

to be honest, you will be completely outclassed by a few. In the main, however, you will find that you will soon be asked for advice as often as you ask for it. Your co-workers may shade you at first in some of the finer points of circuit theory, but your service experience, your "troubleshooting intuition" if you please, will stand you in good stead. And here is my main contention. You know much more than you think you know about this kind of electronics! With a little real effort, you will be able to bring back and enlarge upon all that knowledge that you at one time or another acquired but seldom used. The challenge is there again! And you will thrive on it!

You will find yourself working with an entirely new breed of quality test equipment, using new techniques, and obtaining first-hand that information which heretofore had only been half-understood terminology in some performance specification. Engineers will be available to answer your technical questions. In short, your opportunity for learning will be tremendously expanded. Personally, I think I have learned almost as much in my two years working as an electronics technician as I had in all my years of TV servicing.

Important Differences

There are other pleasant differences that you will quickly notice. Most important, that abiding pressure is gone. Or at least it is greatly reduced. This isn't to say that there is no pressure on you when a vital operation is halted by failure of an instrument for which you have the responsibility of restoring operation. The difference is that this pressure is reasonable. You are not expected to do the impossible. All that is asked is that you give your best. You shop owners will most appreciate this dissimilarity.

No longer will you have to try to explain to a non-technical customer the reason his TV set with the intermittent horizontal sync is not yet ready. No longer will you be called at 11:30 p.m. or 6:30 a.m. to make an "emergency" repair (at regular rates only, of course). And no longer will you have to explain, again and again, why you have to charge four dollars to repair an eleven-ninety-five radio. Conversely, your immediate supervisor in your new job will most likely be a senior technician or engineer who is thoroughly familiar with the cantankerous, unpredictable nature of electronic problems.

Since we are comparing, let's not neglect the obvious. You will now be in an industry in which paid vacations, paid holidays, paid sick leave, paid insurance, coffee breaks, and time and one-half pay are the rule rather than the exception.

If the tone of this article up to now has indicated that I am biased, let me assure you that I most certainly am. I would be less than fair, though, if I did not show a bit of the other side of the coin. With your background of only radio-television servicing, you will have to prove yourself. For in industrial electronics the accent is less on hurrying the job through and more on doing it right, with a strong emphasis on *right*.

You will also most likely have to take a small cut in pay as a price for breaking into the industry. However, within a year you should be earning as much as you were earning in TV work, and doing it in fewer hours.

How Others Have Fared

Lest you think that I am alone in my views on the opportunities for TV technicians in industry, let me bring in a little more personal history. My employer, *Endevco Corp.*, one of the industry's highly regarded accelerometer manufacturers, now has among its personnel four former radio-television service technicians. Terms of employment range from one to three and one-half years. All four came here directly out of consumer electronics. One now holds the position of assistant supervisor; one is a leadman; another is a class A technician; and I, the fourth, am an instrument technician. All four of us share identical feelings about industrial electronics as compared to the TV business. To be blunt, a comparison is ridiculous. Industrial electronics is far and away a better field.

If you are happy in your work in consumer electronics, this article has been a waste of your time. But if you have ever paused, as I had, and asked yourself, "Is this what I want to be doing ten or twenty years from now?" you really owe it to yourself to take that long weekend, or those last few days of your vacation, and check into this missile-age brand of electronics. Reserve for yourself that title, "Industrial Electronics Technician." ▲

If he should attempt the switch, will he have what it takes to make the grade? Here is one side of the argument by a former shop owner.

Transistor Frequency Standard

By DONALD L. STONER, W6TNS and LESTER A. EARNSHAW, ZL1AAX

Design of a one-transistor calibrator that generates 100-kc. marks at frequencies up through 30 megacycles.

A NUMBER of publications have described several transistor communications receivers but none, to date, has included a frequency standard for spotting band edges—or if they have the authors have missed such an article. Actually, the design of a device to generate 100-kc. interval marks up to 30 mc. presents some pretty knotty design problems.

One principal reason is that a transistor oscillator has far less output than its tube counterpart. Harmonics from a tube standard can be considerably attenuated and still be audible on 10 meters.

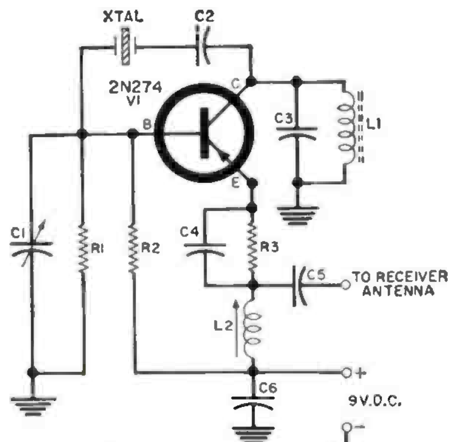
Harmonics from a transistor 100-kc. oscillator are heard with difficulty, if at all, on the 10-meter band. Consider that 28 mc. is the 280th harmonic of the fundamental and a crystal oscillator is not normally high in harmonic output. To increase the harmonic content, it becomes necessary to distort the oscillator waveshape in one way or another and then, with the aid of a suitable circuit, accentuate the harmonics that are desired.

Theory of Operation

The frequency standard shown in Fig. 1 is just such a circuit. It may be redrawn as shown in Fig. 2A. Reduced to this form it will be immediately apparent that the circuit is nothing more than a transistor version of the simple Colpitts. Capacitor C_1 (in Fig. 2A) is made up of both the variable padder and the base-emitter junction capacity. The latter may be quite high—as much as 1000 μμf.—with some transistors. Capacitor C_2 in Fig. 2A includes the collector-to-ground capacitance of the transistor. These two capacities form a divider across the crystal. The small capacitor in series with the crystal effectively reduces shunt capacity which would otherwise tune the crystal to a frequency somewhat lower than 100 kc.

Distortion of the envelope is created by the non-linear transfer characteristics of the transistor and harmonics are thereby produced.

Coil L_2, in connection with the emitter capacity of the transistor, forms a tuned circuit which is resonated to the center of the 80-meter band. Thus harmonics between 3.5 and 30 mc. are emphasized and output, even on 10 meters, is more than adequate.



R_1—39,000 ohm, ½ w. res.
R_2—10,000 ohm, ½ w. res.
R_3—1000 ohm, ½ w. res.
C_1—60-600 μμf. BC padder ("Zero-Beat Adj.")
C_2—47 μμf. mica capacitor
C_3—500 μμf. paper capacitor
C_4—.02 μf. disc ceramic capacitor
C_5—5.6 μμf. ceramic capacitor
C_6—.02 μf. paper capacitor
L_1—10 mhy. choke, see text
L_2—90 t. #36 en. scramble wound on ⅜" slug-tuned form
Xtal.—100 kc. crystal
V_1—"p-n-p" transistor (2N274)

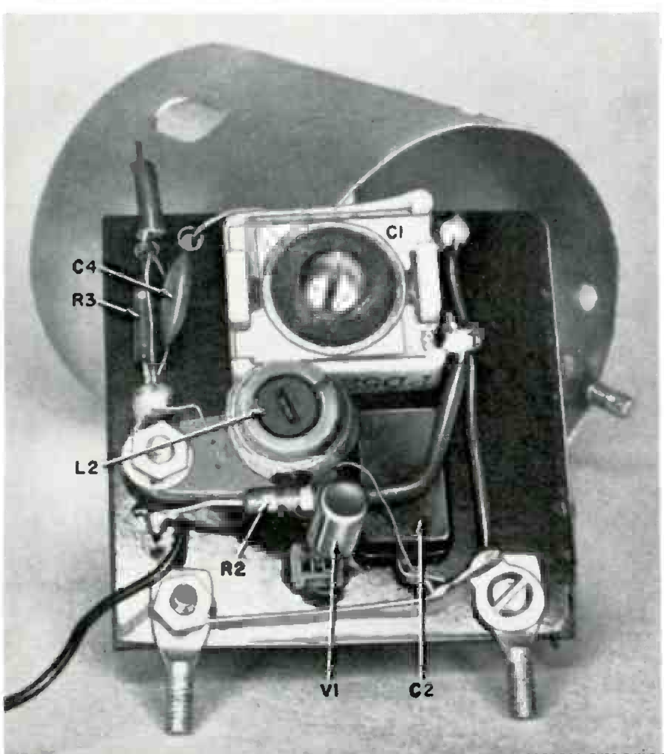
Fig. 1. Circuit diagram of the standard.

Construction

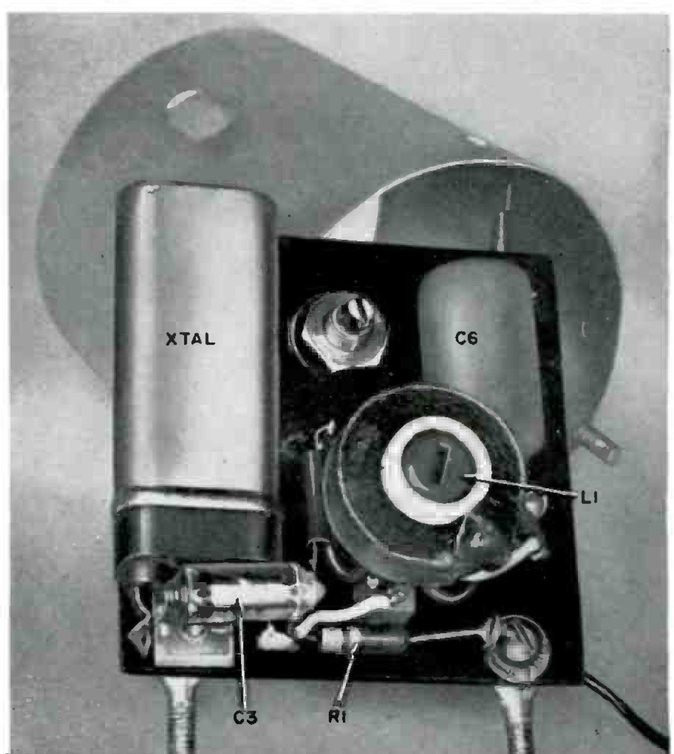
There is nothing difficult about the construction of the frequency standard. A small piece of phenolic board makes an excellent chassis as can be seen in the photographs. The suggested construction size is 2" x 2". To prevent radiation of unwanted harmonics between 100 kc. and 3.5 mc., the entire unit may be placed in a discarded coil can of the type popular in broadcast receivers many years ago.

(*Continued on page* 93)

Circuit is mounted in coil shield can shown in the background.



The crystal side of the Micarta circuit board used by authors.



universal time-constant chart

AN ITEM of information frequently required by the service technician or ham is the exact charge on a capacitor at a specified time after closing or opening a circuit.

If the specified time happens to be precisely one time-constant of the circuit in question, the answer is simple: if the capacitor is charging, it will have reached 63.2 per-cent of the source voltage; if it is discharging, it will have dropped to 36.8 per-cent of its original value.

But what if the time specified (in seconds) is *not* equal to circuit resistance (in ohms) times capacitance (in farads)? What then?

The accompanying nomogram is designed to answer this question. By aligning a straightedge with any two of the three variables, the third value can be read directly.

To make the chart applicable to any problem, voltage values have been "normalized" to the range from 1 to 10. Any voltage value can be converted to this range by appropriate division; if both voltage values are divided by the same factor, the time scale will not be affected.

Time is expressed in time-constants. In a resistance-capacitance circuit, one time-constant (in seconds) is equal to the product of resistance (in ohms) and capacitance (in farads). The time-constant will also be in seconds if resistance is measured in megohms and capacitance in microfarads. With resistance in ohms and capacitance in microfarads, time will be in microseconds.

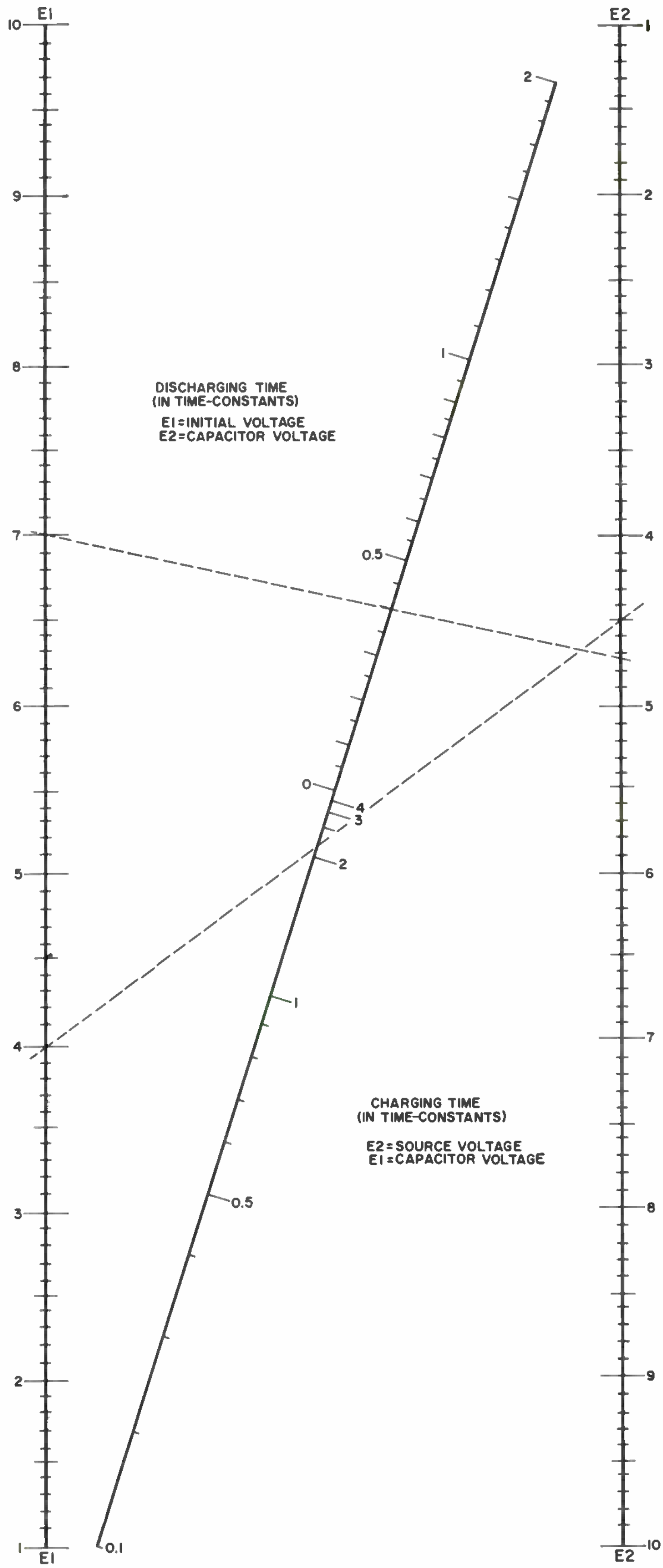
Using the Chart

To use the chart, first calculate the time-constant of your circuit. Then divide this time-constant into the specified time to determine the number of time-constants involved. This figure is the one

(*Continued on page* 106)

By **JIM KYLE**

Useful nomogram for the technician, experimenter, or the ham who works with resistor-capacitor circuits.



IMPEDANCE MATCHING IN PUBLIC-ADDRESS SYSTEMS

Part 1. Low-Z Loudspeaker Lines

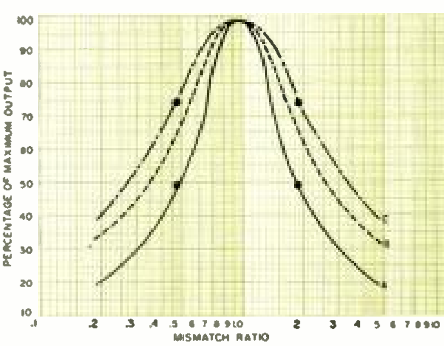
By **MORTIMER S. SUMBERG,** Director of Sales
Bogen-Presto Div., The Siegler Corp.

Practical help for the sound installer and the audio technician in connecting p.a. amplifiers to speakers.

OUR AUTHOR is well known in the commercial sound field as a merchandiser, lecturer, and writer. His electronics experience is broad, including: active radio amateur (W2OYO) for almost 20 years, sales engineer, and instructor during World War II in the Navy's Radio and Materiel School, Naval Research Laboratory, Washington, D.C. He travels approximately 50,000 miles a year in the course of selling audio components to sound specialists and electronic parts distributors. He is a firm adherent of the philosophy that sound-system technical information should be presented in easily understood language.

THE use of sound systems in virtually every type of construction has shown a tremendous increase in the past decade. Unquestionably the major problems in the design and installation of these systems concern selection of components and their proper placement. Excellent descriptive literature provided by amplifier, microphone, and loudspeaker manufacturers has assisted the sound-systems installer, in most instances, to make a reasonably competent selection of components and to install them for effective coverage.

Fig. 1. Extent of power loss due to mismatch.



LOAD IMPEDANCE (in ohms)	PLATE CURRENT OF OUTPUT TUBES (ma.)	MISMATCH RATIO
335	95	2:1 upward
167	128*	—
83	168	2:1 downward

The 167-ohm output impedance is mismatched by 2:1 to speaker load. Tubes are pentodes; design provides low regulation.
*Maximum rating.

With experience—and there is no substitute for this asset—the sound installer has come to anticipate many common problems, *e.g.*, feedback and reverberation, and to provide for their solution. But, in one important area, the average sound technician continues to fare poorly. This concerns itself with the details of connecting the amplifier to the loudspeaker(s).

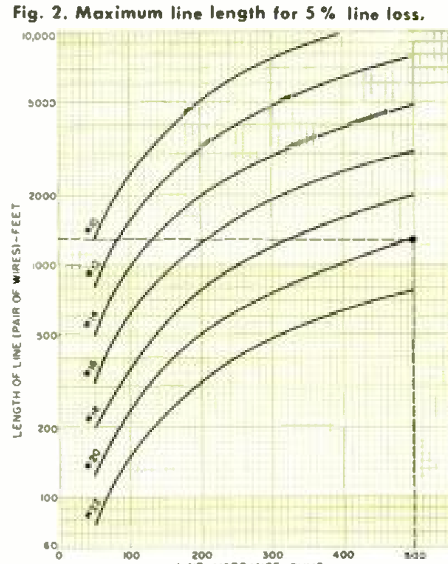
In the installation of every sound system, consideration must be given to the manner in which audio power will be delivered from the amplifier to one or more loudspeakers, with a minimum power loss and minimum distortion. The problem is relatively simple if only one loudspeaker is to be installed at a short distance from the amplifier. In multiple speaker systems requiring distribution of unequal amounts of power over long speaker lines, however, several conditions must be satisfied. Before this can be done, the sound installer has to understand clearly the factors which are involved. The term "impedance matching" is commonly used to refer to the several aspects of the problem. Although amplifier and loudspeaker manufacturers have circulated much educational material in recent years, it is surprising to note that a large number of sound systems operate in an unsatisfactory manner primarily because of improper impedance matching.

In this and succeeding articles, we will consider typical problems and practical solutions; a careful study of each problem and the proper impedance matching method illustrated should enable the sound-system installer to cope with any situation which is likely to arise in laying out a sound system.

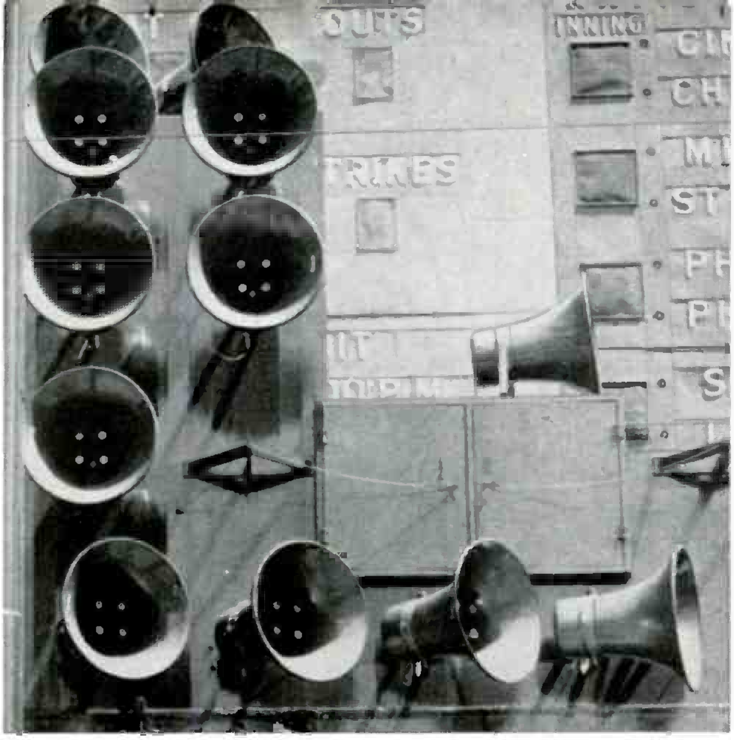
Need for Impedance Matching

At the output of an amplifier the manufacturer usually provides a multi-screw terminal strip for attaching the transmission line, which will interconnect the amplifier and one or more loudspeakers. Each screw on the output terminal strip is marked to indicate the value of load impedance which the amplifier manufacturer wants connected at this point. This impedance value is carefully selected to give the maximum power output from the amplifier at the rated total harmonic distortion. Fig. 3 shows typical output impedance values. The terminal marked "C" (common) connects to one of the two speaker transmission line conductors. The other line conductor connects to any one of the other speaker terminals, the selec-

Fig. 2. Maximum line length for 5% line loss.



Note: When several speaker transmission lines are brought separately to an amplifier, the calculation for wire size should be made for each line independently, using the line-matching transformer impedance that terminates the line and not the combined impedance of all the lines. As an illustration, in a typical installation four independent lines from 2000-ohm speaker transformers might be run to the 500-ohm amplifier output tap to provide a perfect impedance match. Line losses for each line are calculated on the basis of the 2000-ohm terminating impedance rather than the 500-ohm combined impedance.



Comiskey Park (Chicago) scoreboard p.a. system uses thirty separately powered 100-watt speakers, most of which are shown here.

Mobile sound system using four 25-watt driver trumpets. System shown is employed for police and fire work.

tion being made after the load (speaker) impedance value has been determined.

Whether the sound system is of the simple type, employing a single amplifier with a very limited number of loudspeakers or one in which a group of amplifiers feeds varying amounts of power to a large number of loudspeakers, satisfactory operation depends on an efficient transfer of power from the amplifier to the speakers. An amplifier will deliver maximum undistorted power to its speaker load when the impedance of the latter equals the amplifier output impedance, as marked on the output terminal strip. In other words, if a loudspeaker with a 16-ohm voice coil is to be connected to an amplifier which provides a terminal strip as shown in Fig. 3, the speaker transmission line should be run between the loudspeaker and the two taps on the amplifier marked "C" and "16." Since this is a "perfect match," the amplifier will deliver to the loudspeaker its maximum power at the rated total harmonic distortion. Most hi-fi loudspeakers are tied to amplifiers in exactly this manner.

Effects of Mismatch

The sound-system installer will usually have no difficulty providing for a good impedance match between an amplifier and its loudspeaker load. For all practical purposes, a mismatch of less than 20 per-cent may be disregarded and the amplifier may be considered as being properly loaded. A 20 per-cent mismatch upward (*i.e.*, where the load impedance is greater than the amplifier output impedance) would result if a 600-ohm speaker load were connected to an amplifier 500-ohm output tap. When the mismatch exceeds approximately 20 per-cent, however, any or all of the following undesirable conditions may occur: (1) The amplifier will not deliver its maximum power at rated distortion; (2) Frequency response at the high or low end will deteriorate; or (3) Plate dissipation of the amplifier output tubes will be exceeded, with resulting reduced tube life.

Power Loss: The extent of power loss resulting from impedance mismatching varies with the design and the output voltage regulation of the amplifier. A study of Fig. 1 shows that a 2:1 mismatch reduces output power of amplifier "A" by 50 per-cent whereas the output power of amplifier "C" falls off only 25 per-cent. It will be noted that in all three cases the identical power loss developed when the load was higher or equally lower in value than the amplifier output. In other words, an upward mismatch of 2:1 (*i.e.*, 1000-ohm speaker load tied to 500-ohm amplifier output) produces the same 50 per-cent power loss as a 2:1 downward mismatch (*i.e.*, 250-ohm speaker load tied to a 500-ohm amplifier output).

Frequency Response: When the mismatch is in a downward direction, better low-frequency response and poorer high-frequency response result. An upward mismatch produces just the opposite effect. A good impedance match provides the flat response stated by the manufacturer in his amplifier data sheet.

Plate Dissipation of Output Tubes: In recent years some of the finest amplifiers have incorporated class B output stages. The table of Fig. 1 lists plate current which flows in a typical 30-watt class B amplifier under two conditions of mismatch. When properly loaded, the combined plate current is 128 ma.—close to the maximum rating for the tubes. An upward mismatch of 2:1 results in reduced plate current but a downward mismatch of the same ratio causes a plate current flow of 168 ma.—well in excess of the maximum plate dissipation rating. If the amplifier is operated for any length of time under the latter condition, tube life will be considerably shortened and amplifier instability may result.

The foregoing discussion of the effects of mismatch clearly points out several important facts which the sound-system installer must carefully consider whenever an impedance-matching problem arises. These may be listed as follows: (1) If absolute maximum amplifier power—at rated distortion—must be used, an accurate match is necessary. A mismatch of 20 per-cent or less may be considered as unimportant. (2) If mismatching is unavoidable, it should always be in an upward direction (*e.g.*, where the load impedance is greater than that of the amplifier output impedance). A downward mismatch is permissible if the amplifier tap is within 10 per-cent of the load impedance. (3) If an amplifier is operated well below its rated output (the speakers are required to draw considerably less power than the amplifier is rated to provide), the effects of mismatch are less serious and

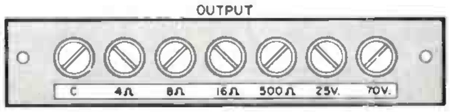


Fig. 3. Power amplifier output connections.

Table 1. Maximum running length of loudspeaker line for a 15% line power loss.

WIRE SIZE (A.W.G.)	LOUDSPEAKER LOAD IMPEDANCE (in ohms)		
	4	8	16
12	190 ft.	380 ft.	760 ft.
14	120 ft.	240 ft.	475 ft.
16	75 ft.	150 ft.	300 ft.
18	47 ft.	95 ft.	190 ft.
20	30 ft.	60 ft.	118 ft.
22	18 ft.	37 ft.	75 ft.

hence greater liberties may be taken.

The techniques commonly employed in the field for properly matching loudspeakers to an amplifier will be thoroughly explored in this and subsequent articles. To insure optimum performance, the installer should always strive for a perfect match. Only when suitable transformers are not immediately available should the sound installer deliberately mismatch to any great extent and this condition should be corrected as soon as he finds it possible to do so.

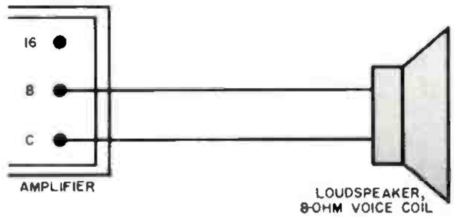
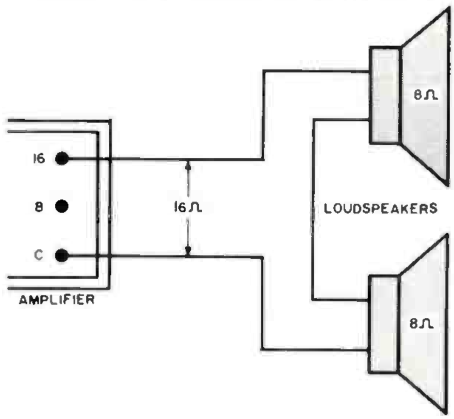


Fig. 4. The single-loudspeaker arrangement.

Fig. 5. Series arrangement of loudspeakers.



Speaker-to-Amplifier Connections

The types of loudspeaker loads which may be connected to an amplifier will, of course, vary considerably. At one extreme the load may consist of a single loudspeaker—at the other extreme hundreds of loudspeakers may be employed with each speaker being driven to a different acoustic level. To provide proper matching to the amplifier for so many different speaker set-ups, three basic arrangements are widely used: low-impedance speaker lines, high-impedance speaker lines, and constant-voltage systems.

Low-Impedance Speaker Lines: Except for special applications, loudspeakers used in p.a. systems are furnished with voice coils having impedance values of 4, 8, or 16 ohms. Infrequently, 45-ohm voice-coil loudspeakers are encountered, particularly in intercom work. When the speaker transmission lines are run directly between the amplifier and one or more loudspeaker voice coils they are referred to as low-impedance lines. When we speak of low-impedance lines in this sense, we are not actually referring to any inherent property of the line itself. We simply mean that the line from the amplifier is connected to a low-impedance speaker load. Since the power loss in low-impedance line conductors is considerably greater than in high-impedance lines (which will be discussed later) it is important that the sound installer consider the total length of the line to determine whether the percentage of power loss is permissible. At the same time, he must compute the cost of the cable—which will increase in direct ratio with the copper diameter of the conductors. For example, a typical plastic-covered speaker cable may cost approximately $2.50 per 100 feet with #18 A.W.G. conductors. The same line length with #12 A.W.G. conductors may sell for $7.00. If several hundred feet of cable are required, the higher cost of the heavier cable may dictate the use of a high-impedance line.

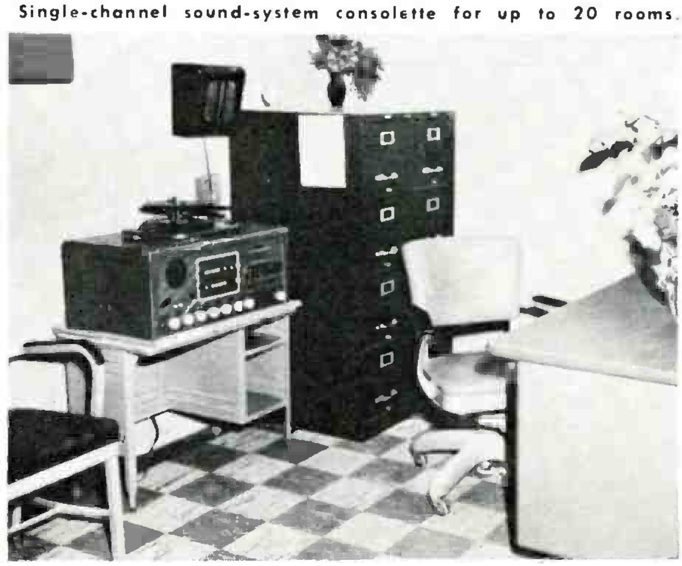
Table 1 shows the maximum lengths of line which can be run at common voice-coil impedances, without exceeding a power loss of 15 per-cent. A study of this table discloses several important facts: (1) Relatively short lines must be used with very low speaker impedances. (2) Large wire sizes are often essential. As an example, it is necessary to use #12 A.W.G. conductors in a speaker transmission line if an 8-ohm loudspeaker is installed 380 feet from the amplifier. (3) As the speaker load impedance increases, longer lines with smaller conductors may be used, at considerable savings in cable costs.

High-Impedance Speaker Lines: When the required length of speaker transmission line exceeds the maximum permissible length indicated for a given conductor size in Table 1, or where a power loss in the transmission line less than 15 per-cent is preferred, high-impedance speaker lines are used. These lines are usually required in complex systems where the large number of loudspeakers, or the different acoustic levels to which they are individually driven, make the use of low-impedance lines impractical. As will be discovered, in a detailed description of impedance matching *via* high-impedance lines, this method greatly simplifies the subsequent addition or subtraction of speakers and the re-adjustment of individual loudspeaker levels.

High-impedance lines generally terminate at the 500-ohm tap on the amplifier output terminal strip. Transformers must be installed at the loudspeaker end of the line to match this value to the low voice-coil impedances of 4, 8, and 16 ohms. To provide comparison with low-impedance speaker line lengths, refer to Fig. 2. Each curve represents a conductor size. To determine the maximum length of the high-impedance line for any given conductor, the point on the proper curve at which the line impedance crosses is first determined. By bringing this point out to the left of the graph we discover the line length. For example, if the speaker load impedance is 500 ohms and #20 A.W.G. conductors are to be used, the line

Multi-channel sound system installed in a modern high school.

Single-channel sound-system consolette for up to 20 rooms.



...nd ...300 ...wer ...line- ...loud- ...0 per- ...er-cent ...speaker ...ble. This sys- ... speaker ...ners at the ...n the high- ...e-matching ... in that no ...d on the part ...t-voltage line- ... available for ...lly the same as ...nventional high-

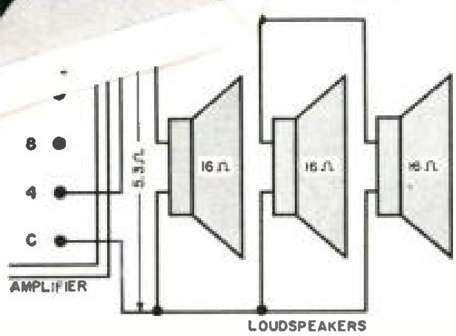


Fig. 6. Parallel arrangement of speakers.

impedance speaker lines but the taps are marked in watts rather than impedance values and it will be demonstrated later how even complex sound-system loads may be matched to the amplifier after making only simple calculations.

Use of this method requires that the amplifier incorporate output taps of 25, 70, or 140 volts (see Fig. 3). As a rule, amplifiers designed to deliver 100 watts or more output power include 70 and 140 volt taps while medium-power amplifiers have provision for 25 and/or 70 volt connections.

Speaker Matching with Low-Z Lines

Single Speaker: As shown in Fig. 4, an 8-ohm loudspeaker is properly matched to an amplifier when the line is terminated at the 8-ohm output on the amplifier. Similarly, if the loudspeaker has a 16-ohm voice coil, the connection is made to the 16-ohm tap. The wire size of the line is determined, of course, by the figures given in Table 1. This simple arrangement is commonly found in home hi-fi set-ups, carnival midway systems, and single-speaker mobile installations.

Speakers in Series: When loudspeakers are connected in a series arrangement, as in Fig. 5, the total load impedance equals the sum of their individual impedances. When four 4-ohm loudspeakers are connected in series, the total impedance is 16 ohms and a proper match is realized when the speaker line is connected to the 16-ohm amplifier output tap. Similarly, two 8-ohm speakers in series, producing a total load impedance of 16 ohms, should be connected to a 16-ohm tap for perfect match.

Should one speaker in a series arrangement fail, the circuit is broken and no power would be delivered to the other speaker(s). For this reason, series connections should be avoided wherever possible. It is even more important to avoid the use of a series connection in installations where a large number of loudspeakers are to be mounted in a cluster arrangement since high total transient voltages may develop which would cause an arc-over in the voice-coil air gap of the loudspeakers.

Speakers in Parallel: When loudspeakers are wired in parallel, as in Fig. 6, the total load impedance may be computed by dividing the impedance of any one loudspeaker by the number of speakers. This rule applies only when the impedances of the individual speakers are the same, in this instance, 16 ohms. The three 16-ohm speakers connected in parallel in Fig. 6 have a combined impedance of 5.3 ohms. Following the rule of always mismatching in an upward direction, the speaker line of 5.3 ohms is properly terminated at the 4-ohm amplifier output tap. The degree of mismatch, which in this instance is unavoidable, would be roughly the same if the speaker line were connected to the 8-ohm tap—but the downward mismatch of the latter arrangement would cause a greater power loss, higher distortion, as well as poorer frequency response.

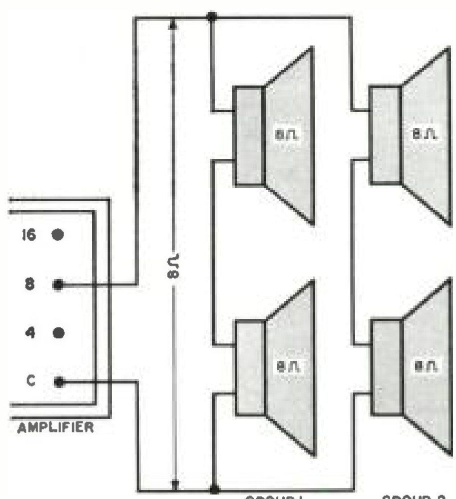
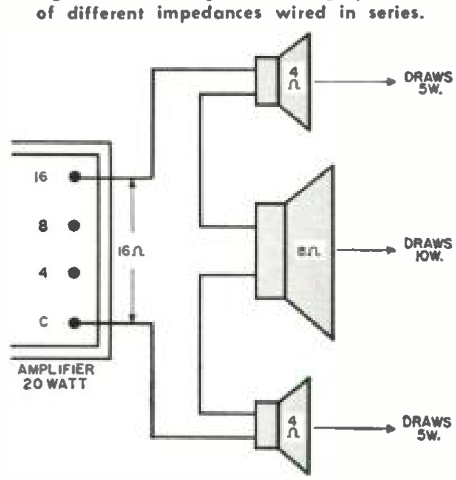


Fig. 7. Series-parallel circuit arrangement of two identical loudspeaker groups.

Fig. 8. Circuit diagram showing speakers of different impedances wired in series.



If only two 16-ohm loudspeakers were used in this parallel arrangement, the load impedance would then be 8 ohms and a perfect match would be obtained by running the speaker transmission line to the 8-ohm amplifier output tap.

This widely used impedance matching arrangement is often found in small churches and auditoriums where a limited number of loudspeakers is adequate and where relatively short speaker lines are practicable.

Series-Parallel Arrangement: In Fig. 7 a total of four 8-ohm loudspeakers have been wired together by paralleling two groups of series-connected speakers. In group one, the two 8-ohm speakers present a total impedance of 16 ohms; similarly the two speakers in group 2 present a total impedance of 16 ohms. Since groups 1 and 2 are paralleled, the resulting impedance equals 8 ohms and the speaker transmission line is therefore connected to the 8-ohm tap on the amplifier.

It will be noted that although an open voice coil in any one speaker will not disable the two speakers in the other group, it will break the circuit between the amplifier and the second speaker in its own group. This wiring arrangement can be expanded, of course, to take in a larger number of speakers. The general practice, however, is to employ line-matching transformers and high-impedance lines (or the constant-voltage system) when more than four loudspeakers are used.

Power Distribution to Speakers

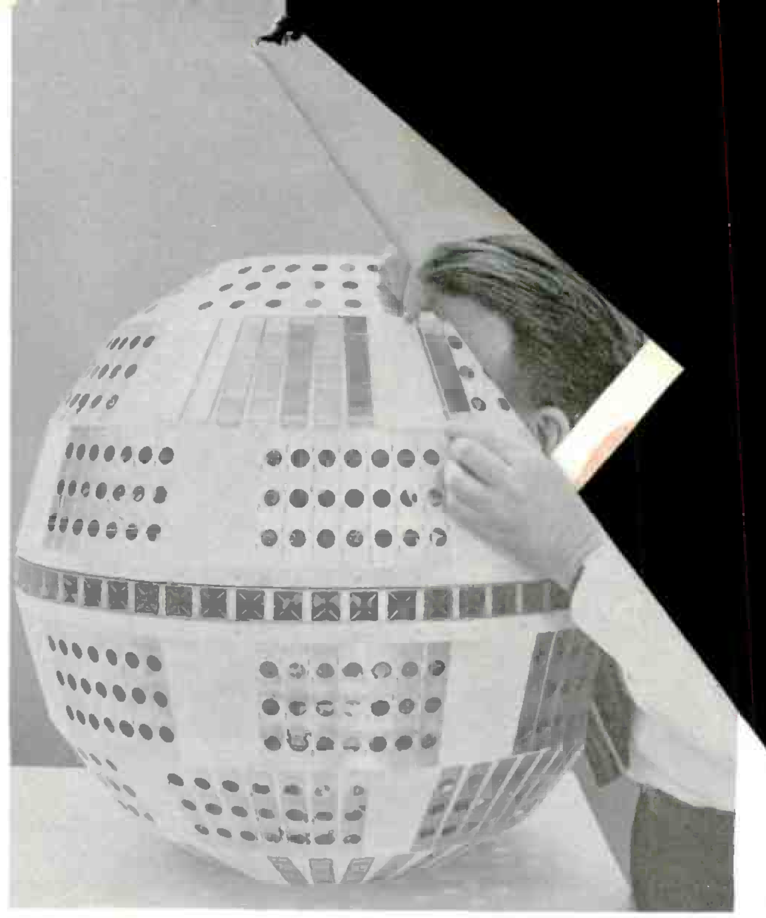
Series Arrangements: When loudspeakers of identical voice-coil impedances are connected in series, equal distribution of power results. For example, each loudspeaker in the arrangement of Fig. 5 will receive one-half of the amplifier output power. In a series arrangement where several loudspeakers of different voice-coil impedances are used, the loudspeakers will be driven to different levels.

In Fig. 8, proper match is made when two 4-ohm speakers and one 8-ohm speaker are wired in series and connected to the 16-ohm output tap of a 20-watt amplifier. As indicated, the 8-ohm loudspeaker receives twice as much power (10 watts) as each of the 4-ohm speakers. The 8-ohm speaker represents half of the total load impedance

(*Continued on page* 89)

Sapphires Protect Solar Cells

Bell Telephone Laboratories *engineer is shown at right carefully setting into place an assembly of solar cells with a transparent covering of man-made sapphires. He is working on a developmental model of a communications satellite that will be expected to relay telephone, television, and other data across the oceans for ten years or more. The solar cells, which convert sunlight into electricity, are covered by thousands of thin slices of sapphire to protect them from space radiation.* ▶



RECENT DEVELOPMENTS IN ELECTRONICS

Shock-Resistant Radomes

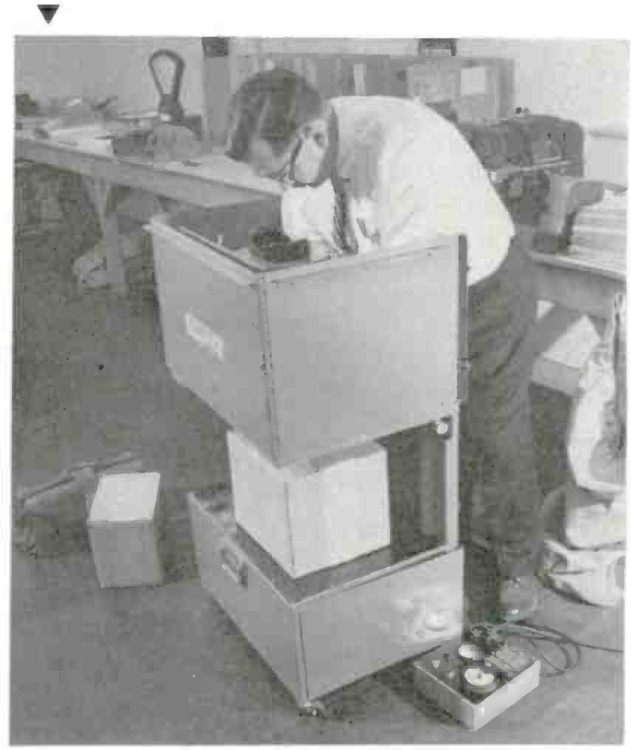
High-strength inch-thick plastic radomes set in heavy concrete pedestals protect the microwave antennas used for communications between missile launching sites at Fairchild Air Force Base (Spokane, Wash.). An underground concrete bunker contains racks of Collins-*built communications equipment. The system is designed to withstand shock from all but a near-direct hit.*

▼

Portable X-ray Detective

Developed for use by officers who must determine whether suspicious parcels contain bombs or weapons, a new Westinghouse *x-ray unit is compact enough to fold into a footlocker and light enough to be taken to a field headquarters as ordinary luggage. It uses 117-volt a.c. power. The unit produces a fluoroscope image or a film record of objects up to 30 inches wide and 18 inches thick. Weighing about 160 pounds and priced at about $4,500, the x-ray equipment has protective shielding adequate to give the operator full protection.*

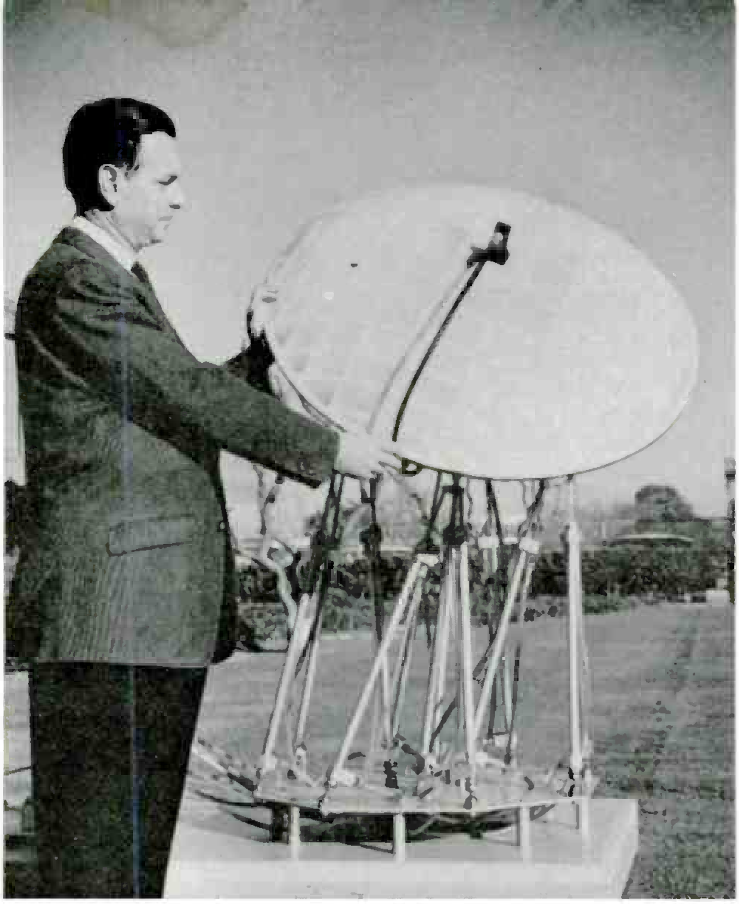
▼

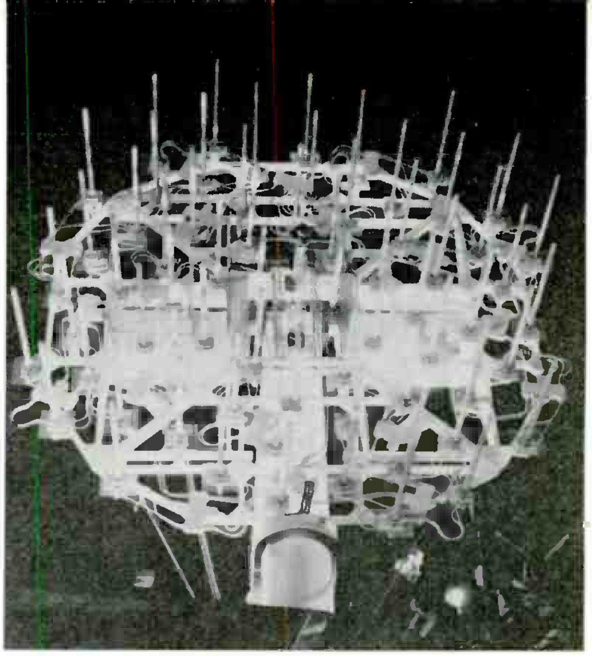


Audio-Analgesia System Patented

A patent has been issued recently to Bay State Electronics Corp. *of Boston for an audio-analgesia system which uses tape-recorded stereo music and "masking" noise to control pain. Both the patient and doctor hear the pain-killing sound via earphones. Actual experience with this type of equipment has been mainly in the field of dentistry.*

▼





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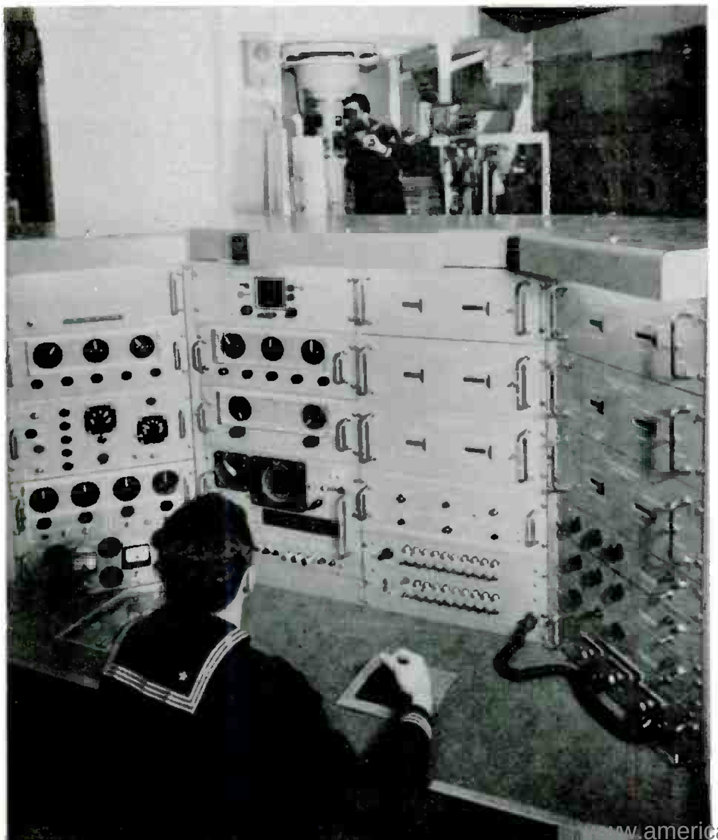
2000-mc. Tracking Array

A complex arrangement of coax-cable interconnections is used in the 2000-mc. telemetry and tracking antenna array shown above. The coax assembly, built by A-T Electronics *in New Haven, has a tolerance which represents a phase error of within 1 degree at the operating frequency.*

▲

Foam-Reflector Antenna

A new type of antenna, composed of a lightweight rigid foam reflector and a positioning arrangement that can move the reflector through any angle of azimuth and elevation, has been developed by Sylvania. *The equipment is less expensive, stronger, lighter, and easier to fabricate than conventional antennas now in use. Potential uses of the antenna include satellite communications and radio and radar astronomy. The antenna's feed horn is buried in its foam surface. The servo-controlled positioning arrangement changes the lengths of twelve hydraulic-cylinder legs, which are grouped into four tripod supports as shown.*



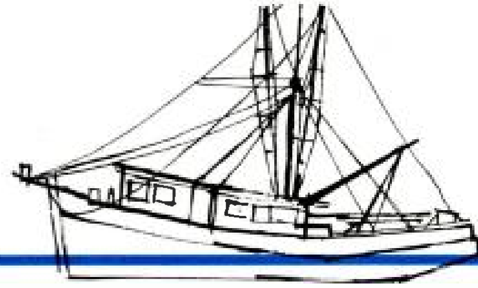
▲

Longest Microwave Hop

Atop 9000-foot Coon Peak above the clouds in Utah, a snow-encrusted microwave dish beams network television programs 136 miles in a direct line-of-sight to a receiving station in Idaho. Designed and built by RCA, the system is regarded as the world's longest single-hop microwave transmission for television relay. In covering the record distance, the microwave beam traverses the entire length of Great Salt Lake and slices through a mountain pass.

Electronic Trainer for Nuclear Sub

◀ *A huge training system that simulates "Polaris" missile firings aboard nuclear submarines has been installed at the U.S. Navy Subschool in New London. The trainer is an accurate reproduction of the navigating and control center of the submarine "George Washington." Using electronic programming techniques and an intricate artificial star sky, the system will be able to look backward or forward in time to reproduce celestial observations for any part of the world. The simulator, designed by* Reflectone Electronics, *Stamford, Conn., will train new and experienced "Polaris" crews.*



MARINE ELECTRONIC

THE increasing availability of low- and medium-priced marine electronic equipment, along with the variety of types, has opened an ever-widening field for maintenance and service operations. Radiotelephones, depth sounders, and direction finders are not only familiar sights on elaborate vessels these days, but even on the smallest of outboard cruisers. Especially with the smaller craft, it is the independent technician who falls heir to the job of providing the needed services.

The man whose chief experience is with radio and TV receivers must learn many additional things if he wishes to take advantage of the opportunity. Beyond getting to know the types of equipment used and how they work, he needs orientation in troubleshooting methods, to the extent that they differ from those to which he is accustomed, if he is to attack service problems with some confidence. If he is to avoid pitfalls not normally encountered with work on household sets, the "dry land" technician also needs some foreknowledge of special business, legal, and other non-technical aspects of such work.

Our first concern is thus with special principles, practices, and problems pertaining to the broad field. Then, in this and the second, concluding article, depth sounders will be examined. Practical analysis will accompany how-it-works data. Other instruments are properly the subjects of separate articles.

Licenses

Before tuning a boat's radiotelephone transmitter and putting it on the air or doing anything to affect its tuning, the technician must have at least a Second-Class Commercial Radio Telephone license. The average service technician should have little difficulty in passing the theoretical part of the FCC test for such a license and need study only the rules and regulations governing radiotelephone operation. (If he works on radar equipment he must have a radar endorsement.)

Furthermore, the technician should not put any transmitter on the air that is not covered by an FCC station license or a ninety-day interim permit. Such a permit, which may be obtained for FCC-approved equipment upon personal application to an FCC office, allows the owner or his agent to use his new equipment while waiting for the agency to assign his call letters.

Current radiotelephone equipment made by reputable manufacturers is readily licensed, but caution should be exercised with second-hand and government-surplus sets. This gear seldom meets requirements as to frequency tolerance, harmonic attenuation, and modulation limiting.

Rental Equipment

If the service dealer is working around commercial waterways, he will, in time, get calls from tug boats and freighters. A great deal of the electronic equipment on these vessels is rented from the manufacturer, who services it free of charge in what he has designated as a service port. If the independent operator is asked to work on rental units, he should determine at the outset who is to pay for the service. The vessel's captain may elect to do so for his own convenience or the leaser may authorize the outsider to proceed, usually at his (the manufacturer's) rates.

Sales

If he obtains dealerships or sub-dealerships, the dealer can supplement his income by selling equipment and special parts. He should be extremely cautious of installment sales. It may be relatively simple to repossess a TV set in his own area, but it could prove much more difficult to take a radiotelephone from a shrimp boat that has gone to a port two-hundred miles away, or a depth-sounder transducer from the bottom of a fishing vessel. Also, a TV set that has had some use may still look quite respectable, but a few doses of salt spray can make a depth sounder look a mess after two or three months.

Power-supply vibrators and depth-recorder chart paper are fast moving items. If not in the normal stock, 807's, 2D21 thyratrons, and 0A5 discharge tubes should be carried for over-the-counter sales.

Yachtsmen are prone to forget to fold down antennas when passing under bridges or going into boat sheds. Consequently, many more antennas than radiotelephones are sold.

Special Problems

Corrosion, particularly around salt water, is the greatest enemy of marine electronic equipment. Not all instruments can be made water-tight; depth sounders, especially, cannot be installed in thoroughly protected places. Tube sockets, bandswitch wafers, and terminal strips are subject to electrical breakdown. The i.f. and r.f. coils often fail, owing to corrosion, where the winding ends are soldered to the terminal. These are often repairable but, if there is any evidence that the coil has been wet or if the corrosion appears to be progressing toward the winding, the part should be discarded.

Freezing of channel-selector switches and gain-control shafts is common. Controls must be replaced; however, it is sometimes possible to free a switch if the shaft can be removed.

Sticking dynamotor brushes, caused by corrosion in the holders and breakdown of the brush-holder insulation, are additional sources of trouble. Vibration, particularly on small boats, is frequently so severe as to break loose self-supported components. Equipment subject to such conditions should be shock-mounted.

At this point, it seems advisable to caution the technician against the

Part 1. An experienced specialist presents a practical introduction to the business and technical problems

By R. C. ROETGER, Sea 'Lectronics

SERVICE DEPTH SOUNDERS

greater electrical shock hazards resulting from the prevalent damp conditions.

Equipment

The land technician probably has most of the shop apparatus he will require for marine work. The bulk of the equipment he encounters will be powered by 6-, 12-, or 32-volt batteries. In order to "fire up" jobs taken to the shop, he should have a bank of storage batteries and a means of keeping them charged (or an equivalent high-current d.c. power supply). If his work is mostly on small boats, 12 volts with a tap at 6 volts will suffice. If his customers have large yachts and commercial boats, 32 volts will be necessary.

Tube-socket test adapters are a great help, for it is not always possible to pull a chassis far enough out of the case to turn it over: lead length and space are factors.

A megohmmeter, independent of an external power source, is desirable for checking questionable insulation and capacitors. A reliable frequency meter (the government-surplus *LM* unit will do) is needed for measuring transmitter frequency and checking doubtful crystals. An r.f. ammeter with 0-1 and 0-5 ranges will take care of most transmitter output measurements. A variable-frequency audio oscillator is needed for aligning depth sounders.

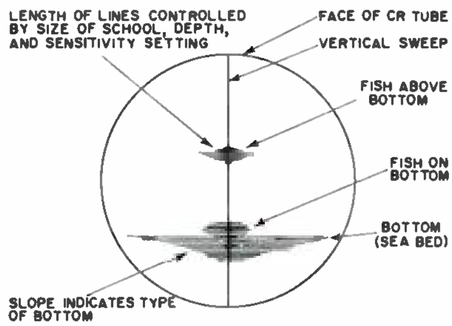


Fig. 1. Scope type indicators use vertical sweep to show presence of fish and type of bottom, in addition to depth.

Soldering on board a boat can be a headache unless the vessel has a shore connection for power or a 117-volt auxiliary generator. There are three ways of approaching this problem: a sufficiently long extension cord; a soldering copper (non-electrical device) that can be heated by the galley stove or a propane torch; or a collection of 6-, 12-, and 32-volt soldering irons.

The dealer should collect, as quickly as possible, a set of instruction books covering the equipment most popular in his location. Also, he should purchase from the government printing office a copy of the FCC rules, Part 8 and Supplements. This publication covers the pertinent section of the laws governing marine radiotelephones—their licensing and use.

Procedures

When working "on board" and a preliminary check does not disclose the trouble, the decision must be made whether to proceed or to take the unit to the shop. If it looks like a long troubleshooting job or involves something like replacing an eight-gang, seven-position bandswitch, the equipment should be taken to the shop and an explanation given to the customer. If the equipment has a separate power supply, it should be determined whether the supply or other section is at fault. If the power supply is good, only the other part should be pulled—provided the necessary power is available in the shop. If the power supply is bad, it is usually wise to take in both sections in case there is also something wrong with the rest of the set. Again, a word of caution: nothing should be removed from a ship of foreign registry unless it is cleared through U.S. Customs.

Most manufacturers guarantee materials and workmanship for periods ranging from ninety days to a year, but do not agree to pay for repair or service labor. At times a customer will call for work on a unit still under warranty, but which was bought elsewhere. In such

Fig. 2. The important elements of flasher type indicators, in block diagram, showing signal paths and other interconnections.

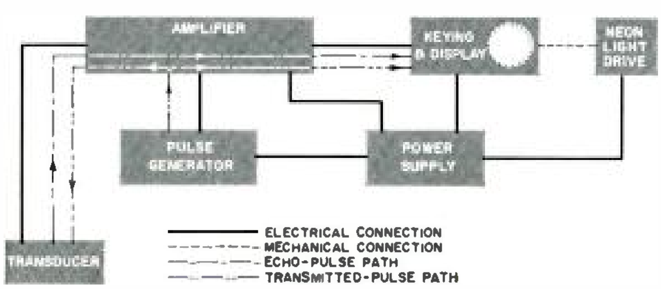
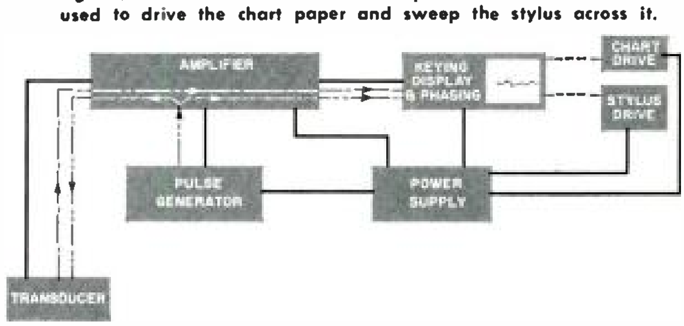


Fig. 3. The basic sections of a depth recorder. Motors are used to drive the chart paper and sweep the stylus across it.



peculiar to this field; then considers the variety of sounder types, including indicators and recorders, now in use.

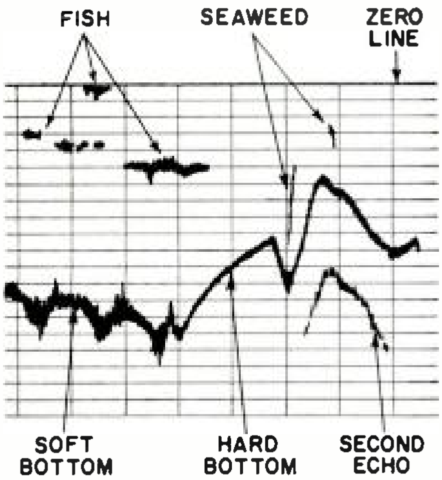


Fig. 4. Sample strip of recorder chart with interpretation of common indications.

instances, it should be explained that he will have to pay for parts and labor and that it is up to him to settle with the manufacturer or dealer.

After a depth-sounder repair, many owners and captains will say: "Let's go out and try this in deep water." Every service dealer will realize that it is not sound economy to go on such joy rides unless the time spent is charged at the regular rate.

Once he has become known around the waterfront, the technician will be called upon to fix a lot of equipment that is not strictly electronic. He will be confronted with fume detectors, battery-charge indicators, engine-synchronization indicators, wind-velocity meters, and many other devices. For diplomatic reasons, he may not be able to refuse this work. He is better off accepting the fact that he should gradually become familiar with such items. A familiarity with basic boat-wiring systems must also be acquired.

The cited requirements should not be a cause for discouragement. For a competent electronics man, they are minor obstacles that should be surmounted easily. If he will take the trouble to obtain his FCC license and doesn't mind getting a little dirty on occasion, he can quickly acquire a rewarding group of marine customers in the prevailing market.

Sounding Principles

With the preliminaries out of the way, consideration of one of the popular families of marine electronic instruments is in order. Depth sounders have been in use for many years to measure the depth of water under a vessel for navigational purposes and, more recently, for determining the nature of the sea bed and the presence of fish.

The underlying principle of all depth sounders is the same. A supersonic or ultrasonic pulse is transmitted from the vessel's hull toward the sea bottom and the returning reflected pulse, or echo, is detected and displayed in some fashion by the sounder. The time consumed by the round trip of the pulse is measured and, since the speed of sound in water is constant, a very accurate determination of the depth is made. The pulses are transmitted many times a minute so as to produce a continuous reading of the depth.

Depth sounders that will read several hundred fathoms are commercially available. Since there are six feet in a fathom, this can mean thousands of feet. However, instruments intended for average use are designed for a few hundred feet.

There are two general types of sounders. Those classified as indicators show the depth of water at any one time. The recorder types produce a permanent record on a chart. Before examining *how* they work in detail, it is useful to identify the various types and establish *what* they do.

Depth Indicators

Flashers: Most common of the indicators is the "flasher" or "red-light" type. Hundreds are found on small boats in fresh and salt water. A neon lamp in this instrument revolves on a disc or radial arm behind a scale calibrated in feet or fathoms. The lamp flashes each time a pulse is transmitted (the zero flash) and again when the echo returns. ("Keying" is the term applied to the triggering of the transmitted pulse; in most instruments it is accomplished by mechanically operated contacts or brushes which turn the pulse generator on and off at the desired rate.) Since the lamp is revolving at a constant speed, there will be an angular displacement between the two flashes. The spacing between the two flashes is directly proportional to the pulse's travel time and thus to the depth of water. Persistence of vision causes the individual flashes, which occur at the keying rate, to appear as solid red bars.

If the pulses strike something between the bottom and the surface, such as a school of fish, a fainter flash will appear between the zero and bottom flashes. The zero flash will always be the same width; the depth flash will be narrow for a hard bottom and wide for a soft bottom. Sometimes in shallow water, three flashes will appear, the third flash showing twice the depth indicated by the second flash. This is known as "double echoing," the third flash being caused by the reflected pulse striking the boat's bottom, returning to the sea bed and again bouncing up to the boat, so making two round trips.

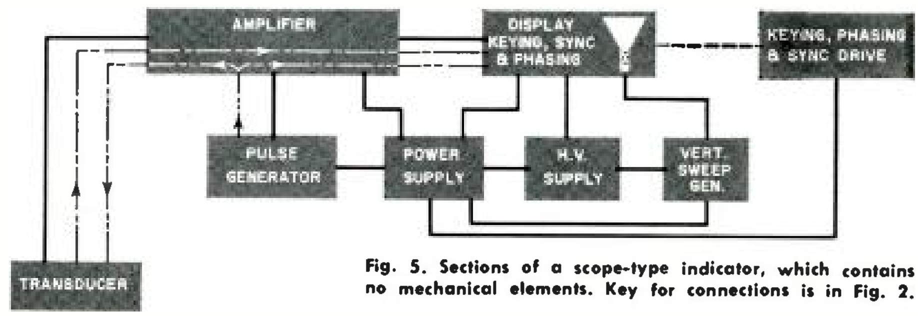


Fig. 5. Sections of a scope-type indicator, which contains no mechanical elements. Key for connections is in Fig. 2.

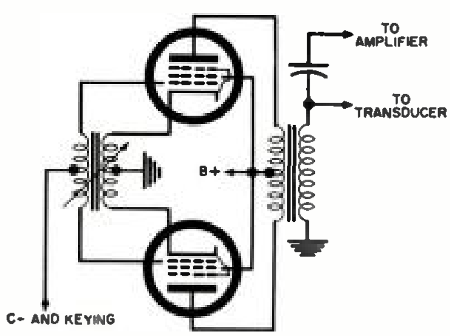
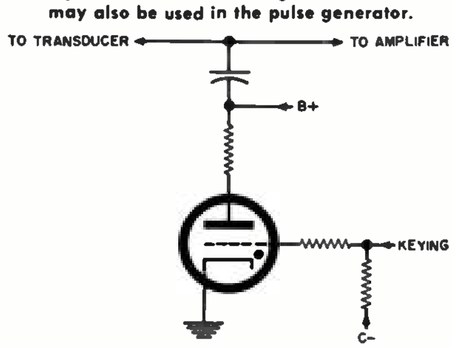


Fig. 6 Some pulse generators rely on vacuum-tube oscillators like this one.

Fig. 7. A cold-cathode, gas-filled tube may also be used in the pulse generator.



Scopes: Usually called "fish finders," indicators which display their information on a CRT are becoming increasingly popular for fishing purposes. An accurately controlled, one-shot vertical sweep is triggered each time a pulse is transmitted. This produces a vertical line on the face of the tube. The spot travels from top to bottom, the retrace being blanked. The zero flash is generally positioned so as not to show on the screen, *i.e.*, it is just ahead of (above) the start of the sweep. Echoes appear as horizontal deflections of the beam. See Fig. 1. Since the speed of the moving electron spot is predetermined and fixed, its displacement from the starting point at any given instant is proportional to the pulse's travel time and thus also the depth. The latter is read from a vertical scale.

Meters: A less versatile indicator, although perhaps easier to read, employs a conventional meter movement, calibrated in feet or fathoms, as the display element. Since the pointer obviously cannot be in two places at once, such an instrument cannot be expected to double-echo or show the relative position of fish above the bottom.

Depth Recorders

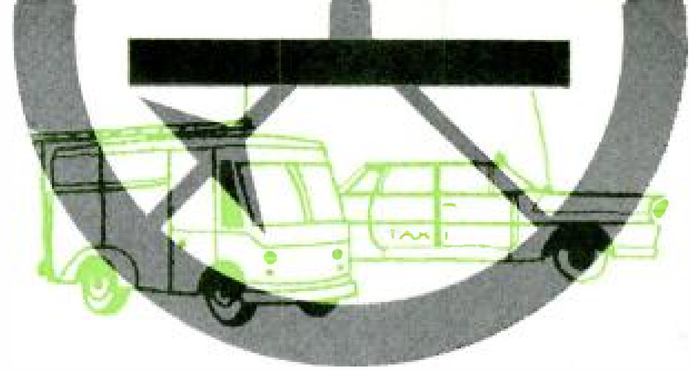
Recorders offer a means of obtaining a permanent record of the depth and the nature of the bottom, also of seeing this record as it is being made on a chart of electro-sensitive paper.

In addition to the circuitry for trans-

(*Continued on page 97*)

By EDWARD M. NOLL

Actual circuits used in commercial land-mobile two-way radio equipment take advantage of the compactness as well as the low-power requirements of the transistor.



TRANSISTORS IN TWO-WAY RADIO

Part 2. Circuits Used in Commercial Equipment

LAST month we discussed basic transistor circuits as applied to two-way radio gear. In this article we will discuss some of the transistor circuits used in commercial two-way radio equipment.

Transistor Exciter

A simplified schematic of the transistor exciter of a *G-E* two-way radio unit is shown in Fig. 10.

The crystal oscillator of the *G-E* transmitter uses a Colpitts-like feedback arrangement to provide the proper crystal excitation. Capacitors C_1 and C_5 function as the feedback voltage divider. Capacitor C_6 is a small trimmer which is used to tune the crystal. In the two-way radio services, frequency tolerance is very tight. In fact, above 50 mc., the frequency tolerance is 0.0005%. Consequently, a frequency-adjustment control is included with the oscillator so that it may be set precisely on frequency. Transmitter adjustments must be made by the holder of a Second Class Radiotelephone license or higher grade.

A double-tuned resonant transformer couples the output of the crystal oscillator to the base input circuit of the buffer stage. Notice that the collector of the oscillator and the base of the buffer are connected to low-impedance points on the windings of the resonant transformer. This arrangement permits correct impedance matching and the use of high-"*Q*" resonant circuits. The resonant transformer is tuned to twice the frequency of the crystal.

The *G-E* transmitter operates in the 150-174 mc. band. The crystal frequency falls somewhere between 5.5 and 7 mc.; hence, a total frequency multiplication of 24 is required. The multiplier stage is used as a doubler, consequently the over-all multiplication of the transistor exciter is 4. The output of the multiplier, through the low-Z coupling coil L_2 (in xfmr. Z_{104}), provides drive for a series of vacuum-tube stages. These stages provide the additional multiplication and amplification of the signal required to bring the signal on frequency with an output of 30 watts.

Notice that a meter test point is located in the emitter circuit of the buffer amplifier. After the crystal oscillator has been set on frequency, the resonant transformer Z_{105} is tuned for maximum emitter current. Winding L_1, which is part of resonant transformer Z_{103} between the buffer amplifier and the modulator, is now resonated for minimum

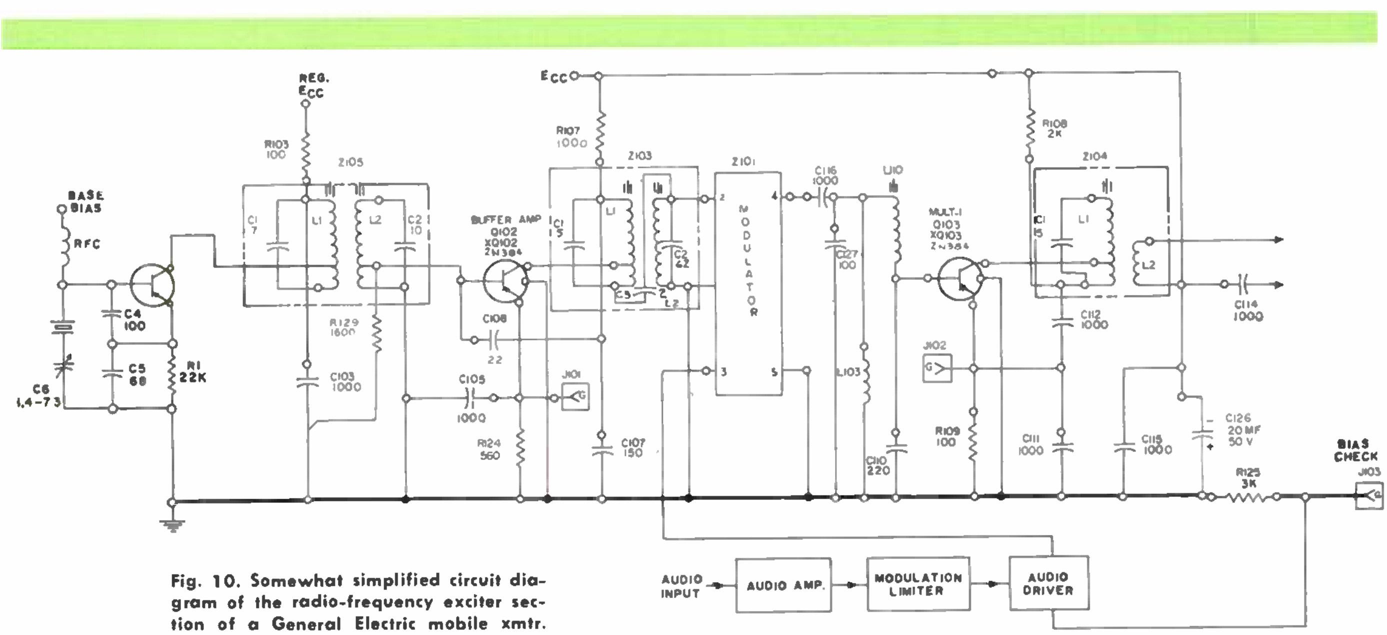


Fig. 10. Somewhat simplified circuit diagram of the radio-frequency exciter section of a General Electric mobile xmtr.

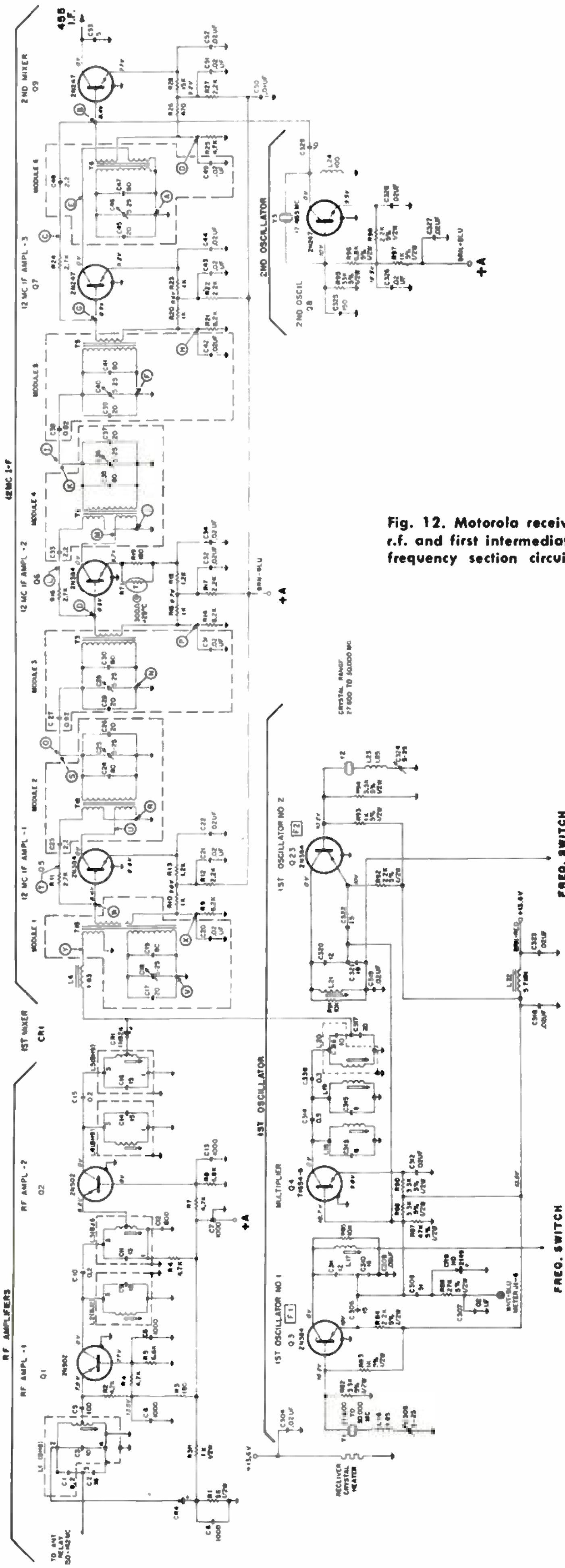


Fig. 12. Motorola receiver r.f. and first intermediate-frequency section circuits.

emitter current as measured at J_{101}.

The emitter current of the multiplier can also be monitored. This test position permits the secondary of transformer Z_{103} to be resonated for maximum emitter current. The collector circuit winding L_1 in Z_{104} is now resonated for emitter-current dip.

The modulator delay line is located between the buffer amplifier and the multiplier. The audio variations on the delay-line bias circuit produce phase modulation of the r.f. signal as it passes between the buffer and the multiplier. Sufficient phase modulation occurs to produce a final FM frequency deviation of ±5 kc. or ±15 kc., according to FCC assignment.

Transistor Receiver

The completely transistorized receiver used in the *Motorola* "Motrac" radio set, Fig. 12, receives FM signals on one or two fixed, crystal-controlled frequencies in the 150-162 mc. band. The receiver is of the double-conversion superheterodyne type with a total of 24 transistors.

Two-frequency operation of the receiver is accomplished by the addition of another crystal oscillator. Only one frequency can be received at a time, with a switch used to select frequencies. In one position the switch completes the d.c. path to ground for the transistor of the No. 1 oscillator, permitting that stage to operate. At the same time it opens the d.c. path to ground for the

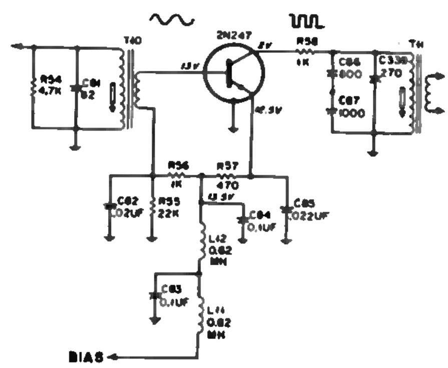
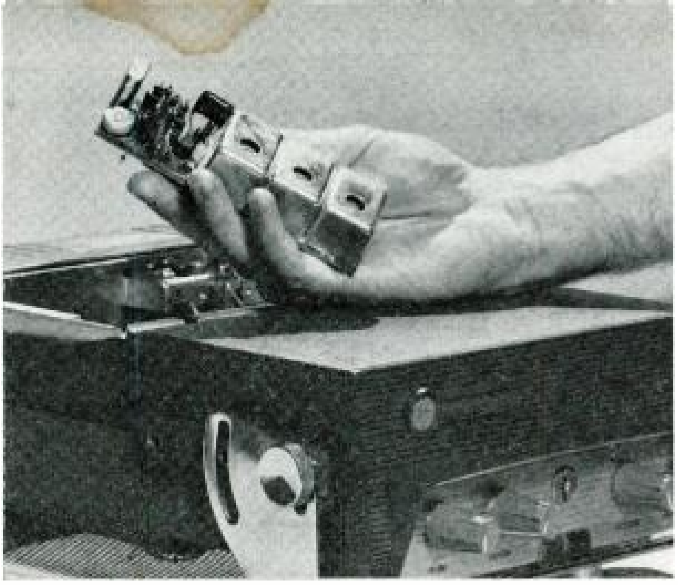


Fig. 11. Transmitter-limiter circuit.

transistor of the No. 2 oscillator, disabling the No. 2 stage.

The r.f. amplifier consists of two transistor stages with a common-base circuit. The carrier signals received at the antenna are coupled to the emitter of the first r.f. amplifier by the impedance-matching network in the input circuit. The two r.f. stages of amplification improve sensitivity and selectivity. The gain of this section is designed to provide optimum signal-to-noise ratio in the signals sent to the first mixer. Selectivity is provided by use of very low-loss coils and by critically coupling the input and output circuits.

Notice that throughout the r.f. and i.f. sections double-tuned interstage transformers are employed. They are not coupled inductively but by way of small coupling capacitors. This method of coupling permits the necessary bandwidth to be attained and, at the same time, sharp drop-off skirts are possible.



The transistorized exciter employed in General Electric radio.

Over-all appearance of one of Motorola's transistorized sets.

In this way off-frequency signal rejection is improved.

No neutralization is provided because transistor amplifiers operating at high frequencies with a common-base circuit do not require neutralization. Excellent stability is maintained without neutralization.

A stable oscillator circuit is a necessity for single-frequency operation. The one or two crystals of the receiver have the benefit of a heater to minimize frequency drift with ambient temperature change. A frequency multiplier follows the receiver crystal oscillator. It has a multiplication factor of five; three output tuned circuits are used to shape and emphasize the fifth harmonic component and prevent the transfer of other harmonics to the crystal diode mixer CR_1 that is employed in the circuit.

The mixer diode produces no voltage gain. An extremely low loss is encountered in the mixer diode; however, this is recovered in the i.f. amplification stages which follow it.

The first i.f. section consists of three capacitively tuned amplifiers and six very high "*Q*" toroidal coils with tuned circuits. The frequency of the first i.f. section is 12 mc. The output from the first mixer is matched to a low-impedance coil and inductively coupled to a high-impedance toroidal coil which has a very high "*Q*" and high selectivity. The impedance is stepped down to match the low input impedance to the base of the transistor amplifier.

The three stages of i.f. amplification follow. A low-impedance winding couples the collector output of Q_5 to the primary resonant circuit (T_{16}). A second low-impedance winding picks up a stabilizing feedback voltage which is fed back to the base circuit *via* capacitor C_{23} and resistor R_{11}. Capacitor C_{27} provides the coupling path between primary and secondary resonant circuits. A low-impedance secondary winding couples the secondary resonant circuit (T_3) to the base of the next stage.

The output of the last 12-mc. i.f. amplifier is applied to the transistor second mixer along with an injection signal generated in the second local oscillator. The second local oscillator frequency is controlled by a crystal. This frequency is 12,455 kc. The frequency of the second local oscillator and the 12-mc. frequency of the first i.f. section is maintained constant for all incoming signals. The difference between the second local oscillator frequency and the first i.f. is the second mixer output.

A five-stage 455-kc. second i.f. amplifier section follows. This includes two limiter stages to remove amplitude variations. A semiconductor FM discriminator is driven by the second limiter.

When a signal is applied to the transistor limiter, shown in Fig. 11, the base is driven positive with respect to the emitter during the positive alternation of the signal; the emitter junction is then reverse-biased, causing the collector current to drop to zero. During the negative half of the input signal, the base becomes more negative, increasing the emitter-to-collector current to its maximum value. Thus, with a signal the collector current is driven to cut-off and maximum; and the limiter produces an output signal of constant amplitude.

The *Motorola* audio amplifier and squelch circuit are shown in Fig. 13. Audio signal reaches the input audio amplifier from the volume control. Signals are amplified in the push-pull driver and push-pull output stage, supplying as much as five watts output to an 8-ohm speaker.

The squelch circuit consists of a noise limiter, noise detector (rectifier), and transistorized d.c. control stage (switching circuit). The purpose of the squelch circuit is to eliminate disturbing noise

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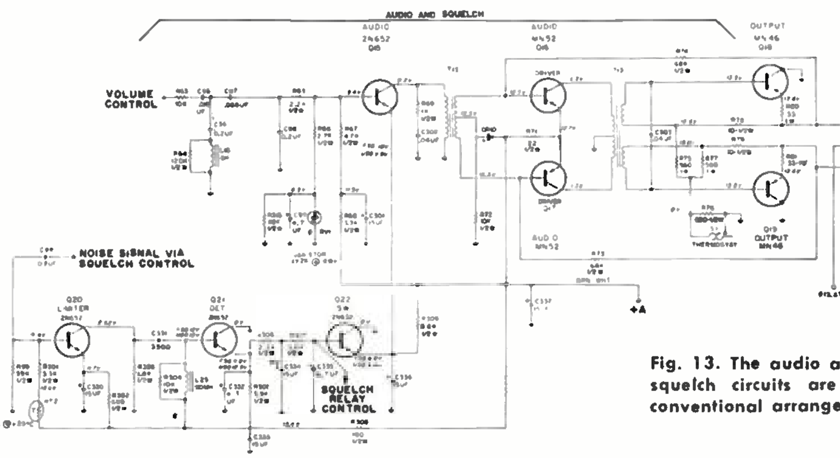
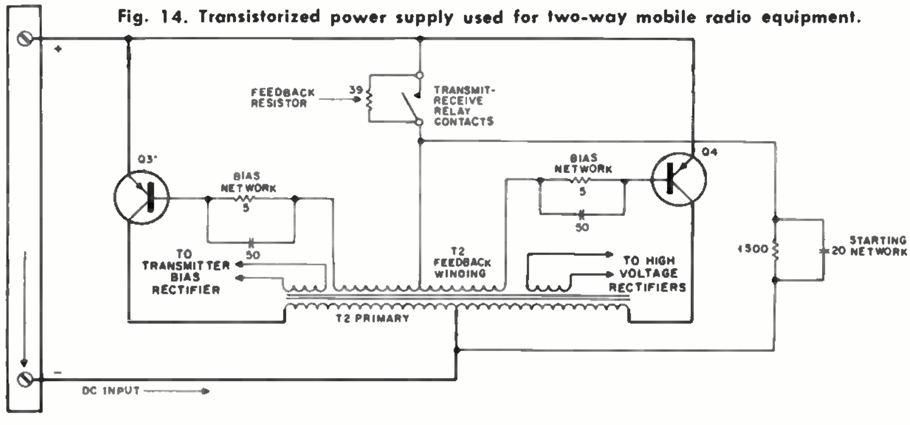


Fig. 13. The audio and the squelch circuits are fairly conventional arrangements.

Fig. 14. Transistorized power supply used for two-way mobile radio equipment.



THE "SIMPLE-TALKIE"

By **HARTLAND B. SMITH, W8VVD**

An ultra-simple hand-held trans-receiver for the ham who can use a very short-range talk-back system. The power input is 10 mw.; range is several hundred feet.

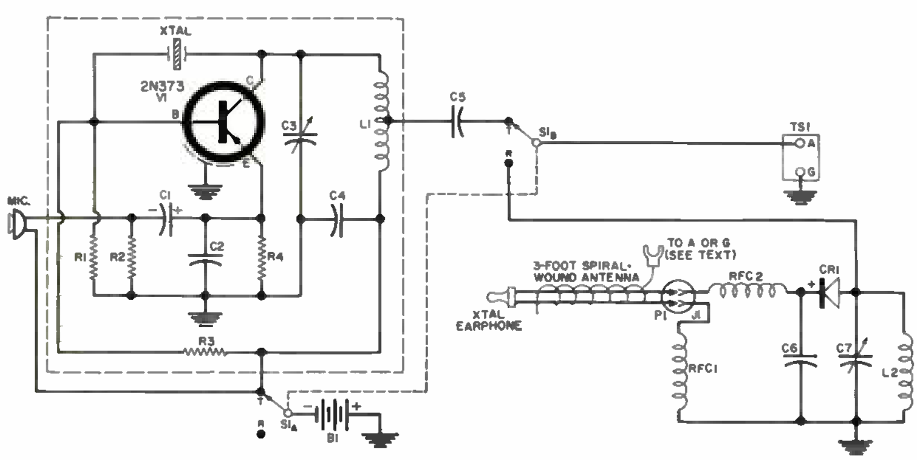
MAYBE you were perched atop a sixty foot pole making an adjustment to your beam antenna or maybe you were in a neighbor's living room checking out a case of TVI. Whatever the circumstance, there is little doubt that at one time or another you have found yourself in a position where you needed a pocket-sized rig to provide instantaneous two-way communication between your shack and some nearby point.

Even though most hams recognize the utility and convenience of hand-held transceivers, few fellows have bothered to construct these interesting little gadgets because of circuit complexity and component cost. The "Simple-Talkie," shown in the photographs, was designed specifically to overcome both of these problems. Since it requires only one transistor and a single crystal diode, the unit is not only easy to build, but inexpensive, as well.

The Circuit

The transmitter section contains a 2N373 transistor which acts as a 21-mc. third-overtone crystal oscillator. Although primarily an i.f. amplifier, the 2N373 was chosen because it costs less than $2.00, provides useful output at high frequencies, and has an adequate collector dissipation rating for this particular application. Modulation is accomplished with a carbon microphone which is coupled to the 2N373 emitter by C_1. Current for the microphone is supplied by the same battery that powers the oscillator.

Circuit diagram of the "Simple-Talkie" shows that it consists of a modulated, crystal-controlled transistor oscillator and a simple crystal-detector receiver.



R_1—10,000 ohm, ½ w. res.
R_2,R_4—560 ohm, ½ w. res.
R_3—50,000 ohm, ½ w. res.
C_1—30 µf., 15 v. elec. capacitor
C_2—1000 µµf. disc ceramic capacitor
C_3—3-30 µµf. mica trimmer
C_4,C_5—4700 µµf. disc ceramic capacitor
C_6—150 µµf. mica capacitor
C_7—140 µµf. var. capacitor (Hammarlund APC-140-B or equiv.)
RFC_1,RFC_2—2.5 mhy. r.f. choke (Grayburne F-25 "Ferri-Choke" or equiv.)
L_1—17 t. #20 wire, 5/8" dia., 3/16" long (B & W 3007) tapped 8 t. from C_3 end
L_2—6 t. #22 wire, 5/8" diam., 3/16" long (B & W 3008)
TS_1—Two-screw terminal strip
S_1—D.p.d.t. slide switch
J_1,P_1—Miniature 2-pin plug and jack (Lafayette MS-284 or equiv.)
CR_1—1N54 crystal diode
B_1—9-volt battery (Burgess 2N6 or equiv.)
Xtal.—21-mc. third-overtone quartz crystal
Mic.—Carbon microphone (see text)
V_1—2N373 transistor
I—Crystal or high-Z magnetic earphone

The receiver tuning capacitor, C_3, has sufficient range to cover the 14-, 21- and 28-mc. bands. Of the six lower frequency ham assignments, these are the ones where the majority of beam antenna checks are made and where most cases of TVI occur. The crystal detector is conventional, except for RFC_1 and RFC_2. These chokes isolate the crystal earphone cord from the rest of the circuit, at least as far as r.f. is concerned. Consequently, a 3-foot length of fine wire may be wound around the cord to act as an antenna. Without the chokes, much of the energy picked up on this antenna wire would be shorted to ground by the capacity coupling that exists between it and the earphone cord that is used.

Construction

The case can be constructed of 1/8" Masonite. Fasten the front, sides, top, and bottom together with good quality glue or cement. The removable back should be held in place with screws that go into the small blocks of wood which are visible in the rear-view photo. One of these is in the upper right-hand corner while the other is just above the battery compartment near the left side of the case. Be sure to drill a small hole in the back to allow for screwdriver adjustment of C_3.

The outer dimensions of the "Simple-Talkie" are 6¼"x 3⅛"x 1³⁄₁₆". If you want to use subminiature parts and a jeweler's loupe, you can undoubtedly come up with a much smaller version. However, as it stands, the "Simple-Talkie" will easily fit into a jacket pocket. By steering away from extreme compactness you'll find that the wiring process is made much less difficult.

A 2"x 2⅞" piece of 1/16" thick Bakelite acts as the transmitter chassis. Mounting holes for the transistor and crystal sockets, as well as small holes for the leads of the various parts, must be drilled in the board. With the exception of C_2 and C_4, all components are mounted on one side of the board with their leads passing through to the other side where the interconnections are made. This style of construction is almost as compact as a printed circuit. For the home builder it is much more practical since it allows him to make revisions without having to etch a new board.

A carbon microphone cartridge removed from a surplus handset or chest microphone will provide adequate output to modulate the 2N373. The author used a *Western Electric* T-1 unit. Dial-drive cement holds it in place behind an opening in the front panel. Connections are made to the cartridge by soldering directly to the silver electrodes on its back.

Testing & Operation

Test the transmitter before you mount it in the case. Temporarily connect the battery. Set your communications receiver to the frequency in the 21-mc. band marked on the third-overtone crystal. As you tune C_3 through its range, the signal from the transmitter should be heard in the receiver. If it isn't, carefully recheck the wiring. The circuit isn't tricky and the oscillator ought to start without difficulty. A number of transistors and crystals were tried in the original "Simple-Talkie" and they all worked right off the bat. Measure the current drawn by the oscillator. It should be in the vicinity of 1 to 1½ ma.

Now connect the mike and talk into it. The audio quality won't be hi-fi, but if the unit is working properly, the speech signal will be satisfactory for communications purposes. After you have checked out the transmitter, mount it in the case, along with the receiver components, and finish wiring the unit.

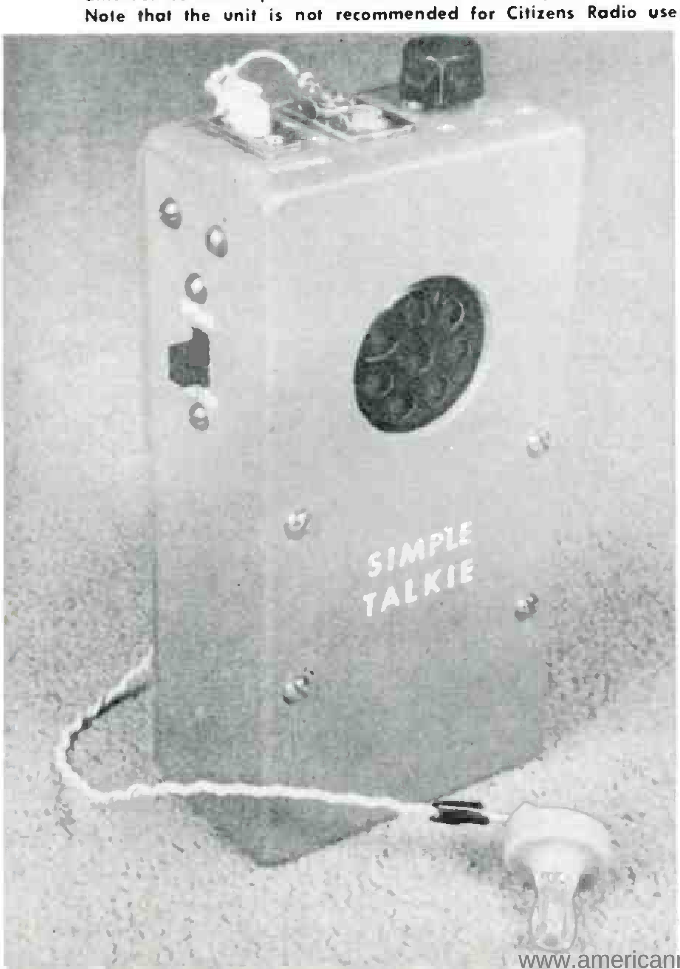
Antennas & Range

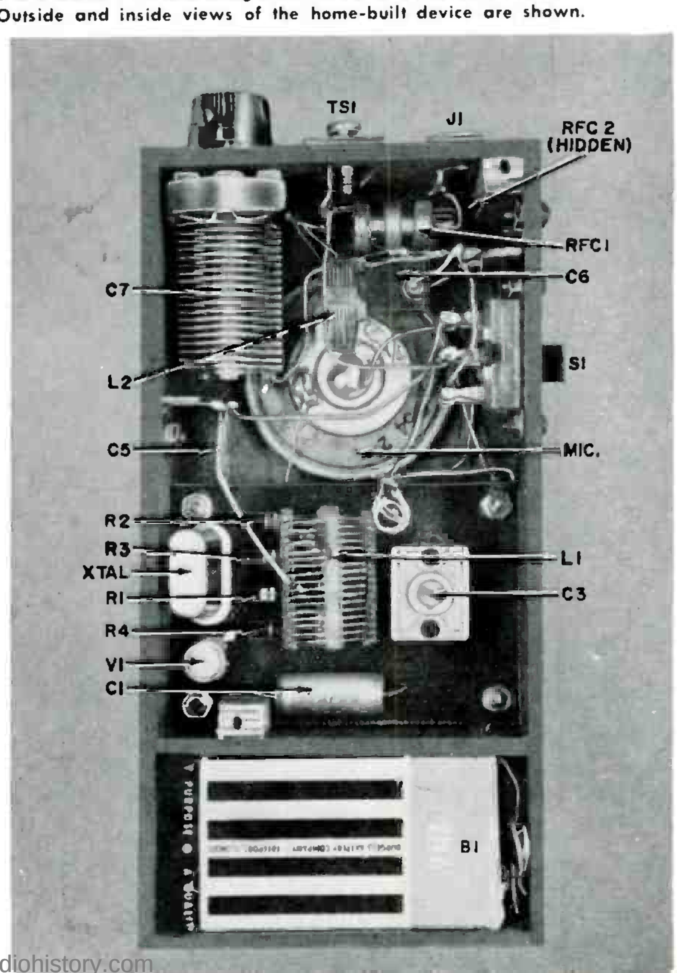
A number of different antenna types may be used with the "Simple-Talkie." When you're climbing around on a roof or are up on a tower, you won't want to bother with a whip. Under these circumstances, you can use the wire previously referred to which is wrapped around the earphone cord. Tape one end of this wire near the phone and spiral wind it along the cord. Solder a lug to terminal the other end and connect it to terminal "A" of TS_1. This arrangement will work satisfactorily as long as you are within approximately 100 feet of the beam or other antenna which is tied to your home rig.

When greater range is desired, remove the earphone antenna from "A" and connect it to terminal "G" of TS_1.

(*Continued on page* 74)

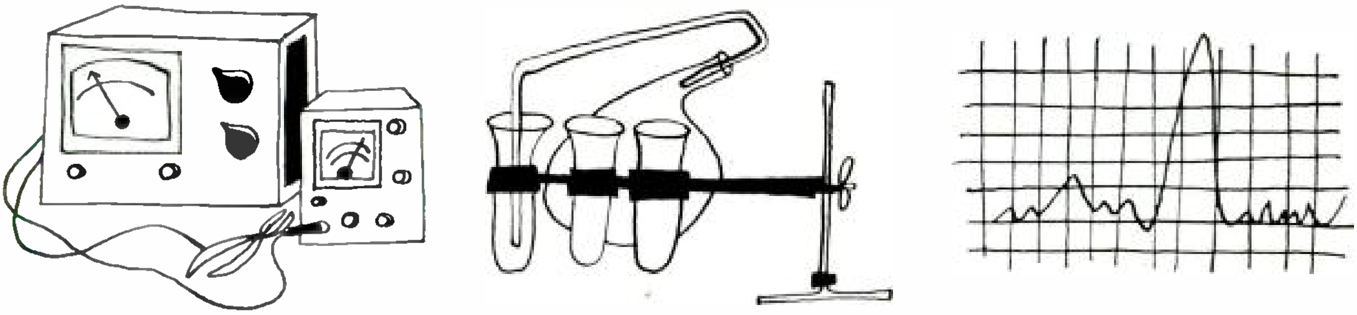
The inexpensive device shown here contains a 21-mc. radiophone transmitter and a receiver that tunes the 14-, 21-, and 28-mc. amateur bands. It provides a convenient two-way communications link which aids in making transmitter, antenna, and TVI tests. Note that the unit is not recommended for Citizens Radio use. Outside and inside views of the home-built device are shown.





Electrophoresis:

• TECHNIQUES • APPLICATIONS • MAINTENANCE •



By **JOHN R. COLLINS** / The electrical properties of complex molecules, like proteins found in living tissues, permit separation and identification. This facilitates blood analysis and other lab tests.

ALL living cells, animal and vegetable, are constituted of proteins, so it is not surprising that medical and biochemical laboratories devote much effort to separating and examining protein materials. The task is not easy, for protein molecules are large, heavy, and quite complex, being made up of strings of amino acids which, in turn, are composed of clusters of carbon, hydrogen, oxygen, nitrogen, and sometimes other atoms. Their electrical properties in solution will startle electronic technicians accustomed to dealing with more elementary particles. Modern electronic devices, however, have gone far towards taking the witchcraft out of protein analysis and making it a science.

Proteins are separated and analyzed by an electrochemical process called *electrophoresis* (Greek for "borne by electricity"), a system based on the ability of an electric current to transport charged particles in solution. Although many solutions, including spinal fluid and tears, have been examined electrophoretically, most research has centered on blood serum—the clear, slightly yellowish liquid which remains when blood is allowed to clot and the blood cells and fibrin have been removed.

Blood serum is composed chiefly of the protein materials globulin (subdivided into *alpha* 1 and 2, *beta*, and *gamma* types) and albumin. Their relative concentration in the blood is not constant, but varies with cell metabolism. Electrophoresis provides a means of comparing the concentration of proteins in a patient's serum with a normal sample.

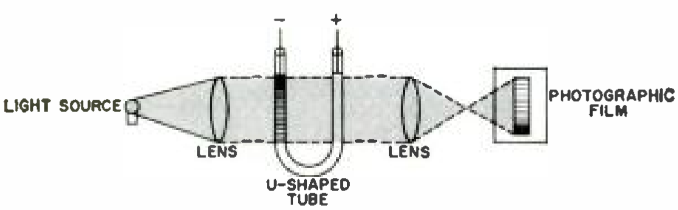


Fig. 1. Elementary apparatus for electrophoretic analysis.


Fig. 2. Filter-paper strip with separate bands of proteins.

Much literature has been compiled on the relationship between the concentration of blood proteins and various physical disorders. Cirrhosis of the liver, for example, is characterized by a marked decrease in albumin and an increase in *gamma* globulin. An elevation of *beta* globulin, or sometimes of *alpha* 2 globulin, occurs in multiple myeloma, a disease attacking the bone marrow. A deficiency of *gamma* globulin appears to be related to unusual susceptibility to virus infections.

Electrophoresis is useful not only for diagnosis—it is valuable also for following the success of measures taken to cure disorders.

Basic Theory

Migration of ions in solution to charged electrodes is a familiar process. Less familiar is the migration of larger particles, often composed of many molecules. However, scientists discovered many years ago that clay particles in muddy water would migrate if electrodes were placed in the water and a battery connected across them. The phenomenon was traced to partial ionization, a condition in which atoms or molecules on the surface of particles become ionized while the rest remain uncharged.

Because of their huge size, protein molecules behave like large particles and are subject to partial ionization. Unlike most other particles, however, protein molecules may carry either a positive or negative charge, depending on the acidity of the solution in which they are dissolved. This unusual characteristic is traced to partial ionization.

Protein molecules contain (among other elements) an amino group (NH_2) and a carboxyl group (COOH). In very acid solutions, the amino group forms the positive ion, NH_3+, while ionization of the carboxyl group is blocked. In less acid or alkaline solutions, the carboxyl group forms the negative ion, COO—, and ionization of the amino group is blocked. Consequently, a protein molecule may be attracted to either the positive or negative electrode, depending on the acidity of the solution containing it.

Each type of protein has an acidity at which its tendency to ionize is minimum. This is called its *isoelectric point*. Positive ions form if the surrounding solution is more acid, negative ions if it is less acid; at the isoelectric point, however, the forces are in balance and practically no ions are formed. It follows that conductivity is also minimum at the isoelectric point, since there are few charged particles to carry current.

The electric charge associated with a protein molecule increases as the acidity or alkalinity of the surrounding solution gets farther from the isoelectric point. Because they have different isoelectric points, each type of protein molecule will carry a different charge in a given solution. The speed of migration depends on the charge and molecular weight (also different for each type of protein) and these differences form the basis of electrophoretic separation.

Apparatus

The first experiments in electrophoresis were carried out in U-shaped tubes, as in Fig. 1. The mixture of proteins to be analyzed is dissolved in an electrolyte, called a *buffer solution,* and placed in the bottom of the tube. More buffer is then poured over the mixture, and a d.c. voltage impressed across it. Since the speed and direction of the protein molecules are determined by their weight and charge, molecules of the same type will all travel together at the same speed to form a distinct layer in the solution. If several proteins are present, as in blood serum, several layers will be formed. A light beam directed through the tube is diffracted by the various layers and then focused on a photographic film. Information on the nature and concentration of the ingredients is obtained by analyzing the resulting pattern.

The *moving-boundary* method, as this process is called, does not permit complete separation of the constituent proteins. Consequently, much present work is carried on in a supporting medium rather than in solution. When strips of filter paper are used as a supporting medium, proteins can be completely separated, and for this reason the process is called *zone separation.*

Paper Electrophoresis

The apparatus used for zone separation on filter paper is shown in Fig. 3. Two electrophoresis cells are displayed at the left. Each consists of a rack to hold the filter-paper strips, a Plexiglas container, and tanks to hold buffer solution. The paper strips, held in place with rubber pegs, are kept damp by means of paper wicks which extend from the strips to the tanks of buffer solution. Electrical contact is made by means of platinum electrodes extending the length of the cell.

The buffer-solution level must be high enough to cover the lower end of the wicks but not to touch the paper strips directly. The top of the Plexiglas cover has a slit running its entire length, which is normally covered with a strip of tape. About 15 minutes before beginning a test, the tape is peeled back, buffer solution is poured over the strips to wet them thoroughly, and the tape is replaced. When the excess liquid has drained off the strips and the cell is saturated with water vapor, the tape is again peeled back just long enough to permit the test sample to be applied in a narrow band to each strip. The tape is then replaced before too much water vapor escapes.

When these preparations are finished, the cell is connected to a regulated power supply, pictured in the center of Fig. 3. From 6 to 24 hours are needed for the proteins to separate into individual groups. During that period, it is important that the output of the power supply remain constant and that the moisture level be maintained in the cell. The cell must be kept away from direct sunlight or other sources of heat, since the mobility of the particles increases with temperature. It must also be kept sealed, since water vapor lost through evaporation is replaced by buffer solution, and this tends to change the acidity.

When separation is complete, the strips are removed from the cell, dried in an oven, dyed with a suitable dye—usually bromphenol blue—and thoroughly rinsed. The result is a strip with clearly defined pigmented bands, as shown in Fig. 2.

Proteins can be identified by the distance they migrate in a given period and at a known voltage. The relative depth of color is proportional to the amount of protein in each band. The filter paper itself does not retain the dye. An instrument called a recording densitometer, shown on the right in Fig. 3 and in some detail in Fig. 4, is used to determine the depth of color in the bands. For simplicity, only the most essential features have been portrayed. A densitometer must also have a lens system to focus the light, an adjustable slit for zeroing the instrument, and a constant-speed motor to drive the filter-paper strip and the recording chart.

The operating principle is not difficult to understand. Light from a tungsten lamp passes in a narrow beam through

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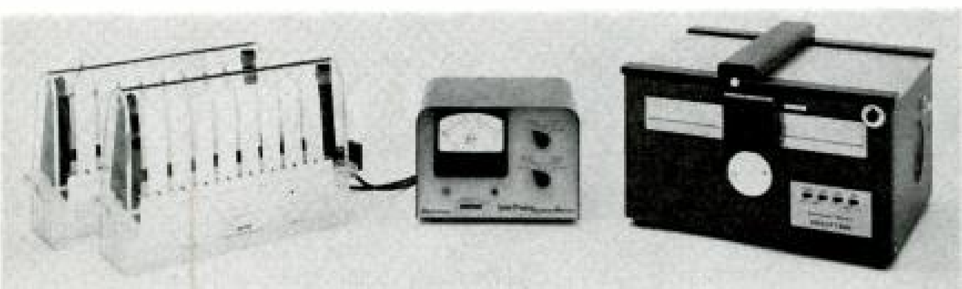


Fig. 3. Zone-separation apparatus: two cells (left), power supply, and densitometer (right).

Fig. 5. Typical curve traced by a recording densitometer. ▶

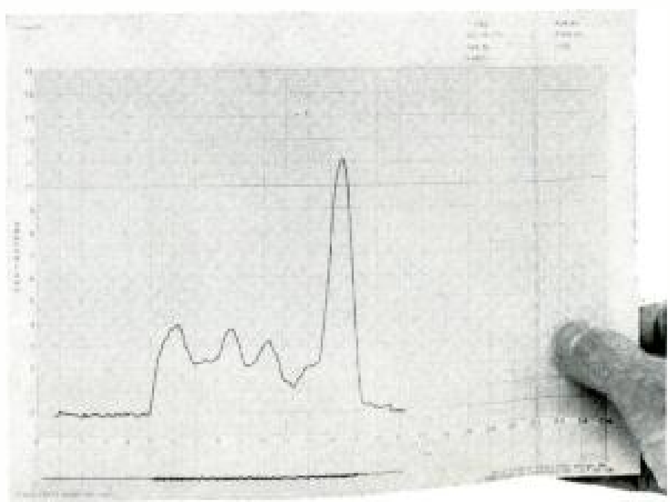
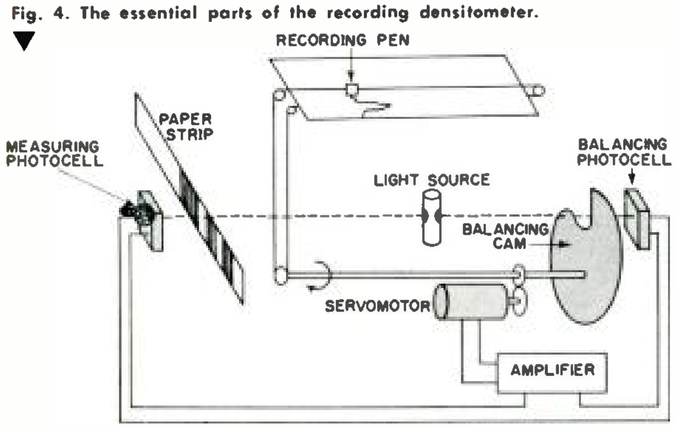
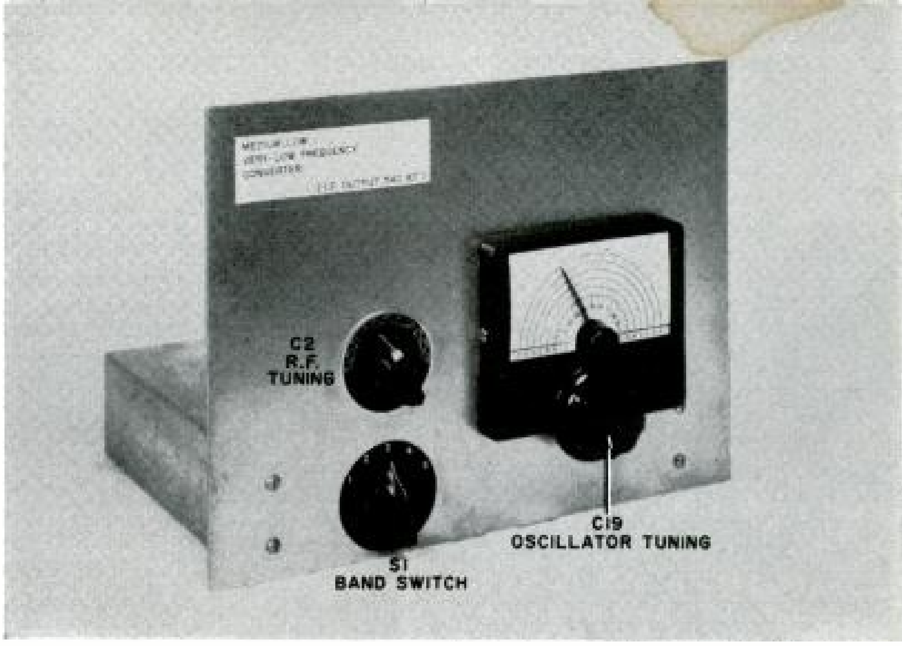


Fig. 4. The essential parts of the recording densitometer. ▼



Below the Broadcast Band



Front-panel view of the low-frequency converter constructed by the author. The output frequency of the unit is at the low end of the broadcast band.

THERE are many radio old-timers who vividly remember the long-wave radio stations which, in their day, used to provide hours of listening enjoyment in the form of code practice material, regular press copy, weather information, and time checks. There are many newcomers to radio who became familiar with the low-frequency services, with the multitude of marine radio beacon, aeronautical radio beacon, and aeronautical range stations, through their work in the Armed Forces during World War II and the Korean conflict.

Even so, the author has found that there are many persons actively engaged in electronics who are completely unaware of the considerable activity "below the broadcast band." The author was mildly surprised himself when he noticed, several months ago, an article announcing the new standard-frequency stations, WWVL and WWVB, which operate on 20 and 60 kc. respectively. That's right, kilocycles!

The purpose of this article is to give you an idea of what goes on "below the broadcast band" and to show how, without too much effort or expense, you can build a simple converter for your present receiver in order to tune the frequency range between 10 and 530 kilocycles.

Frequencies & Uses

First of all, what are these low-frequency bands called and why would anyone want to operate a transmitter on these low frequencies? The nomenclature for the frequency bands covered by this article is indicated in Table 1. The uses to which the frequencies from 10 to 510 kilocycles may be put are determined by international treaty. These allocations are shown in Table 2. The frequencies from 30 to 300 kc. are normally used for long-distance ground-wave communication. Frequencies in the medium band, covering 300 to 3000 kc., are usually used for long-distance communication over sea water or medium-distance communication over land. The use of ground-wave for transmission at low frequencies, providing sufficient power is used, permits 24-hour-a-day coverage of large global areas whereas sky waves cause fading and are subject to daily, seasonal, and other variations, due to the change in ionospheric conditions.

It was found, many years ago, that the use of frequencies well below 500 kc. in the northern latitudes (above 60 degrees North) was an effective means of maintaining radio communications during the magnetic disturbances or auroral conditions which sometimes prevented propagation of the higher frequencies entirely. Since very-low frequencies make use of the ground wave for transmission, stations operating on these frequencies may be found coming through in fine style morning, noon, and night all through the year.

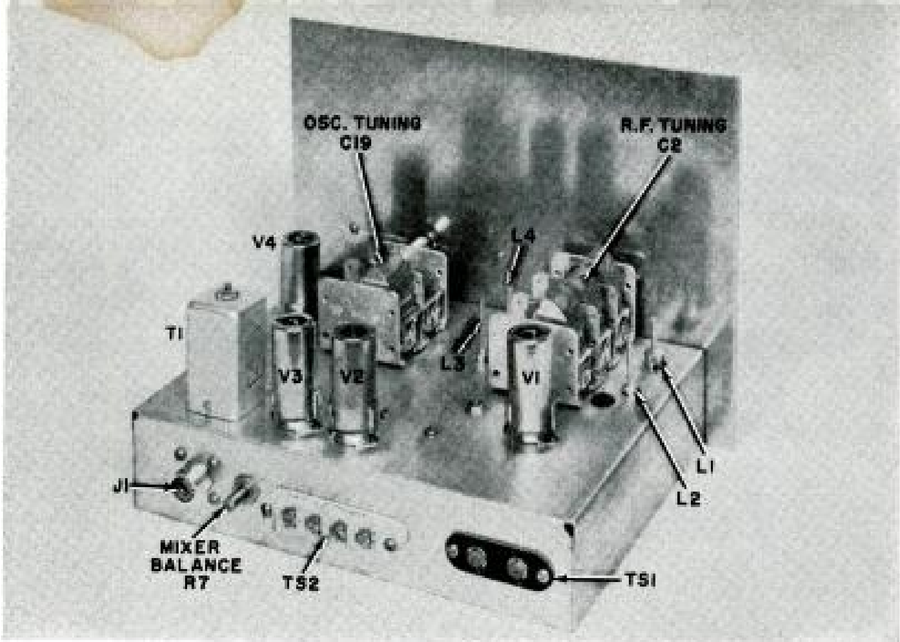
As far back as 1923, *AT&T* was operating a single-sideband transatlantic radiotelephone circuit on 55 kc. Even after the transatlantic and other circuits shifted operations to the higher frequencies, the low-frequency station was maintained as an emergency link with Europe when magnetic storms would virtually wipe out all higher frequency communications.

Not long ago, in November 1960, high-frequency radio conditions were the poorest that they had been in six years. A solar eruption took place on November 12 and on November 13 a high-frequency radio blackout existed to almost all areas of the world. During this time, the author was making checks on the low-frequency converter, which will be described later, and was able to copy many of the foreign c.w. stations operating in the v.l.f. region without difficulty. The reason for maintaining these very-low and low-frequency stations is obvious, especially today when breakdowns of foreign communication circuits are intolerable. There are, however, several other reasons for maintaining the existing stations and for adding new and higher powered stations to the v.l.f. spectrum.

The U.S. Navy operates quite a number of stations in the very-low and low-frequency bands. These stations are capable of running tremendous power in order to transmit information to Navy submarines lurking some 90 feet below the ocean surface. One such station is located at Jim Creek, Washington and can deliver a megawatt into its antenna system. This station is presently being keyed *via* a high-frequency radio link from San Francisco and uses the call NPG. Another Navy station, NBA in Panama, transmits timing signals on 18 kc. These signals consist of a keyed carrier of 300 milliseconds' duration, conforming to a particular pattern. This station operates 24 hours a day, seven days a week. WWVL, the National Bureau of Standards' station at Boulder, Colorado, has been transmitting continuously on 20 kc. since April 5, 1960 and is presently delivering 10 kw. to the antenna. WWVL transmissions

Table 1. Nomenclature for the frequency bands described in accompanying text.

Frequency Range	Frequency Subdivision
3-30 kilocycles	Very-low
30-300 kilocycles	Low
300-3000 kilocycles	Medium



Top chassis view. The r.f. tuning capacitor is actually made up of all three gangs of C_2 wired in parallel. For oscillator tuning, a single gang is used.

By RICHARD A. GENAILLE

Design of sensitive low-frequency converter for 10 to 530 kilocycle range. World-wide submarine and marine communications, aircraft beacons, weather and time signals may be heard via communications or broadcast set.

have been heard as far as 9000 miles from Boulder. Plans call for raising the power to 40 kw. and later to 300 kw.

WWVB, another Bureau of Standards' station at Boulder (formerly KK2XEI) has been operating on 60 kc. with an effective radiated power of 1.5 w. This station can be received at distances up to 1700 miles, using specialized narrow-band receivers and phase-lock systems. According to the Bureau, it is expected that the radiated power from WWVB will be raised to 6 kw. within the next year. Incidentally, the Bureau is quite interested in reports concerning special uses of the 20 and 60 kc. broadcasts from Boulder.

One might wonder why these standard-frequency stations are operating on such low frequencies. The reason is that the 20 and 60 kc. transmisions get away from the small, but significant, errors that result from ionospheric propagation of the higher standard-frequency transmissions. The need for extremely high accuracy in frequency and time measurement, together with the necessity for covering the globe irrespective of propagation conditions are the prime reasons for the shift to v.l.f.

In addition to providing the military with another useful communication channel and the scientist with a means for obtaining accurate technical information, the lower frequencies supply much useful material for almost anyone who may care to tune in. The experimenter can make good use of the standard-frequency transmissions for accurate calibration of audio-frequency and r.f.-signal generators. The ham or would-be ham who wishes to get in some code copying practice can find a number of civilian and military stations on the air sending excellent practice material

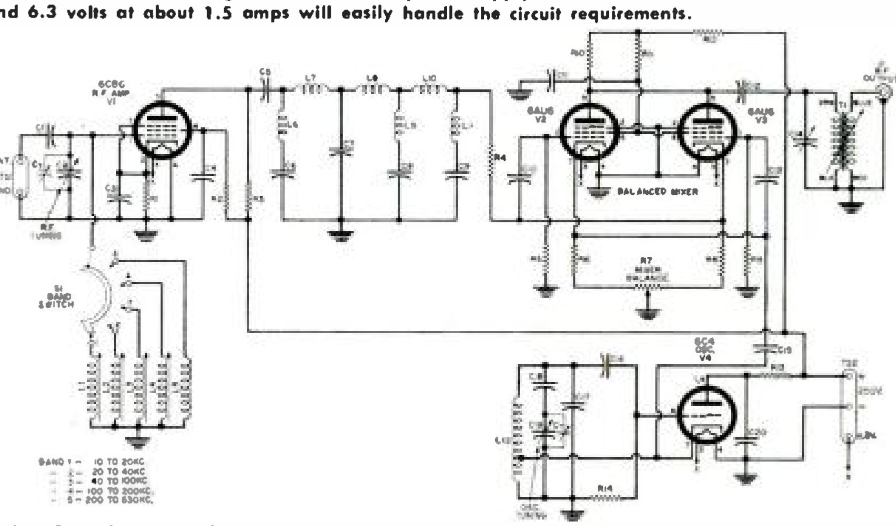


Fig. 1. Circuit incorporates balanced mixer to remove the local-oscillator signals as well as a low-pass filter network to attenuate local broadcast station signals. An external power supply that will deliver 250 volts at about 50 ma. and 6.3 volts at about 1.5 amps will easily handle the circuit requirements.

R_1—220 ohm, ½ w. res.
R_2—39,000 ohm, 1 w. res.
R_3—10,000 ohm, 1 w. res.
R_4—10,000 ohm, ½ w. res.
R_5, R_8—100,000 ohm, ½ w. res.
R_6, R_9—510 ohm, ½ w. res.
R_7—1000 ohm linear taper pot ("Mixer Balance")
R_{10}—1000 ohm, 1 w. res.
R_{11}—27,000 ohm, 1 w. res.
R_{12}—75,000 ohm, 2 w. res.
R_{13}—56,000 ohm, 2 w. res.
R_{14}—47,000 ohm, ½ w. res.
C_1, C_5—.01 µf. mica capacitor
C_2—36-1100 µµf. var. capacitor with trimmer (Allied 60 H 726 or equiv. with all three gangs connected in parallel. "R.F. Tuning")
C_3—.001 µf. disc ceramic capacitor
C_4, C_{11}, C_{20}—.1 µf. paper capacitor
C_6, C_9—18.3 µµf. capacitor (Centralab Type TCZ 15 µµf. and 3.3 µµf. connected in parallel)
C_7—61 µµf. capacitor (Centralab Type TCZ 51 µµf. and 10 µµf. connected in parallel)
C_8—16.8 µµf. capacitor (Centralab Type TCZ 10 µµf. and 6.8 µµf. connected in parallel)
C_{10}, C_{12}, C_{13}, C_{14}—.01 µf. paper capacitor
C_{15}—70-480 µµf. mica trimmer
C_{16}—100 µµf. silver mica capacitor
C_{17}—82 µµf. silver mica capacitor
C_{18}—.002 µf. silver mica capacitor
C_{19}—15-468 µµf. var. capacitor with trimmer (Allied 61 H 059 or equiv., use one gang only. "Oscillator Tuning")
L_1—45-215 mhy. horiz. linearity coil (Miller #6330 or equiv.)
L_2—15-60 mhy. horiz. linearity coil (Miller 6319 or equiv.)
L_3—4-30 mhy. horiz. linearity coil (Miller #6315 or equiv.)
L_4—.5-5 mhy. horiz. linearity coil (Miller #6313 or equiv.)
L_5—300 µhy. peaking coil (Miller #6155 or equiv.)
L_6, L_{11}—3.3 mhy. choke coil (Miller #976 or equiv.)
L_7—4.7 mhy. choke coil (Miller #978 or equiv.)
L_8—3.9 mhy. choke coil (Miller #977 or equiv.)
L_9—5.6 mhy. choke coil (Miller #979 or equiv.)
L_{10}—2.7 mhy. choke coil (Miller #975 or equiv.)
L_{12}—Osc. coil for 175 kc. i.f. (Miller #5481-K or equiv.)
J_1—U.h.f.-type coaxial connector (Amphenol SO-239)
S_1—S.p. 5-pos. non-shorting switch (Centralab #1000 or equiv.)
TS_1—Two-terminal strip (Birnbach #1260 or equiv.)
TS_2—Three- or four-terminal strip (Millen #37304 or equiv.)
T_1—540-1700 kc. ant. coil (Miller #A320-A or equiv. with low-impedance primary connected to output connector, see text)
V_1—6CB6 tube
V_2, V_3—6AU6 tube
V_4—6C4 tube

Kilocycles	Service
10-14	Radio navigation
14-90	Fixed, Maritime mobile
90-110	Fixed, Maritime mobile, Radio navigation
110-160	Fixed, Maritime mobile
160-200	Fixed
200-285	Aeronautical mobile, Aeronautical navigation
285-325	Maritime navigation (radio beacons)
325-405	Aeronautical mobile, Aeronautical navigation
405-415	Aeronautical mobile, Aeronautical navigation, Maritime navigation (radio direction finding)
415-490	Maritime mobile
490-510	Mobile (distress and calling)

Table 2. Partial listing of various services and their frequency allocations.

in the form of regular press copy or code groups.

Again, for the ham or other experimenter, there are at least a dozen stations sending radioteletypewriter signals. These stations are on continuously, making it possible to copy for extended periods of time in order to make adjustments to one's equipment. Many persons will find that copying DX signals on the low frequencies can be a most fascinating pastime. Still others may make considerable use of the very detailed weather information available from the aeronautical range and navigation stations operating in the medium-frequency range. The biggest problem will be what to use for receiving the very-low, low, and medium frequencies. Receivers for these bands are not exactly easy to come by, even on the surplus market.

Low-Frequency Converter

Low-frequency receivers are not readily available unless one has inherited one from World War I days, however, a most satisfactory arrangement is to use a converter in conjunction with a reasonably good general-coverage receiver. A converter to tune the low frequencies can be constructed quite easily and without all of the problems confronting the builder of a v.h.f. or u.h.f. type converter. The one constructed by the author worked so well, even as a breadboard model, that it is quite possible others interested in low-frequency work will wish to use the same or similar arrangement.

The unit shown in the photographs covers the range from approximately 10 kc. to 530 kc. The i.f. output is set at 540 kc. and feeds directly to the antenna connector on the author's general-coverage *Hallicrafters* SX-96 receiver. All of the components used are standard broadcast and TV receiver replacements, obtainable at most radio parts dealers. Those who use the components specified in the parts list can use the photos as a guide to parts layout.

The schematic of the low-frequency converter is shown in Fig. 1. V_1 is a 6CB6 used in a common circuit arrangement as an r.f. amplifier. In order to make use of a reasonably priced tuning capacitor, it was decided to provide coil bandswitching. The cost of larger capacitors which would cover a greater tuning range and possibly result in the elimination of one or more coils is hardly justifiable in view of the considerable hop in price when going from the inexpensive three-gang tuning capacitor to something larger. Four horizontal linearity coils are used, together with a peaking coil, to obtain the coverage desired. Coil L_1 covers the 10 to 20 kc. range, L_2 covers 20 to 40 kc., L_3 covers 40 to 100 kc., L_4 tunes 100 to 200 kc., and peaking coil L_5 takes the unit from 200 to 530 kc.

The filter following the r.f. amplifier may or may not be required depending on the proximity of local broadcast stations. This filter, consisting of coils L_6 through L_{11} and capacitors C_8 through C_9, is designed to attenuate all signals above 530 kc. with extremely high attenuation at the i.f. output of 540 kc. At the author's location at least three broadcast stations are within a few miles and cause some "birdies" to appear on the dial at various points if the filter is not used.

The oscillator tube, a 6C4, is used in a conventional Hartley circuit. The tuning range is approximately 550 to 1070 kc. As would be imagined, the stability of the oscillator at the frequencies tuned is extremely good.

Since, at the very-low frequencies, the oscillator is tuned to within 10 kc. of the i.f., it was decided that because of the variation in selectivity of general-coverage receivers it would be advisable to attenuate the oscillator frequency in the mixer circuit. This called for some type of balanced mixer circuit which would not only attenuate the input signal but the oscillator signal as well, leaving only the 540-kc. beat at the output. The circuit in which V_2 and V_3 are used performs the mixing function well and provides the desired attenuation. This balanced mixer is unique in that single-ended inputs can be used and single-ended output is available, thus eliminating the need for balanced push-pull drive and simplifying the circuit arrangement. R_7 is the mixer balance control whose adjustment will be described later.

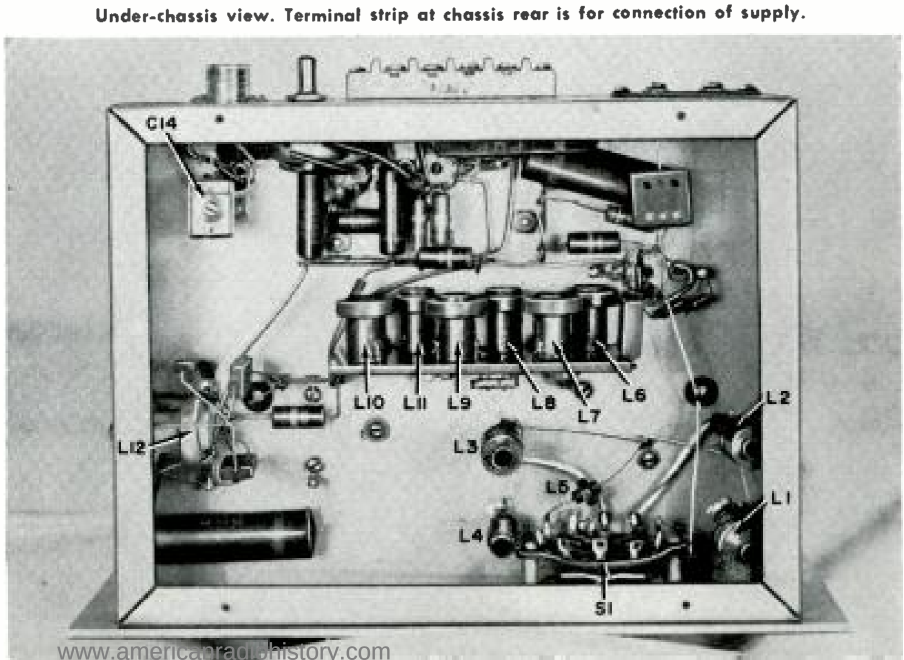
Output transformer T_1 is an antenna coil normally used to match a low-impedance antenna to a high-impedance grid circuit. In this circuit the coil is reversed in order to provide a better match to the receiver input. Present-day receivers are usually designed for a fairly low input impedance, on the order of 50 to 300 ohms.

Construction of the unit is straightforward, with no gimmicks or other tricks required to obtain satisfactory performance.

Alignment of Converter

Alignment of the converter is quite simple. After checking the wiring, power should be applied and the unit permitted a short warm-up period. During warm-up connect a short length of wire to the general-coverage receiver antenna terminal and set the receiver to tune the broadcast band. Place the short antenna from the receiver near

(*Continued on page* 90)



Under-chassis view. Terminal strip at chassis rear is for connection of supply.

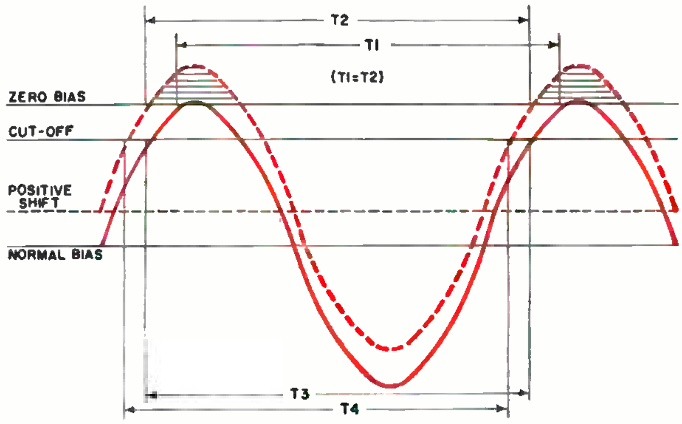


Fig. 1. Sine-wave frequency is usually unaffected by bias shift.

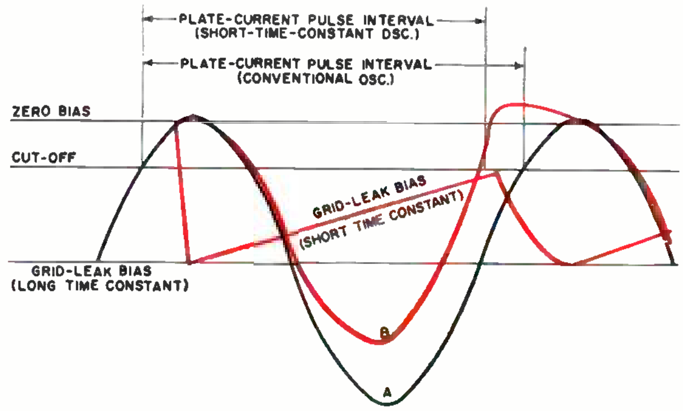


Fig. 2. Operation with long and short time constants compared.

NEW HORIZONTAL OSCILLATOR FOR TV

By LOTHAR STERN, Motorola Inc.

A modification of the old sine-wave circuit combines its advantages with those of more recent generators.

FEW TV circuits have undergone as much change as the horizontal oscillator. This vital circuit is involved in more than one function. The force that drives the electron beam across the CRT face is ultimately derived from it. The high voltage that makes the beam possible also stems from this source. Simplification, improved performance, and greater reliability—characteristics that do not always go hand in hand—have been the reasons for modification. Recent *Motorola* receivers use an oscillator that represents an interesting reconciliation of the advantages sought.

A review of horizontal oscillators, past and present, illustrates the problems. Early sets used sine-wave generators, which provided high-level output but became unwieldy because of the required auxiliary circuitry. In addition to a phase detector for noting frequency deviation, a reactance-tube stage was needed to obtain oscillator correction.

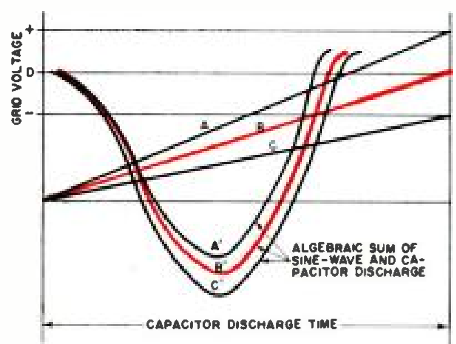
Thus the shift to forms of multivibrators or blocking oscillators occurred. These two were simpler in that they eliminated the elaborate reactance tube, as frequency could now be controlled by direct application of the correction voltage to an oscillator grid.

With the advent of the present wide-angle picture tubes, however, increased deflection power was needed—more than could be developed directly from the output of a multivibrator or blocking oscillator. Following up such circuits with additional amplifiers meant adding more stages—the very reason for which the sine-wave oscillator was abandoned. The *Motorola* circuit, a modification of the sine-wave oscillator, eliminates the reactance tube and its associated parts while providing all the driving power needed. It simultaneously reduces complexity, improves noise immunity, and is more reliable. This is accomplished with a design change that makes frequency control possible by direct application of a d.c. voltage to the oscillator grid.

To understand the difference, we must recall why the conventional sine-wave oscillator does not lend itself to such control. The time constant of its grid-leak resistor and capacitor is long, so that grid bias does not fluctuate. Suppose we chose to change this bias—say through the addition of a small, positive voltage in series with the normal, grid-leak bias, as would be achieved by direct application of a d.c. control voltage. The solid lines in Fig. 1 show the normal bias and normal grid waveform in such a circuit. The broken lines show the reduced bias resulting from the addition of a positive voltage and the corresponding waveform.

The zero-bias line may be used to observe whether a frequency change has occurred. With it, we can measure from a point in one sine-wave cycle to the corresponding point in the next cycle. This interval is exactly the same for the original waveform (T_1) as it is for the one that occurs after the bias shift (T_2).

Fig. 3. Effects of grid-voltage changes.



Suppose that the stage was originally biased so that plate conduction would occur only during the upper portions of the positive-going halves of the sine wave. The interval between the start of plate-current pulses is shown as T_3. When bias is reduced, the plate pulse (T_4) would start sooner, but the interval would not be changed. In other words, there would be a slight shift in phase, but frequency would be the same. Actually there would be a short-term increase in frequency *while the bias was changing*, but this would quickly revert to normal frequency due to the self-neutralizing property of the bias.

Introduction of a negative voltage to increase bias would similarly fail to alter frequency. In addition, this could produce instability by increasing total bias to the point where amplitude of the oscillations in the tank circuit might not be high enough to produce grid conduction at the peak of each cycle.

The characteristic opposition to frequency change, however, can be modified by reducing the values of the grid-leak resistor and capacitor to shorten the time constant substantially. The resultant bias will no longer be fixed, since the capacitor will be permitted to discharge appreciably during each cycle of oscillation and then to recharge. This brings about more than one noteworthy deviation from the normal situation already described.

In Fig. 2, the normally fixed bias obtained with a long time constant is again shown, along with the oscillator output (waveform *A*) associated with it. Also shown is the fluctuating bias voltage at the grid, resembling a saw-tooth, due to the discharging and charging of the capacitor when a short time constant is used.

The total grid voltage at any instant is actually the algebraic sum of the voltages due to tank-circuit oscillation and bias variation at that instant. Thus if we combine the voltage waveform for the fluctuating bias with that of the oscillator tank (waveform *A*), the result is waveform *B*.

The firing or cut-off point of the tube,

(*Continued on page* 96)

DOMESTIC REPLACEMENTS for

This list of available types for current models in 24 brands, European as well as Japanese, is based on specific applications and sets rather than mere transistor-to-transistor correlation.

THE USUAL list of transistor equivalents gives the number of each foreign-made type and, along with it, the number of the type made in this country whose characteristics correspond most closely to the former. The approach used here, which is quite different, was chosen for more reasons than the mere sake of novelty.

The receivers in question need not have been made abroad themselves. It often happens that radios are put together here with transistor complements obtained from other shores. Nevertheless, with few exceptions, the transistor type numbers on foreign-made units differ from designations used in this country. This is true even where readily available, American-made types are highly similar in both electrical and physical properties—a fact which helps make direct replacement easier.

Transistors are not the only semiconductors used in many of the circuits in question. Since the problem of relating dissimilar type numbers carries over into the replacement of crystal diodes, equivalents for imported detectors are also included in the listing.

The reasons for using the receiver and the application as the basing points for choosing a replacement, rather than the

RADIO NAME AND MODEL	CONVERTER OR MIXER		OSCILLATOR		1st I.F. AMPL.		2nd I.F. AMPL.		A.F. DRIVER		A.F. AMPLIFIER		OTHER		
	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	USE
CHANNEL-MASTER															
6501	2T73	——			2T76	——	2TS20	——	2T66	2N649	2T66	2N649			
6502	2T73	——			2T76	——	2TS20	——	2T66	2N649	2T66	2N649			
6503	2T73	——			2T76	——			2T65	2N649	2T65	2N649			
6504	2T73	——			2T76	——			2T65	2N649	2T65	2N649			
6508	2SA52	——			2SA49	——	2SA53	——	2SB54	2N406	2SB56	2N40B			
6509	2SA52	——			2SA49	——	2SA53	——	2SB54	2N406	2SB56	2N408			
6511	2SA52	2N412			2S53	2N410	2S53	2N410	2S44	2N406	2S56	2N408			
6512	2S60	——			2S53	2N410	2S45	2N410	2S44	2N406	2S56	2N408	2S44	2N406	A.G.C. Ampl.
6514	2S60	——			2S53	2N410	2S45	2N410	2S44	2N406	2S56	2N408	2S44	2N406	A.G.C. Ampl.
COLUMBIA															
400	2S52	2N412			2S53	2N410	2S45	2N410			2S56	2N408			
600	2S52	2N412			2S53	2N410	2S45	2N410	2S54	2N408	2S56	2N408			
610	0C44	2N219			0C45	2N218	0C45		0C71	2N406	0C72	2N408			
CONTINENTAL															
150	HJ23D	2N411			HJ22D	2N409			HJ15	2N405	HJ17D	2N407			
160	HJ23D	2N411			HJ22D	2N409	HJ22D	2N409	HJ15	2N405	HJ17D	2N407			
MB-7	2SA17	——	2SA81	——	2SA12	2N218	2SA12	2N218	2SB75	2N215	2SB77	2N217	HV-15	1N2326	Diode
SW-7	HJ60	——	HJ71	——	2N218	2N218	2N218	2N218	2N215	2N215	2N217	2N217			
TR-100	2S30	2N412			2S31	2N410			2S33	2N408	2S33	2N408			
TR-200	2N219	2N219			2N218	2N218	2N218	2N218	2N215	2N215	2N217	2N217			
TR-215	2S30	2N412			2S31	2N410	2S31	2N410	2S32	2N406	2S33	2N408			
TR-300	2S31	2N410	2S30	2N412	2S31	2N410	2S31	2N410	2S32	2N406	2S33	2N408	2S32	2N406	1st A.F. Ampl.
TR-632	2SA15	2N219			2SA12	2N218	2SA12	2N218	2SB75	2N406	2SB77	2N408	HV-15	1N2326	Diode
TR-650	2SA15	2N219			2SA12	2N218	2SA12	2N218	2SB75	2N215	2SB77	2N217	HV-15	1N2326	Diode
TR-751	2SA80	——			2SA83	——	2SA83	——	2SB75	2N406	2SB77	2N408	HV-15	1N2326	Diode
CROWN															
TR-666	HJ23D	2N412			HJ22D	2N410	HJ22D	2N410	HJ15	2N408	HJ17D	2N408			
TR-875	HJ73	——	HJ71	——	2N218	2N218	2N218	2N218	HJ62	2N215	2N217	2N217	HV-15	1N2326	Diode
TR-999	2SA152	——	2SA152	——	2SA14	——	2SA151	——	2SB153	2N406	2SB154	2N408	HV-15	1N2326	Diode
EXCEL															
T-7	2S52	2N140			2S13	2N139	2S13	2N139	2S14	2N109	2S56	2N109			
FLEETWOOD															
NTR-6G	2S30	2N412			2S31	2N410	2S31	2N410	2S32	2N406	2S33	2N408			
HITACHI															
TH-621	HJ23D	2N140			HJ22D	2N139	HJ22D	2N139	HJ15	2N109	HJ17D	2N109			
TH-627R	2SA84	2N412			2SA12	2N410	2SA12	2N410	2SB75	2N406	2SB77	2N408			
TH-664	HJ23	2N412			HJ22	2N410	HJ22	2N410	HJ15	2N406	HJ17	2N408			
TH-862R	HJ74	2N219	2N219	2N219	2N218	2N218	2N218	2N218	2N215	2N215	2N217	2N217			
WH-761M	2SA84	——	2SA84	——	2SA12	2N410	2SA12	2N410	2SB75	2N406	2S877	2N408	HV-15	1N2326	Diode
WH-822	HJ72	——	HJ71	——	2N218	2N218	2N21B	2N218	2N215	2N215	2N217	2N217			
LAFAYETTE															
FS-91	2SA152	2N412	2SA152	2N412	2SA14	2N410	2SA151	2N410	2SB153	2N406	2S8154	2N408	HV-18	1N2326	Diode
FS-112	2T73	——			2T76	——	2T76	——	2T85	2N649	2TB9	2N649			
LINMARK															
T-60	2S52	2N412			2S53	2N410	2S53	2N410	2S24	2N408	2S56	2N408			
T-61	2S52	2N412			2S53	2N410	2S53	2N410	2S24	2N408	2S56	2N408			
T-62	2S52	2N412			2S45	2N410	2S45	2N410	2S44	2N408	2S56	2N408			
T-63	2S52	2N412			2S49	2N410	2S53	2N410	2S44	2N406	2S56	2N408			
T-80	ST333	——			2S156	——	2S156	——	2S159	2N406	2S163	2N408			
T-40	2S52	2N412			2S49	2N410	2S53	2N410			2S44	2N406			

IMPORTED TRANSISTORS

By JERRY EIMBINDER
Semiconductor & Materials Div., RCA

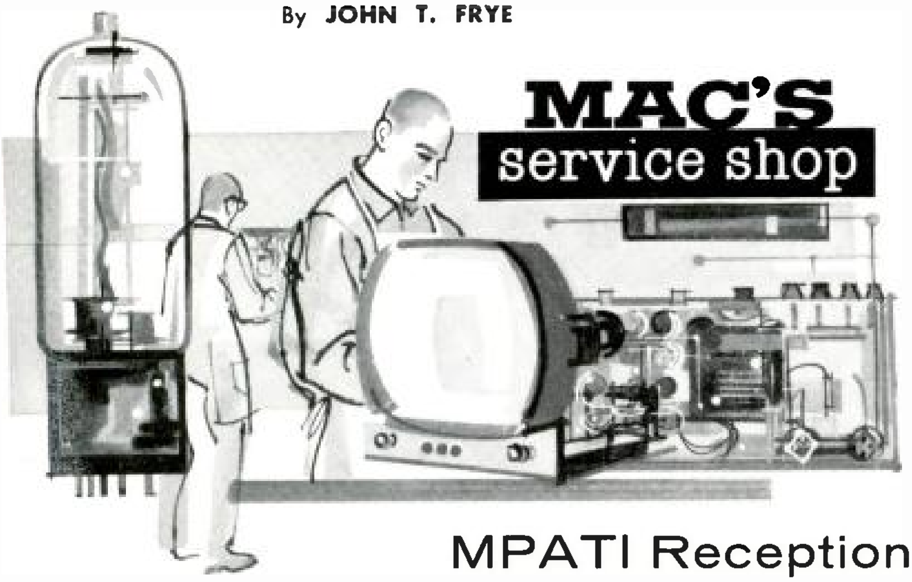
transistor directly, are several. To begin with, the number on a defective transistor may have become illegible. However, the receiver itself is obviously on hand. Since the chart also identifies each transistor by the stage in which it is used, as well as the set, proper replacement without unnecessary guesswork is still possible. A simple schematic or other identifying sticker on the chassis or in the case will simplify the job. If it is not available, some relatively minor circuit tracing should establish the circuit function by clarifying the relationship of the stage to others in the receiver.

A careful scanning of the chart will show that, where a given foreign transistor appears more than once, the recommended domestic equivalent listed is not always the same in each case. The apparent inconsistency is further evidence of the advantage this type of chart holds over a straight-forward transistor-for-transistor listing. Depending on differences in specific characteristics, one transistor may work very well when replacing a similar but not identical type in one application, but make a poor substitute for the same original unit in another position. Voltage ratings may be a factor. Transistor *A* may take over admirably for transistor *B*, for example, in a set whose battery potential is only 4½ volts. In a 12-volt receiver, however, transistor *A* may be in danger of breakdown. In other cases, differences in frequency characteristics may be a factor.

In trying replacements, a couple of precautions should be kept in mind. First, the power must be turned off when making the substitution. Although this sounds elementary, it is easily overlooked when plug-in transistors are involved. Second, re-alignment for optimum performance may be desirable. Most replacements are available from more than one source. All are available from *RCA*. ▲

RADIO NAME AND MODEL	CONVERTER OR MIXER		OSCILLATOR		1st I.F. AMPL.		2nd I.F. AMPL.		A.F. DRIVER		A.F. AMPLIFIER		OTHER		
	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	ORIG. TYPE	REPLACE. TYPE	USE
MACO															
T-16	0C44	2N219			0C45	2N218	0C45	2N218	0C71	2N408	0C72	2N408			
MINUTE MAN															
6T-170	2S52	2N412			2S45	2N410	2S45	2N410	2S44	2N406	2S56	2N408			
NANOLA															
6TP-106	2S52	2N412			2S49	2N410	2S45	2N410	2S44	2N406	2S56	2N408			
NORELCO															
L-0X95T	0C49	——			0C45	2N218	0C45	2N218	0C71	2N406	2N217	2N217			
L-1X75T	0C44	2N219			0C45	2N218	0C45	2N218	0C71	2N406	0C72	2N270			
L-2X97T	0C44	2N219			0C45	2N218	0C45	2N218	0C71	2N406	0C72	2N408			
L-3X76T	2N247	2N274			2N218	2N218	2N218	2N218	0C71	2N406	2N270	2N270			
L-3X86T	0C170	2N371			0C45	2N410	0C45	2N410	0C71	2N406	0C72	2N270			
L-3X88T	0C170	2N371			0C45	2N410	0C45	2N410	0C71	2N406	0C72	2N408			
L-3X95T	0C170	2N371			0C45	2N410	0C45	2N410	0C71	2N406	0C72	2N408			
L-4X95T	0C170	2N371			0C45	2N410	0C45	2N410	0C75	2N406	0C72	2N408			
NORDMENDE															
Mambo	2N113	2N412			0C612	2N410	0C612	2N410	0C304	2N406	0C74	2N408			
Transista	0C615	2N1178			AF105	2N1180	AF105	2N1180	0C304	2N406	0C74	2N408	0C614	2N1180	I.F. Ampl.
PETITE															
NTR-120	2S30	2N412			2S31	2N410	2S31	2N410	2S32	2N406	2SB33	2N408			
NTR-150	2SA30	2N412			2SA31	2N410	2SA31	2N410	2SB32	2N406	2SB33	2N408			
POLYRAD															
P-86	2N219	2N219			HJ62	2N410	HJ62	2N410	2N215	2N215	2N217	2N217			
REALISTIC															
90L696	2S52	2N412			2S53	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
REALTONE															
TR-555	2NJ8A	2N219			2NJ5A	2N218			2NJ9D	2N215	2NJ9A	2N217			
TR-801	2NJ8A	2N219			2NJ5A	2N218	2NJ5A	2N218	2NJ9D	2N215	2NJ9A	2N217			
SHARP															
TR-182	2S52	2N411			2S45	2N409	2S53	2N409	2S54	2N407	2S56	2N407			
SONY															
TR-710A	2T201	2N412			C76	——	C76	——	D64	2N649	2T312	2N408			
TR-711	2T201	2N412			2T76	——	2T76	——	2T65	2N649	2T85	2N649			
TR-714	2T201	2N412			2T75	——	2T76	——	2T64	2N649	2T65	2N649			
TR-812	2T201	2N372	2T201	2N371	2T76	——	2T76	——	2T64	2N649	2T323	2N408			
STUZZI															
671-B									0C304	2N217	0C308	2N217	0C360	2N217	A.F. Preampl.
TOSHIBA															
6TP-304	2S52	2N412			2S49	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
6TP-309	2S52	2N412			2S53	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
6TP-314	2S52	2N412			2S49	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
6TP-354	2S52	2N412			2S49	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
6TP-357	2S52	2N412			2S49	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
7TP-352	2S60	——			2S49	2N410	2S53	2N410	2S54	2N408	2S56	2N408			
8TR-294	2S52	2N412			2S53	2N410	2S53	2N410	2S54	2N408	2S56	2N408	2S44	2N406	A.G.C. Ampl.
VICTORIA															
TR-650	MC101	——			MC101	——	MC101	——	0C71A	2N406	0C72	2N408			
YASHICA															
YT-100	MC101	——			0C44	2N219	0C44	2N219	0C71	2N406	0C72	2N408	MA23	1N2326	Diode

By **JOHN T. FRYE**



MAC'S service shop

MPATI Reception

IT WAS the last of August, and Summer was starting to fade. She was still sufficiently beautiful, though, to require an unchivalrously sharp scrutiny to detect the failing bloom. However, if you were a cad and a worrier, you could see the days were a little shorter, the noonday shadows were a little longer, the grass was taking on a slight coppery tinge, and the leaves on the trees seemed a trifle tired from their long, long dance.

Mac and his assistant, Barney, had been pounding away at the radios and TV sets since early morning; but now they were taking a short breather.

"Say, Barney, I see the Midwest Program on Airborne Television Instruction plane is going to start a full academic year of broadcasts September 11th," Mac said. "How did you make out with receiving the test patterns and sample lessons telecast back in May?"

"Gosh, what with vacations and everything, I never did tell you about that, did I?" Barney exclaimed. "I had a real ball trying to find out what was important in picking up the transmissions from the plane. I didn't learn all the answers, but I learned some of them. The first thing I did was to go on the seventy-five meter amateur phone nets of Ohio, Michigan, Wisconsin, Illinois, and Indiana and alert the members to the fact the plane was going to start transmitting from KS2XGA on Channel 72 and KS2XGD on Channel 76 and ask that those who could try to pick up the test patterns and report to me.

"As you might know, the hams came through splendidly. They are trained observers, and most of them are interested in and have experience with u.h.f. reception. I received dozens of reports from locations ranging from directly beneath the plane to points 250 miles away from Montpelier, Indiana, over which the plane cruises while it is transmitting. The reports included such details as the kind of receiving equipment used, type and height of antenna, kind of feedline, comparison between straight u.h.f. receivers and converter-and-v.h.f.-receiver combinations, results obtained with two or three different antennas at the same receiving site, and the actual quality of reception on both channels."

"What conclusions did you reach from all this information?"

"My first conclusion is you can't depend on the height of the plane—it flies at 23,000 feet—to give you good reception automatically, even though you're within virtual line-of-sight range. The antenna is intended to radiate a circular pattern to the horizon some 210 miles away. This results in an area of comparatively weak signal within a radius of approximately thirty miles from the orbit point and explains why the first reports I got from directly beneath the plane were disappointing. I don't mean good reception can't be had inside this area, but you need more than a pair of rabbit ears for consistently good reception. You see, the fact the plane is flying a figure-8 pattern within a ten mile radius of the orbit point over Montpelier makes for a problem with a conventional antenna aimed at the horizon. The signal is coming *down* at an angle that varies sharply with the movement of the plane. An antenna for this close-in area must have a broad beamwidth both vertically and horizontally, and this rules out all high-gain antennas."

"How about here, some sixty miles away?"

"The recommended antenna for a distance of approximately fifty miles is one with a beamwidth of 50° and one with 6-db gain over a dipole cut to frequency. This beamwidth seemed twice what it should be to embrace a 10-mile-radius circle fifty miles away; so I checked with the MPATI people. They explained my trig was OK, but they had increased the radius of the plane's orbit to twenty miles in figuring the beamwidth to allow for the plane's being blown off course."

"How about vertical angles?"

"This is an important factor close to the plane, but at fifty miles, you only need to raise the line-of-sight five degrees from the horizontal to 'see' the plane at 23,000 feet; so I figure this is not important from fifty miles on out. The movement of the plane, though, causes something of a problem, for the signal goes through a slow waxing and waning as the plane moves toward and away from the receiving point. That means you need enough signal to keep the receiver's a.g.c. working all the time if this variation is not to be noticed in the picture."

"How about the tilting of the transmitting antenna as the plane banks? Doesn't that make a big difference in reception?"

"No, because the antenna is gyro-stabilized to keep it pointing at the center of the earth, plus or minus one degree, even when the plane goes into a twenty-degree bank. And incidentally, this is the first single antenna ever to transmit sound and picture for two channels simultaneously."

"What else did you learn?"

"I learned these u.h.f. frequencies—both channels are well above 800 megacycles—separate the men from the boys in receivers, antennas, and installations. Some corner-cutting v.h.f. receivers have u.h.f. added as a kind of selling feature. They will do a fair job on a strong local u.h.f. signal, especially one on the low end of the band; but when it comes to pulling that 800-megacycle-plus TV signal from a hundred miles away, these receivers can't cut the mustard. It takes a well-designed, low-noise u.h.f. front-end to do that. Some stations reported very poor reception, but a couple of days later they reported they were getting a good signal from the same antenna after they changed receivers or used a hot u.h.f. converter with the original receiver. Others improved their reception greatly by changing to a better type u.h.f. antenna."

"What kind of antenna is best?"

"There is no 'best' antenna for all locations. Beyond 150 miles, I had good reports from *Winegard's* collinear arrays, either the Model K1483 designed for general coverage or the Translator Model K7283-T. *Taco's* Model C-1033-T, *Channel Master's* parabolic reflector, corner reflectors, rhombics, and ten- or twelve-element yagis cut for the translator channels also gave a good account of themselves in these weak-signal areas. Closer in, excellent signals were picked up by vertically stacked bow-ties in front of a screen reflector."

"What did you use?"

"I started with just my all-v.h.f.-channel yagi antenna feeding into a *Blonder-Tongue* BTU-2S converter, working into my vintage Model 202 *Radio Craftsmen* receiver. This combination gave me good pictures on both channels. I figure the driven element of the v.h.f. yagi must act as a long wire at the u.h.f. frequencies, for I get the characteristic antenna pattern of four major lobes, each at about a 30° angle with the element, when I rotate the antenna. I connected a v.t.v.m. to the receiver's a.g.c. voltage so I could compare signal strengths produced by different antennas aimed in different directions, etc. Signals from the two channels were almost identical in strength, and both went through a slow variation as the plane passed over its flight pattern.

(*Continued on page 80*)

TAPE LOOPS FOR LANGUAGE LABS

By **RAOUL J. FAJARDO**

A simple method produces significant results in the growing area of audio-educational technology.

ELECTRONIC language laboratories, audio classrooms, and the like have become indispensable additions to modern educational institutions. (See "The Listening Center Technician," February 1961, ELECTRONICS WORLD.) With the array of available equipment and the variety of techniques it makes possible, instructors and electronic technicians are likely to overlook some simple but most useful techniques. One of these is the use of short-duration tape loops, which requires no equipment other than a conventional, portable tape recorder.

While doing post-graduate work at Stanford University, the author used such loops in the development of a language-teaching concept that can be called "sympathetic response." This method can be used not only in the process of learning a language, but also as an aid in the memorization of mathematical formulas or any other material where uniform repetition is required for memory reinforcement. However, before considering applications, let us first see how the tape recorder can be arranged to operate with a short-duration loop.

When the material to be learned has been decided upon, it is recorded, by the instructor or the student, at a speed of 3¾ inches per second. The slow speed keeps the length of the loop short. The material should not exceed one minute; a duration of 30 to 45 seconds is most desirable. Examples of what can be recorded in this length of time include a verb conjugation repeated by two voices, a brief conversational pattern, and three or four trigonometric formulas. Once the material is recorded, the tape is cut and the ends spliced together to form the endless loop, which is then ready for use.

The problem now is to set up the tape recorder to handle this loop. The accompanying illustrations show how this can be done with machines that operate either horizontally or vertically. No reels are used. The loop is threaded around the heads as usual, but the other end of the loop is held loosely around a smooth, metal hook of the comon hardware-store variety.

In the case of a vertical machine (Fig. 2), the hook can be fixed on a wall or door frame. The height of a one-minute loop at 3¾ ips would be about 9 feet, but the hook may be lower than this to permit some slack and to accommodate shorter loops. The machine is positioned on the floor to adjust the loop for satisfactory tension.

Fig. 1. With a hook in the separated cover of a horizontal machine, spacing may be adjusted to accommodate loop size.

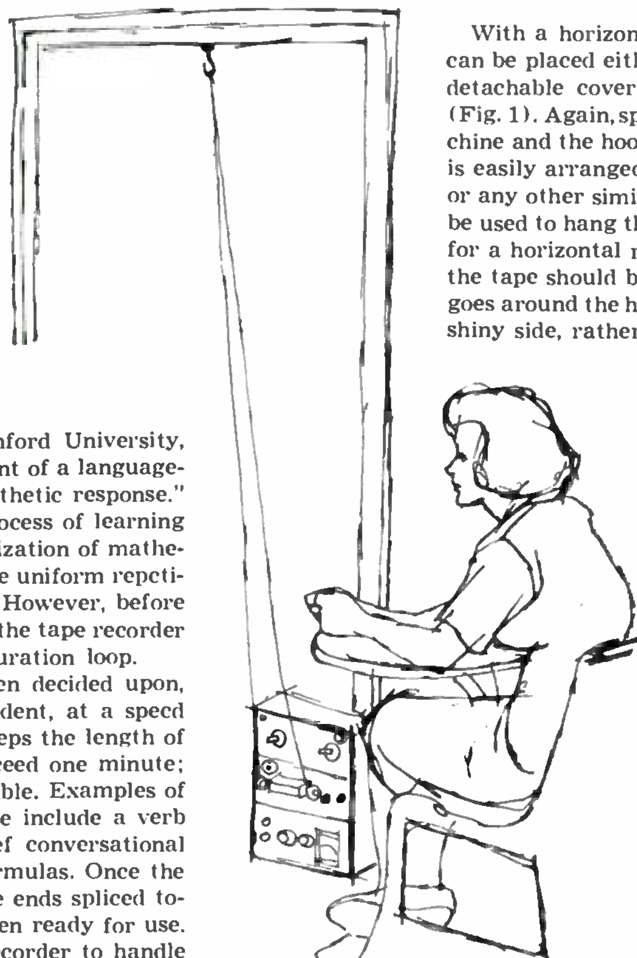


Fig. 2. A hook driven into a door frame or wall supports a tape repetition loop with a vertically operated recorder.

With a horizontal machine, the hook can be placed either on a wall or on the detachable cover of the tape recorder (Fig. 1). Again, spacing between the machine and the hook for smooth tape feed is easily arranged. A smooth door knob or any other similar protrusion can also be used to hang the loose end of the tape for a horizontal recorder. In any event, the tape should be turned over where it goes around the hook or knob so that the shiny side, rather than the dull side on which the iron oxide is deposited, is the one that makes contact with the object.

"Sympathetic Response"

If the tape machine is now turned on, there is a constant and uniform repetition of the recorded material. An important consideration is the fact that the situation differs from one in which a live person recites the material over and over. In the latter case, the individual's voice soon shows signs of boredom or irritation, which impedes rather than helps the process of memorization. It is precisely the uniformity of the recorded repetition that appears to give the method its unique usefulness and advantage; for it is this uniformity that makes possible the "sympathetic response" referred to earlier, by means of which memorization is accomplished with little pain or effort. The psychological factors that appear to make the technique effective are worth further consideration.

When short-duration loops of the type described are played over and over, listeners first notice some resistance when they attempt to pay attention, especially if the material is of the kind they are not eager to memorize. However, after the loop has played from three to five minutes, this psychological barrier is overcome suddenly. Resistance stops and the listener finds no effort in repeating the material aloud in unison with the tape. Subconsciously he has begun to act in sympathy

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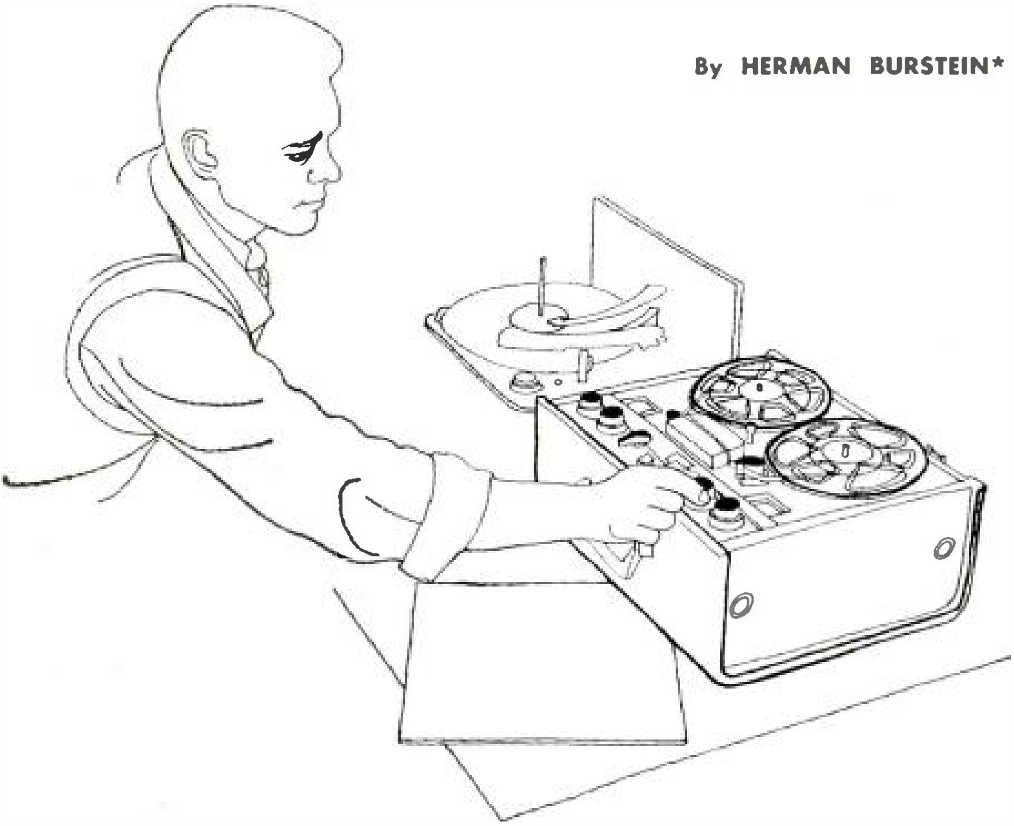


By HERMAN BURSTEIN*

SELECTING A TAPE MACHINE

Important features to look for, along with some helpful suggestions on choosing a tape recorder or tape player.

THE PROSPECTIVE purchaser of a tape machine is confronted with numerous, and perhaps perplexing, choices. To begin with, home tape machines cover a price range from under $100 to over $600. What amount *should* one spend to get what is really wanted, without overspending on what isn't needed? That is just one question. The purchaser must come to grips with a number of other choices, such as: stereo or mono? If stereo, shall it be half-track or quarter-track? Should it have a single record-playback head or separate record and playback heads? Should it be a transport with or without electronics? If *with* electronics—then with record and playback electronics, with record electronics only, or with playback electronics only? Buy a machine with or without a self-contained power amplifier and speaker? How many speeds? Should it have a magic-eye indicator or vu-type meter?

These alternatives suggest that home tape machines come in many variations, but the purchaser need not be confused by this profusion of choices. The various kinds of tape machines do fall into certain basic categories and it is the purpose of this article to describe these basic types and discuss their relative merits.

As a further guide to the would-be purchaser, this article deals with the performance characteristics and tape machine features that must be considered before making a purchase. The relative importance of each characteristic or feature depends upon the use to be made of the machine and the user's requirements as to quality of performance—high-fidelity or some other grade of "fidelity." For these reasons, this article cannot presume to say which is more important and which is less important. This the purchaser must decide for himself. What this article can do, however, is provide the purchaser with a list of things to keep in mind when he goes out looking.

Basic Tape Machine Elements

Before trying to distinguish among basic categories of tape machines, let us first consider the fundamental elements which may be combined in a variety of ways. These are illustrated in Fig. 1. The elements are five: (1) a transport mechanism that moves the tape past the heads or shuttles it rapidly between the reels in the course of winding or rewinding; (2) a record amplifier to build up the incoming signal, provide equalization (mostly or entirely treble boost) before the signal goes to the record head, and supply high-frequency current to the record and erase heads; (3) a playback amplifier to build up the signal generated by the playback head and to provide the necessary equalization (mostly or entirely bass boost); (4) a power amplifier, which is frequently single-ended; and (5) a speaker.

In the majority of home tape machines, namely those employing a single record-playback head, the record and playback amplifiers are fundamentally one unit, with suitable switching to change equalization and connections when alternating between record and playback. In a minority of machines—but, oddly enough, the ones that as a rule run highest in price—the power amplifier and speaker are omitted.

(Many home machines include a microphone in the purchase price. However, this is an accessory rather than a fundamental element. Seldom are the microphones of high-fidelity caliber.)

Basic Variations

The elements of a tape recorder are put together by their manufacturers in five basic ways. This does not include the distinction between mono and stereo machines, nor between those with a single record-playback head and those with separate heads. The latter distinctions will be discussed separately.

1. *Tape Player*: The simplest and least expensive purchase is that of a tape player which consists only of the transport mechanism, incorporating a playback head. This is analogous to the record player; it is used only with pre-recorded tapes (commercial or made by your friends) and does not permit recording. The output of the head goes to a conventional audio preamplifier, provided that the latter has an input intended for a tape head. Virtually every preamplifier made during the last few years will accommodate a tape head.

2. *Tape Player with Electronics*: This is the same as No. 1, except that it includes a playback amplifier. At somewhat greater cost, this means you need not rely on your preamplifier for the necessary equalization and amplification of the signal from the tape head. There are several possible advantages here. A cable from the tape player to your preamplifier may pick up appreciable hum due to its length or routing. Such a cable, if longer than a foot or two, may cause appreciable treble loss due to cable capacitance.

Audio preamplifiers generally provide equalization for only one tape speed,

*Author of "Getting the Most Out of Your Tape Recorder," co-author "Elements of Tape Recorder Circuits."

whereas most transports operate at two or three speeds. The tape player with its own electronics will usually provide different, and appropriate, equalization for each speed. Moreover, change in speed will automatically be linked with change in equalization.

More accurate equalization will possibly be obtained from the tape player that includes electronics because a playback amplifier designed to go with a specific kind of head can take into account the characteristics of this head with respect to frequency response. Ideally, all playback heads should have the same frequency response, but in fact there are deviations from ideal performance at the low- and high-frequency extremes. Finally, a playback amplifier should have extremely low noise and hum, because the output of the playback head is just a few millivolts. Manufacturers of quality tape machines can usually equal or better the noise characteristics of all but a very few preamplifiers.

It is possible to purchase a tape playback amplifier separately. This may be advantageous to the person who owns a mono tape player with electronics and wishes to convert it to stereo by replacing the head and adding playback electronics for the second channel.

3. *Transport with Record-Playback Electronics*: This, in essence, is a tape recorder. Not only can you play prerecorded tapes, but you can also make tapes of broadcasts, phonograph discs, and (through a microphone) live performances.

As with playback amplifiers, it is possible to buy record-playback electronics separately. However, integrated record electronics are advantageous for several reasons: (*a*) For optimum performance in terms of low distortion and good treble response, the value of bias current fed to the record head is quite critical; the integrated electronics can take into account the specific requirements of the head on the accompanying transport. (*b*) Different erase heads require different amounts of current and the integrated record electronics can take this into account. (*c*) The integrated electronics can assure that the record-level indicator provides proper indication of the amount of signal being impressed on the tape, taking into account the characteristics of the record head on the accompanying transport. All this is not to say that the separate amplifier cannot do a proper job. However, a considerable amount of adjusting and trial may be required before the separate electronics can do as good a job as the integrated unit.

4. *Transport with Record Electronics Only*: This is rather a "new breed." Since most preamplifiers provide inputs for tape playback heads, a fair saving in cost can be effected by omitting the playback electronics, leaving only the record electronics. This is done in at least one brand of tape machine on the market.

5. *Self-Contained Tape Recorder*: This is the type of unit we ordinarily associate with home use—namely one that includes a power amplifier and speaker so that one need not rely on an external audio system for playback. Admittedly, the power amplifier and speaker that can be squeezed into a tape machine case are of limited quality but their usefulness is considerable. For example, if you have made a recording at a friend's home, at a club, at school, etc., you need not wait until you get home to check on whether your recording was successful.

At the same time, every self-contained home tape recorder should provide an output jack so that you can feed the signal into a high-fidelity system. In addition, the output should be located at a

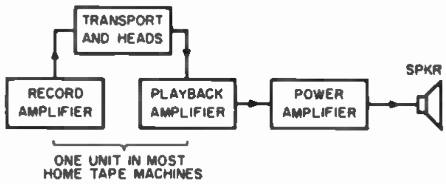


Fig. 1. Basic elements of tape machine.

point prior to the power-output stage so that the signal is free from the distortion and frequency losses that are usually encountered in the power-output stage of a tape recorder.

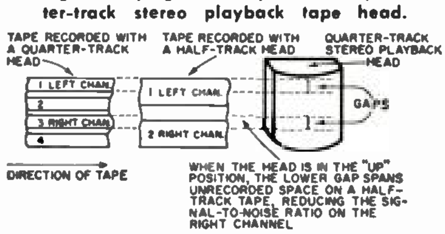
Some tape recorders make available, as an accessory, a combination power amplifier and speaker in a single case. This is apt to be of substantially better quality than the amplifier and speaker in a self-contained unit.

Many stereo tape machines of the self-contained variety have only one speaker, although they may have two power output stages—one of them for an external speaker. If the machine does have two speakers, one is often incorporated in the lid which can be removed and placed at any reasonable distance from the machine. Sometimes there are two speakers in foldout "wings" of the carrying case.

Stereo versus Mono

Although the trend is toward stereo, mono machines are still available. In addition, there are some machines that are "betwixt and between"—namely, those that permit stereo playback but provide

Fig. 2. Playing stereo tapes with a quarter-track stereo playback tape head.



THE HEAD IS SHOWN IN THE "UP" POSITION FOR PLAYING QUARTER-TRACK TAPES. IT SHOULD BE MOVED DOWN TO PLAY HALF-TRACK TAPES WITHOUT LOSS IN SIGNAL-TO-NOISE RATIO

only for monophonic tape recording.

Most home stereo machines incorporate quarter-track heads because half-track stereo has become virtually obsolete. The advantage of quarter-track stereo is that a tape can be recorded in both directions, with resulting economy of tape and convenience of use. However, a quarter-track head can play half-track stereo tapes; for maximum signal-to-noise ratio on both tracks, some machines permit the quarter-track playback head to be raised or lowered so that its two gaps are properly located with respect to each track. This is illustrated in Fig. 2 for a tape moving from left to right. The head is shifted up for playing quarter-track stereo tape, and shifted down for playing half-track stereo tape.

Although the potential purchaser of a tape recorder owns a mono audio system, it may nevertheless be advantageous for him to buy a stereo tape machine. In the first instance, if he converts his audio system to stereo, he need not be concerned about replacing or modifying the tape portion of his set-up. Second, a quarter-track stereo machine enables him to record four mono channels on a reel of tape, whereas a mono machine will record but two. Third, stereo machines, as a rule, are more flexible than mono units.

Separate Record & Playback Heads

Separate record and playback heads involve separate record and playback amplifiers and thus the cost of such a machine is decidedly greater than that of a comparable unit with a single record-playback head and a combination record-playback amplifier. The advantages of separate heads are: (1) While recording with one head, the tape can be played back with the other head so that one can immediately check whether the recording is satisfactory in terms of frequency response, distortion, signal-to-noise ratio, etc. (2) Simultaneous recording and playback greatly facilitates the various tests of performance and the various adjustments that may be required, such as those of bias current, equalization, and recording level indication. (3) The best results are achieved by using separate heads, each contructed in a somewhat different manner for its specific function. Thus a playback head designed solely for this purpose will yield a somewhat greater output, resulting in a better signal-to-noise ratio. By the same token, the record head will be less demanding in its signal voltage requirements, lessening the chances of distortion. (4) Maximum flexibility is obtained, including the ability to achieve echo effects and sound-on-sound recording.

Specifications & Features

In shopping for a tape machine, you

should be alert to the performance specifications and features of the various units on the market.

If you are interested in high-fidelity performance, the following are minimum specifications (assuming that the machine lives up to them):

1. Frequency response flat within 2 db, or possibly 3 db, between 40 and 15,000 cycles at 7½ ips.

2. Signal-to-noise ratio of at least 50 db, based on a recording level producing 3% harmonic distortion at 400 cycles (or similar frequency).

3. Wow and flutter not over .2%. (Some home machines get below .1%)

4. Speed accurate within 1%. (Studio-type professional machines are accurate within .2%.)

5. NAB equalization at 7½ ips, for accurate frequency response in playing pre-recorded tapes.

Features to consider include the following:

1. *Type of record level indicator*: The magic-eye type, particularly if it incorporates a "floating action" circuit so that the human eye can follow its maximum indication, is perfectly acceptable. In fact, it is superior to the vu meter in that it indicates peak recording level, where one has to worry about distortion. On the other hand, the vu meter permits one to make finer and more definite gradations of recording level. Be wary of the meter that looks like a vu meter but doesn't have its dynamic characteristics.

2. *Tape speeds:* The 7½-ips speed is still the minimum for high-fidelity. Quite good results can be obtained at 3¾ ips. For long recording sessions where high-fidelity is not imperative, 1⅞ ips can be very useful—for example in recording a long program of dance or background music for an evening of entertainment. With a 7" reel of double-play tape, 8 hours of material can be recorded on two mono tracks; or 16 hours on four mono tracks.

3. *Mixing facilities for the low-level (microphone) and high-level inputs*: Some machines allow you to use only one or the other inputs because inserting a plug into the high-level input disconnects the mike input. Of those that permit you to use both inputs simultaneously, the most flexible ones are those with individual gain controls for each type of input. However, these tape recorders also tend to be the most expensive.

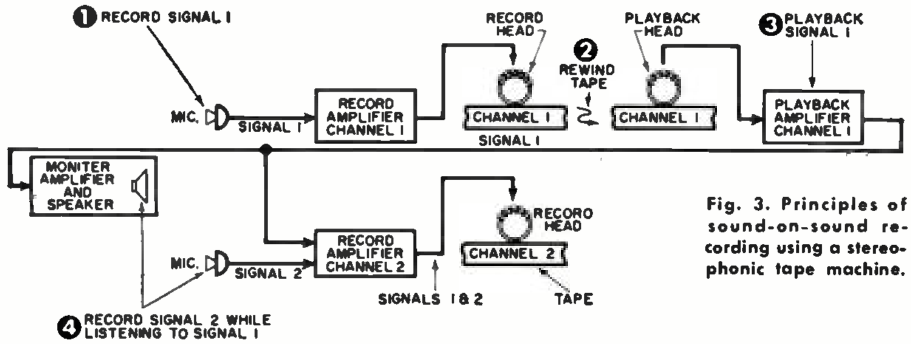


Fig. 3. Principles of sound-on-sound recording using a stereophonic tape machine.

4. *Tape lift device* to space the tape away from the heads when winding or rewinding, thereby minimizing head abrasion.

5. *Tape counter*, which can be helpful in locating desired passages on a recorded tape, indicating how much of the tape has been used up, and showing how much tape remains.

6. *Means employed for tape-to-head contact*: Most home tape machines employ pressure pads to assure good contact between the tape and the heads. Sometimes pressure pads are used against both the erase head and the record-playback head; sometimes against the erase head only; and sometimes against neither head but against the tape guide. Wow and flutter are apt to be lowest when fewest pressure pads are used and when none is used against the record-playback head. Professional machines avoid pressure pads and, instead, use a combination of tape guides and tape tension to maintain good contact.

7. *Automatic shut-off*: Some machines permit automatic shut-off at the end of a reel, provided that you attach a metallic leader to the tape. A few are designed to shut off at any interruption in the tape.

8. *Adjustment facilities (for the audio service technician)*: When the time comes, it will be easier for the audio service technician to obtain maximum operating potential from the machine if it incorporates alignment controls instead of fixed circuit components with respect to bias current, record-level indication, and equalization.

9. *Bias frequency*: The bias frequency should be upward of 60,000 cycles to minimize the chance of audible beats between the bias frequency and harmonics of the audio signal.

10. *A-B switching*: If the machine has separate record and playback heads, it should incorporate a switch permitting you, when recording, to compare the playback signal with the incoming signal.

11. *Push-button controls*: Push-button controls can simplify operation. On the other hand, they mean greater mechanical complexity inside the tape machine and that much more to go wrong.

12. *Rapid start and stop*: If you start or stop a recorded tape somewhere in the middle of the reel, it can be most annoying if the machine produces a sort of growl because it comes up to full speed gradually or slows down gradually. A number of machines avoid this disconcerting effect by providing almost instantaneous start and stop.

Sound-on-Sound Recording

Sound-on-sound recording permits a number of signals to be recorded successively on the same track and also synchronized with each other. Thus a person can transform himself into a duo, trio, quartet, etc, by playing various singing or instrumental roles successively on the same stretch of tape.

In the case of the mono machine, sound-on-sound requires separate record and playback heads and that the playback head precede the record head—contrary to conventional practice. This is not so for stereo machines hence sound-on-sound has gained popularity as stereo units have come to the fore.

A stereo recorder permits sound-on-sound recording if (1) one channel can be put in the record mode while the other is in the playback mode (with the record head in the second channel disabled if there are separate heads) and if (2) the high-level and low-level inputs can be used simultaneously. As yet, these requirements, particularly the first, are satisfied mainly in high-priced machines. But, since the problem is essentially one of additional switching flexibility, it can be expected that a substantial number of moderate-priced machines will follow suit.

If the requirements are met, the technique, illustrated in Fig. 3, is as follows. The first signal (usually, but not necessarily, picked up by the microphone) is recorded on channel 1. The tape is rewound. Channel 1 is played back through a Y-connection for recording on channel 2 and for monitoring by the performer *via* an internal or external audio system. At the same time the performer uses the microphone to record the second signal on channel 2 through the mixing facility. The microphone level is controlled by the recording gain control for channel 2. The level of the playback signal from channel 1 can be controlled by the playback gain control. The procedure is repeated to record additional signals.

This article has covered the many variations in equipment available for use with tape. It is now up to the reader to decide what features he wants, how much quality he requires, and how much money he is prepared to pay to get the tape machine features of his choice. ▲

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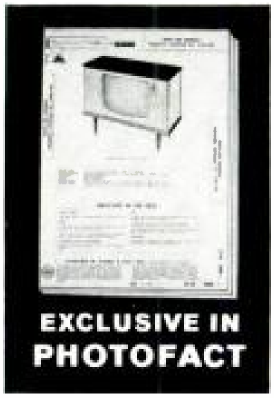

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- Uniform symbols in each schematic; same circuit layout form each time

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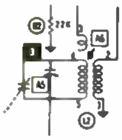
- "CircuiTrace" identification numbers for printed circuits
- Schematic items keyed to chassis photos and parts lists
- Special capacitor and resistor ratings
- Coil and transformer color codes or terminal identification



- Test points labeled
- Special currents shown (B+, horizontal output cathode, horizontal output screen)
- Alignment adjustments and test points labeled
- Tube functions shown
- Control and switch functions shown
- Switch sequence indicated
- Power supply "sources" shown
- Fuse ratings indicated
- Coil resistance over 1 ohm shown
- Coding of electrolytic capacitors shown

REPLACEMENT PARTS LISTS

- Lists standard, locally available replacement parts
- Includes notes for special installation or other considerations
- Includes ratings and/or measured values for assisting in selection of replacement parts
- All parts keyed to chassis photos and schematics for quick reference

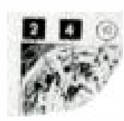
TUBE PLACEMENT DIAGRAMS

- Shows tube types and functions; top and bottom views shown
- Includes filament connections on series string
- Indicates TV sound and sync paths
- Tube failure check charts included
- Shows blank pin or locating key on each tube
- Includes fuse locations and ratings.

ALIGNMENT INSTRUCTIONS

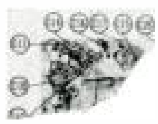
- Gives step-by-step easy-to-follow alignment data
- Procedure makes use of standard service-type equipment
- Alignment frequencies are shown on chassis photos near adjustment number—adjustments are keyed to schematic and photos

"CIRCUITRACE" FEATURE



- Invaluable printed board servicing aid—indicates points on board photo and schematic for quick, easy measurement of components, or test locations

FULL PHOTO COVERAGE



- All chassis views are shown in actual photographs
- All parts are numbered and keyed to the schematic and parts lists
- Test and alignment points indicated

FIELD SERVICE NOTES

- Outlines procedure for "in the home" adjustments
- Gives hints on quick access to pertinent adjustments, safety glass removal, etc.

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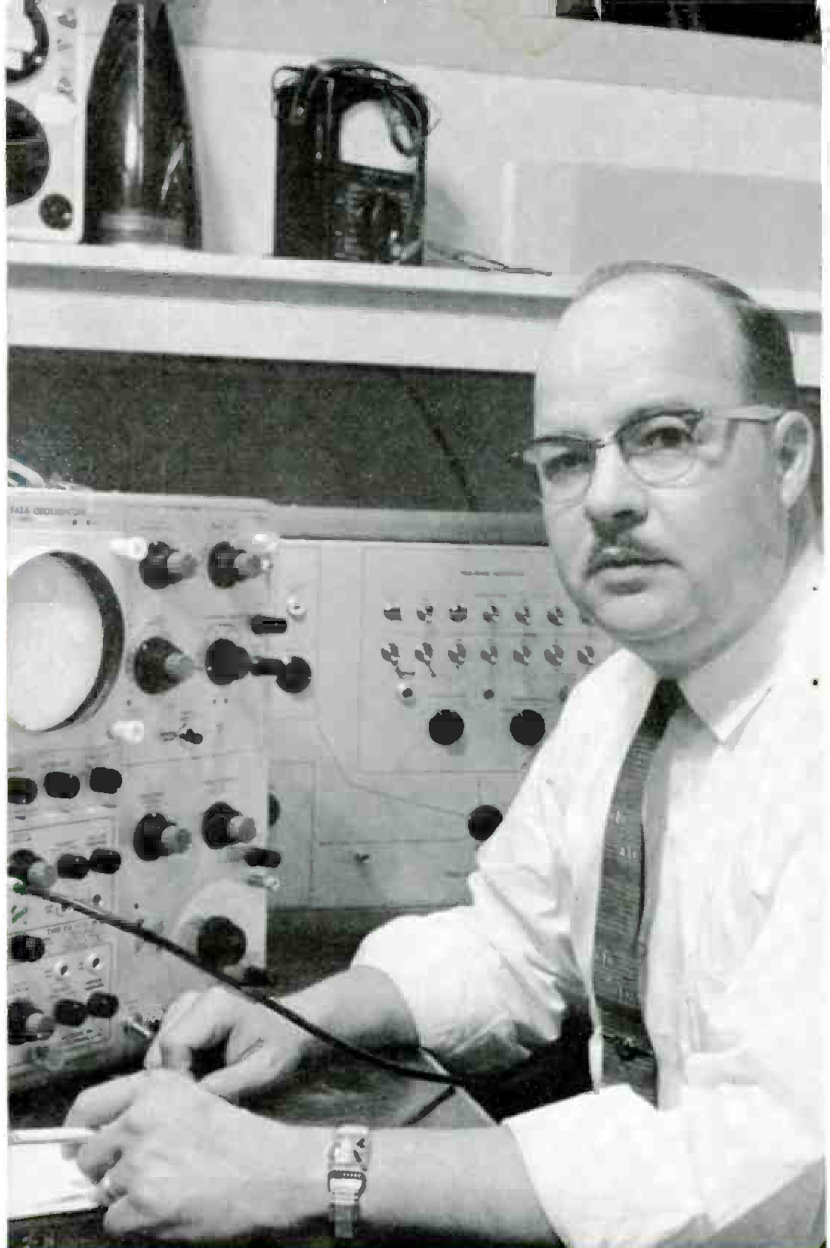

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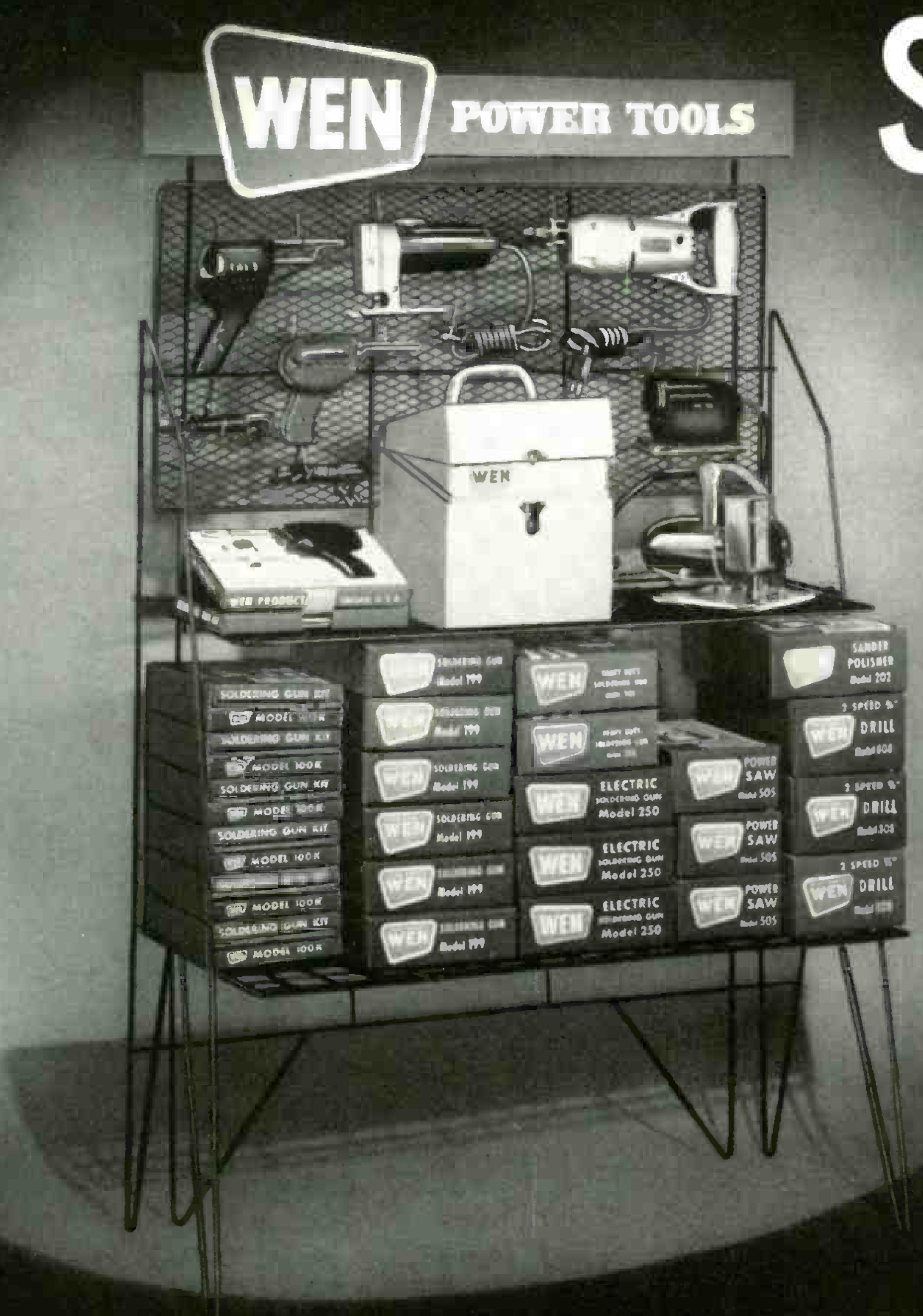

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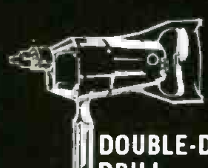

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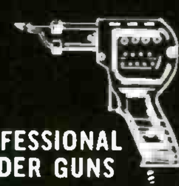

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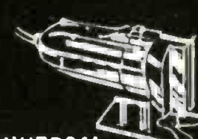

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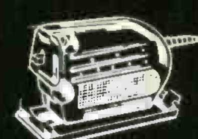

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RECORD & REEL REVUE

By BERT WHYTE

SINCE this is being written on the sunny shores of the Caribbean, at La Playa just outside San Juan, I hope you will forgive the brevity of this month's round-up as I succumb to the soporific effects of the water and sun! Here, then, are my reactions to this month's assortment of goodies on disc and tape.

BEETHOVEN
"APPASSIONATA"
"FUNERAL MARCH"
Sviatoslav Richter, pianist. Victor Stereo LSC2545. Price $5.98.

Richter's stamp of individualism is clearly evident in these performances, which is not to say that he takes interpretive liberties in excess but that we recognize his unique clarity and articulation and his amazing control of dynamics.

His "Appassionata" is warm and richly expressive and a model of balance and phrasing, but it does not quite match the fervor and eloquence of some others—notably that of Serkin. On the other hand, his "Funeral March" is formidable indeed. He seems to take the nickname seriously and the sonorities he produces are in dark umber shades which lend the reading a feeling of inexorable power.

The stereo miking of the solo piano is well done . . . good over-all detail and presence are allied with a reasonable acoustic perspective which gives the sound a pleasing naturalness and roundness of tone without the penalty of excessive reverb.

Richter is one artist whose readings are more easily appreciated, especially in the more subtle effects, when he gets the benefit of a certain style of recording. This he has not always been given, but such is not the case here. The piano sound is clean and free from ringing in the harder transients and, throughout, I could not detect any mushiness or overload. If you still have ideas that solo piano does not benefit from stereo recording, a listen to this would be enlightening.

SIBELIUS
SYMPHONY #2 IN D MAJOR
Philharmonia Orchestra conducted by Herbert von Karajan. Angel Stereo S35891. Price $5.98.

With recordings of the Sibelius First and Third symphonies probably forthcoming, plus this present reading of the Second, this would give von Karajan the round-robin on all the Sibelius symphonies. Von Karajan's ideas about Sibelius are extremely varied. He seems happier with the less romantic and craggier of the Sibelius symphonies. His readings of the Fifth and Sixth are among the best available.

With this recording of the unabashedly romantic Second, he pulls out all stops and while some may like his treacly approach, I think it is a bit overblown. But he does elicit some fabulous playing from his men and, from a strictly conductorial viewpoint, this is a *tour de force*.

The stereo sound is instantly recognizable as the M/S type favored by *Angel* and some other European companies . . . meaning that they are still seeking to capture a big concert-hall ambience and engrave it on a stereo disc. Unfortunately, it rarely happens without considerable sacrifice of inner detail and over-all orchestral presence.

The sound itself is clean enough and all that, but you keep straining to hear many sections with the definition you have come to expect. There are some beautiful depth effects, but these are not enough to compensate for the other shortcomings. The Ormandy stereo disc of this symphony is still the preferred reading—with sound to match.

BERLIOZ
SYMPHONIE FANTASTIQUE
Vienna State Opera Orchestra conducted by Vladimir Golschmann. Vanguard Stereo Demo SRV120 SD. Price $2.98.

The "umpteenth" recording of this work and a good one too, but isn't there anything else to record? Golschmann is a versatile man, with a good flair for the moderns and might be better employed in this fashion.

The performance here is taut and controlled and has a great deal of power, but a little more free-wheeling approach would have made for more excitement. The expected sonic fireworks in the "March to the Gallows" and the "Witches' Sabbath" are delineated with *Vanguard's* customary effectiveness. The percussion is heavy, solid, and accurate . . . the brass has nice bite and brilliance, the bass line sonorously powerful without a trace of muddiness.

Directional effects were good and, as always in their Vienna recordings, *Vanguard* does one of the best jobs in presenting good depth effects. There are other recordings more sonically spectacular and with readings more frenetic in the last two movements, but what you get here for the money is well worthwhile.

BRAHMS
SYMPHONY #3
VARIATIONS ON A THEME BY HAYDN
Columbia Symphony Orchestra conducted by Bruno Walter. Columbia MS6174. Price $5.98.

As you could logically expect, Maestro Walter's performances of these Brahms staples are characterized by a rich expressive warmth, a pervasive feeling of geniality—or to use that overworked word—"gemutlichkeit."

Just for fun, I dug out the old LP disc of the Third Symphony which Walter did many years ago and found little difference, except for more leisurely tempi in this present disc and a shade more mellowness. There was one thing, however, which was quite noticeable and that was the playing of the orchestras. With all due respect for the Columbia Symphony, which I am well aware is made up of some crackerjack musicians, it is still a recording orchestra and just doesn't have the cohesiveness of ensemble of the Philharmonic. Since Dr. Walter had the helm of the New York Philharmonic for so many years and had the group very acutely attuned to him, why not record with them?

In any case, this is a welcome addition to the stereo catalogue and, from a purely sonic viewpoint, one of the best. The directional effects are not as pronounced as they might be, but the job is adequate and the depth perspective particularly well done. The over-all sound is clean and wide range in both frequency and dynamics.

SCHUBERT
SYMPHONY #9 ("The Great")
North German Radio Symphony conducted by Hans Schmidt-Isserstedt. Telefunken Stereo 18041. Price $2.98.

Once in a while a real bargain comes along in the record world . . . and this disc is one of them. Take a perceptive, vigorous performance, notable for its careful phrasing and rock steady tempi—which the conductor builds into a truly exciting climax—and couple this with a stereo sound with an excellence far above the usual mean for records in this price range, and the word "bargain" takes on real meaning.

I still think the Krips performance on *London* is the exemplar and with truly magnificent stereo sound to match but, considering the difference in price, this disc might make some people pause. The sound here is clean and precise, the dynamics impressive, and the stereo effects, while subtler than prevail in American recording, are well carried out. Better surfaces here than in many higher priced records.

TAPE TOPICS

There is nothing worse than a big build-up and then a big letdown. Such was the case with the Chicago Parts Show, wherein the rumored appearance of the *3M/Columbia* tape cartridge as a commercial product just didn't bear fruit. Rumors are, of course, just that—most of the time.

However, there seemed to be so much smoke on this one that I thought we would surely see the fire. Nothing! Not a trace. Furthermore, in an attempt to find out what had happened, I personally contacted Dr. Goldmark at *Columbia*. Result? No comment.

Now I saw, and a goodly number of other critics and engineers saw, the original model of the *3M/Columbia* tape cartridge—well over a year ago. Further, we heard the product demonstrated and were suitably impressed. Now either that was a prototype shown much too far in advance and subsequent unforeseen production bugs have not been worked out, or the device works like a charm and is being withheld from the market—either to insure present market stability, or who knows? In any case, it would be nice to know what the real story is, for the unit seemed to have tremendous potential.

In the meantime, the present four-track tape market continues in somewhat subdued fashion. It goes without saying that the summer brings its usual production slump, but releases seem to have been even fewer than normal for the "slump period." With the discounts available in certain metropolitan centers, the price differential between tape and disc has almost vanished. It would seem logical for people to prefer the longevity of tape and its other supposed advantages, once the price barrier is removed. Perhaps there is a lesson to be learned from this—and some of the interested parties had better look into this matter.

I cannot help but think that one of the underlying causes here is that there is not enough *quality* differential between the *average* stereo disc and tape. In other words, given record and tape playback equipment of equal quality, the average person expects to hear *greatly superior* sound from the tape. When this is not readily apparent, the buying stimulus is reduced—if not lost altogether. What is the answer? One part of this is easy. I have Joe Doakes in my home and I have played the same work on stereo disc and stereo tape. Without hesitation he preferred the tape to the disc. Why?

Because he could hear the vast difference and the reason he could hear the difference was that I was playing for him a *direct one-to-one copy of the master tape*. Well, what do you expect, you say. The answer obviously is that present mass duplication techniques for stereo tape leave a great deal to be desired and until someone comes up with a method whereby stereo tapes can be produced so that their superior quality is easily and immediately apparent to the average listener, the disc will still take precedence. I realize that this is a tall order, but if tape—and this means both reel and cartridges—is ever going to really take over from the disc, this quality advantage will have to be gained.

This month's tape crop is meagre—but summer can't last for ever and I think we will see a spate of new releases, especially in view of the non-appearance of the *3M/Columbia* cartridge which should be a shot-in-the-arm to the reel-to-reel outfits.

PHILHARMONIC BALL
Vienna Philharmonic Orchestra conducted by Willi Boskovsky. London Stereo LCL80062. Price $7.95.

Willi Boskovsky has made a series of "Ball" recordings for *London*—all of the same persuasion, namely, as lightweight potpourris of Straussian confetti. This latest in the series is a little more diverse and contains, in addition to the usual "Blue Danube" and "Pizzicato Polka," such items as "Auf Der Jagd," with its gunshots echoing with the realism of stereo and the "Egyptian March," with its heavy beat and tinkling triangle.

The *London* sound is some of the best on stereo tape from them and is clean throughout with broad dynamics, good directionality and center fill, and just the right amount of reverb. The only mar is the level of tape hiss which, at full room level, is obtrusive in the quieter sections.

WAGNER
DIE WALKURE (Highlights, Act 3)
DAS RHEINGOLD (Highlights)
George London, baritone; Otto Edelmann, bass; et al with soloists and chorus with Vienna Philharmonic Orchestra conducted by Georg Solti. London Stereo LOL90028. Price $7.95.

It would be a rare record fan or audiophile who has not heard sung the praises of the *London* recording of "Das Rheingold" . . . justifiably so, for whatever magic amalgam of score, plus hall, plus mike placement . . . the sound is truly spectacular. This was the first recorded opera in which the obvious advantages of the stereo medium in creating movement to simulate stage action was properly and successfully used.

Listening to a recording like this, especially over a stereo system in which the speakers can be hidden from direct view, is an eerie experience, because you seem to *see* almost as much as you hear!

All the sensational sections from the complete opera are excerpted here, thus you have the "Descent of the Nibelungs," the "Forging of the Rainbow Bridge," the "Entry of the Gods into Valhalla," etc. The impact of eighteen steel anvils, selected for pitch, and the thunder sheet sound are awesome, as are many other effects throughout. All was clean here, except unhappily the climax of the anvil sound which overloads slightly. Possibly another copy where a different tape emulsion and a different bias were used might not have this same defect. It is hard to pinpoint the cause of the trouble by "remote control."

The selections from "Die Walkure" are good and the stereo sound is clean and effective, but I'm afraid the "Rheingold" so overshadows it that it will not be played as often as its own excellence justifies. ▲

The "Simple-Talkie"

(*Continued from page* 51)

Make a whip from a 20" piece of stiff wire and fasten it to terminal "A." You will now be able to converse with your fixed station over a distance of at least 250 feet.

If you want even more range, remove the whip and connect one end of a 22-foot wire to "A." If you're outside, clip the other end to a convenient tree or bush and stretch the wire to its full length. If you happen to be indoors, just lay the wire out in a more or less straight line on the floor. This form of antenna will permit you to communicate with your home "QTH" over a distance of at least 600 feet. In one test, while talking with a 35-watt station, excellent signals were obtained in both directions at 700 feet. If you have a high-power transmitter in your shack, usable communication should be possible beyond 1000 feet.

At first glance, these ranges may seem rather short. However, since most beam antenna checks and TVI tests will be made within a few hundred feet of your house, you will find that coverage of the "Simple-Talkie" is more than adequate. Although a couple of transistorized audio stages, added to the detector, would extend the receiving range, the improvement in over-all performance would hardly warrant the resulting increase in cost and complexity.

If you want to try DX-ing, you can hook the feeder of a 21-mc. beam to TS_1. When there's no "QRM" on the band, you'll find that it's a lot of fun to talk around town with mosquito power. Of course, you'll have to use the regular station receiver if you want to hear someone more than a few blocks away.

If you change from one antenna to another, re-peak C_3 for maximum output as indicated on a field-strength meter or the "S"-meter of your receiver. Be careful when using a whip! Don't hit an innocent bystander in the face or eye with it.

The input to the oscillator is approximately 10 milliwatts. At this level, the transistor literally loafs along. Total drain of the rig, including mike current, is about 15 ma. Since power is required only when S_1 is in the transmit position, battery life will be excellent. In fact, under most conditions of use the battery will last almost as long as it would on a dealer's shelf.

In view of the fact that it operates on the 15-meter amateur band and is used to converse with other amateur stations, a "Simple-Talkie" *may be run only by the holder of a valid amateur license!* Citizens Band operation is not recommended. Although the oscillator can be made to work when a third-overtone 27-mc. crystal is plugged in, the two-way communication range will be quite short because the 1N54 just isn't sensitive enough to pick up a 5-watt Citizens transmitter over any appreciable distance. ▲

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Transistors in 2-Way Radio

(*Continued from page* 49)

which would otherwise be heard in the speaker during intervals between received messages.

In the absence of a received r.f. carrier, noise from the discriminator is amplified by the noise amplifier limiter. This noise voltage is rectified, drawing more or less current in the noise-detector stage. More current is drawn when the receiver is fully squelched (squelch control fully clockwise); less current is drawn when the receiver is in the unsquelched condition.

When the noise detector is drawing higher current, a lower voltage is developed at the emitter element of the detector. This causes an increased bias to be applied to the switching transistor which results in increased current through the transistor. In effect, this short-circuits the emitter-to-collector path, causing the switching transistor to appear as a closed switch. Under these conditions, increased current through resistor R_{300} causes a low voltage to appear at the emitter of the first audio-amplifier stage. This low voltage causes the audio amplifier to draw very little current, making the first audio amplifier inoperative. Therefore, the following audio stages do not receive signals and the speaker is quiet.

When an on-frequency signal is received, the noise reaching the squelch circuit diminishes entirely, so that there is little or no output from the noise detector. As a result, the d.c. control stage appears as an open switch and the audio amplifier is biased normally. Under these conditions, the incoming signals reach the speaker.

Transistor Power Supply

The transistor power supply provides an efficient and reliable method of converting the low-voltage d.c. input from the battery to the required high-voltage d.c. output for mobile transmitters and receivers. A transistor power supply can be built into a compact unit. The transistors can be mounted on a cast-aluminum radiator, referred to as a "heat sink" because it radiates the heat away from the transistors. Thus, the transistors may be operated at relatively high ambient temperatures and are capable of handling the high power required.

A typical *Motorola* transistor power supply is shown in Fig. 14. The supply consists of a transistor multivibrator and a step-up and feedback transformer. The function of the multivibrator is to convert the low-voltage d.c. to a high-voltage a.c. variation across the transformer secondary. This a.c. variation is rectified and filtered to develop the high d.c. voltages needed by the transmitter and receiver.

When the d.c. voltage is applied, the changing voltage across the starting network causes a changing current in the feedback winding and bias network. As in any multivibrator circuit, a slight unbalance will cause one transistor to conduct more than the other. This quickly results in this transistor being driven to maximum current while the other transistor is completely cut off. However, the high current drawn by the conducting transistor soon saturates the transformer core. With core saturation there is no feedback from the primary into the feedback winding. With the loss of feedback, the high base voltage is no longer sustained on the conducting transistor, consequently its current decreases and feedback of opposite polarity is induced into the feedback winding.

Now the second transistor is driven into conduction and the first transistor goes into cut-off. The conduction of the second transistor soon saturates the core primary again and feedback of original polarity develops.

The cycle now repeats with the first transistor being driven into conduction and the second cut-off. The multivibrator "on-off" switching of the transistor develops an a.c. voltage variation across the transformer primary which develops a stepped-up a.c. voltage variation across the secondary.

The function of the feedback resistor, in association with the "transmit-receive" relay contacts, is to establish the optimum operating conditions for the transistor power supply under conditions of reception and transmission. For reception the power demand is less and therefore the feedback resistor is placed in the circuit to establish the correct collector-to-emitter current flow. In the transmit state, the feedback resistor is shorted out; efficient oscillations result under the greatest current demand of the transmitter.

This article has shown just a few of the transistor circuits that are being used in two-way radio equipment. As time goes on, more and more of this type of equipment will be transistorized, from oscillator stages right through to the power amplifier. This is bound to occur since the transistor's characteristics make it almost ideally suited to mobile two-way radio use. ▲

CAPACITOR SUBSTITUTE

By KENT A. MITCHELL, W3WTO

EVER need a capacitor of a few micro-microfarads in value—one which your "junk box" couldn't supply? It's Sunday, or late at night, and the parts supplier is closed. Well, no need to quit working on your latest electronic brainstorm until later. Why not use the distributed capacitance present in a section of common transmission line as a temporary substitute?

Using the values given in the table below, one need only cut off the length calculated, from whatever type of transmission line is available, to obtain the desired capacity. Allowing a generous safety margin, 1000 volts r.m.s. may be considered the maximum voltage rating for these "capacitors." ▲

300-ohm flat twin-lead	4.4-4.6 μμf. per ft.
300-ohm tubular twin-lead	5.6 μμf. per ft.
RG-59 and RG-11 coax . . .	21.0 μμf. per ft.
RG-58 and RG-8 coax	29.0 μμf. per ft.

Mac's Service Shop

(*Continued from page 60*)

Pointing the center of a lobe at the center of the flight pattern reduced this variation in signal strength."

"Did you try other antennas?"

"Oh sure! I tried vertically stacked bow-ties, a corner reflector, two half waves in-phase, with and without a reflector, and a simple folded dipole. Holding any of these antennas in my hand right beside the receiver, I could pick up the test patterns with the antenna in just the right position. A movement of six inches would make the picture disappear. Furthermore, the 'right position' constantly changed as the plane moved something that did not happen when I was receiving a fixed station. With the antenna up on the tower, this effect practically disappeared. I finally put a corner reflector up on my rotating mast because it is simple, rugged, light, low-cost, and capable of doing a good job on the MPATI signals since its gain increases with frequency. At the same time, it performed well on the low-end-of-the-u.h.f.-band stations."

"How about lead-in?"

"I can't quite go along with using coax unless there's a u.h.f. amplifier or converter mounted right at the antenna that's designed to work into this cable. Even the best coaxial cable has very steep losses at 800 megacycles, and you still have to use baluns to match a 300-ohm antenna to the cable and to match the cable to a 300-ohm receiver. Noise pick-up on the feedline at these frequencies isn't enough of an item to warrant taking these losses. Open-wire line is undoubtedly the lowest-loss all-weather line for long runs out in the open, but it's hard to handle and to keep taut. Personally I think u.h.f. twin-lead, such as Celluline or the hollow type, is a good compromise for home installations. It's important, though, to keep the line as far away as possible from metal objects. You can convince yourself of this quickly by taking the line out of a stand-off insulator and holding it near a tower leg while you watch what happens."

"As I get it, you're not interested so much in a commercial installation for receiving MPATI signals as you are in a good general coverage u.h.f. installation that will still do a good job on the signals from the plane."

"Exactly. I see this MPATI thing as an excellent opportunity for receiver manufacturers, antenna manufacturers, service technicians, and radio amateurs to obtain a lot of useful information on u.h.f. signals. For the next nine months, more people will have an opportunity to receive those 800-megacycle-plus signals than were ever reached by a single u.h.f. station before. If we pool the experience acquired, maybe we can take a giant step forward in u.h.f. TV reception. If the FCC has its way, all telecasting may be pushed up to the u.h.f. frequencies in the next few years; so it's high time technicians learn all they can about what constitutes a really good u.h.f. installation.

"The MPATI people are collecting reception reports, and the engineers are working hard on the problem. *Jerrold, Blonder-Tongue,* and possibly some other manufacturers have produced crystal-controlled, low-noise converters and amplifiers for these frequencies. There are several translator-frequency antennas on the market. But I'm interested in what technicians, hams, and experimenters can learn for themselves by working with signals from the plane. A half-wave dipole at these frequencies is only a little more than 6½" long; so a pretty elaborate antenna array can be built in a small space. A v.t.v.m. connected to the a.g.c. circuit of a receiver converts the latter into a sensitive comparative field-strength meter. It's a golden opportunity to experiment with stacked rhombics, parabolic and corner reflectors, broadside arrays, helical and horn types of antennas, etc."

"Were there any transmitting problems?"

"Vibration is the worst one. I remarked that I could see dark bands moving behind the test pattern that looked exactly like what you see on the screen during an *aurora borealis* display. The MPATI folks said they saw these, too, and were sure they were produced by vibration from the plane's motors. Since all of the equipment has to be very solidly mounted in the plane, insulating tape recorders and other transmitter gear from the vibration is a very special problem; but they were licking it by ruggedizing all equipment and going to transistors wherever they could. I might mention, too, that the transmitters were only working at half-power during the tests. A new power supply installed in the plane by now should enable both transmitters to run the full 50 kw. video and 5 kw. audio this fall. That will make some difference, although not as much as a layman might believe.

"The educational programs we lucky ones will be able to receive will be an added bonus," he continued. "Many of the sample lessons telecast last spring were most interesting. I especially liked the biology lessons, the college algebra, and the *Que Tal Amigos* beginning Spanish lessons presented by Senor Lueras. I'm looking forward to the Russian language course and the art course. Say! Do you suppose they will have live models?"

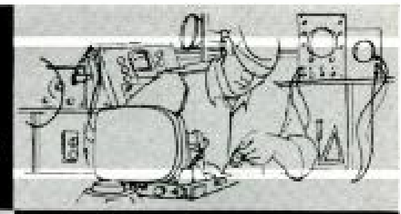
"Down, boy, and back to work!" Mac said sternly. "You were making pretty good sense up until now, but I knew it couldn't last." ▲

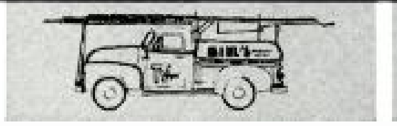
STAG HAMFEST SLATED

THE 24th Annual Stag Hamfest, sponsored by The Greater Cincinnati Amateur Radio Association, has been scheduled for Sunday, September 24th at Stricker's Grove, Compton Road, Mt. Healthy, Cincinnati, Ohio. The committee expects 1500 attendees this year.

A varied and interesting program has been planned and those in the Greater Cincinnati area are urged to attend. Contact either George J. Zins, K8IMC or Elmer H. Schubert, W8ALW for full details on this event. ▲

SERVICE INDUSTRY NEWS





IN MANY quarters, pay-TV has been opposed vigorously as posing a serious threat to the well-being of the independent service industry. The required decoding devices (the argument goes) will be attached to and effectively part of the TV receivers. Sponsors of the pay system will have to insist on complete control of these devices. This will include installation and maintenance. Once organized for such purposes, the sponsor will be in an enviable position for broadening his activities to include service of the TV receivers themselves. In fact, with receivers and decoders so closely integrated with respect to function and fault development, it will be difficult to avoid branching out. The independent service dealer will suffer heavily.

Ironically, one of the most serious exponents of toll television is a TV set manufacturer whose reputation for respecting the independent service technician is well known. *Zenith Radio Corp.*, which has carefully avoided establishment of its own servicing arm or resort to extended warranties, is also promoting Phonevision, its own system of toll TV. In a recent speech to California service dealers, Ted Leitzell, *Zenith* PR director, clarified policy.

He first identified the four phases of his firm's relationship with independent service: the present, long-established policy; the policy to be followed with respect to color sets, now on the way; the installation, removal, and service of decoders attached to the TV sets of Phonevision subscribers; and finally the service of the sets themselves owned by subscribers.

On the first point, he noted that "*Zenith* has always regarded the servicing dealer and the independent service industry as one of the major elements in its over-all success." The policy of "not setting up factory service installations" was reiterated. On color TV, he pointed to the already stated intention of leaving this strictly in the hands of independents and discussed some details of his company's color training program, already under way.

Concerning decoders and the forthcoming Phonevision operation in Hartford, Conn., he first stated that arrangements were in the hands of a subsidiary of *RKO General,* with *Zenith's* participation limited to manufacture of the equipment and the provision of technical advice. Nevertheless, Leitzell was able to give assurances concerning *RKO* policy, based on *Zenith's* advice.

In Hartford, as elsewhere later, Phonevision will attempt to enfranchise local independent service establishments to handle installation and service, providing assistance and advice with respect to required techniques and equipment. If this plan succeeds, Phonevision, which will own the decoders, will still have to check them annually and audit records contained therein. However, local companies could still be used for removal and replacement, handling direct contact with the set owner.

If it is not possible to obtain adequate results with existing service organizations, *RKO* will have to set up its own local organization—but for decoder handling only. There will be no involvement with service on the receiver itself. In this connection, Leitzell said there is much misunderstanding about the relationship between the TV set and the attachment. The latter does not in any way alter the former or affect its operation. Snapping a switch on the decoder will permit normal receiver operation, permitting immediate determination of which unit is at fault if trouble develops.

He added his belief that, since pay-TV will place an additional premium on high-quality TV reception, it could actually act as a stimulant for the independent dealer rather than as a bane.

We have no certain way of predicting exactly how things will work out if pay-TV succeeds. But this speech gives rise to an interesting thought. Does toll television inherently pose any greater threat to independent service than free TV has? Or does the threat depend, not on the nature of the system itself, but on the attitudes of those who control it? Pay-TV is not a factor in the present service market, yet this has not prevented some set manufacturers from getting into service. The manufacturer's viewpoint may count for more than his product in determining his influence on independents.

Community Service

Alameda County TV & Radio Assn. of California has decided to undertake officially what some of its members have been doing on their own. ACTRA people have been donating their services on Sundays to keep in order the TV sets used by shut-ins at the local Fairmont Hospital. Some evidence of the attitude such efforts engender toward independent service is to be gleaned from letters ACTRA has received from the hospital itself and from the county Council of Social Planning.

Rather than let this project fall regularly on the shoulders of the same half dozen or so volunteers, ACTRA has elected to assign members in rotation. Thus each member will be required to donate a few hours of his time only once a year. The effort is contagious. Others being drawn into the act include a local picture-tube builder, *Aragon Electronics*, which has offered to donate needed CRT replacements.

"Fast-Buck" Exposé

Allen Roberts, feature columnist of "TSA News," organ of the Television Service Assn. of Delaware Valley, Penna., has decided to get his own answers as to how shady TV service operators, specializing in the $2 house call, work. After several tries, he found employees of such outfits who were willing to talk.

One question frequently asked about these outfits is, "Where do they get their men from?" School trainees and men with jobs in electronic plants are taken on either full or part time. Most are led to believe the jobs will give them legitimate, practical training. However, they soon learn they are to be nothing more than tube salesmen and chassis pullers. They are given small, fixed salaries and must rely on commissions (15% on all tubes sold or on all pulled-chassis jobs). These outside men are equipped with tube caddies, often filled with reclaimed tubes, and are given the following instructions: "If you can pull the set, pull it, no matter what is wrong. . . . If you can't pull the set, sell them 5 or 6 tubes, using the reclaims wherever possible." Billing for unnecessary parts and tubes, from artificially inflated price lists, is common.

"Where do these outfits get their customers?" Repeat business is obviously negligible. They run large numbers of newspaper ads and list phone numbers in various parts of the city. Most are the numbers of phone answering services. With part-time tube pullers all over the city, they can usually get a man out anywhere, anytime. Thus they can advertise 24-hour-a-day, 7-day-a-week service. Most of their business comes from newspaper and phone-book listings.

Oklahoma Liaison

The move to make TESA a household word for reliable radio and TV service in the Oklahoma City area gained impetus with an agreement reached between the local association and channel 5 (KOCO-TV) in that area. The latter has agreed to run frequent 10-second spots identifying members of the service group with "Television Service You Can Trust" and displaying the TESA emblem. In addition, a different TESA member will be interviewed each week on a regular local program, at which time questions will be solicited from viewers concerning TV service. Methods are now being worked out under which individual members will be able to "co-op" advertising time with their suppliers. The Oklahoma arrangement appears to be more extensive than those worked out in other parts of the country. ▲

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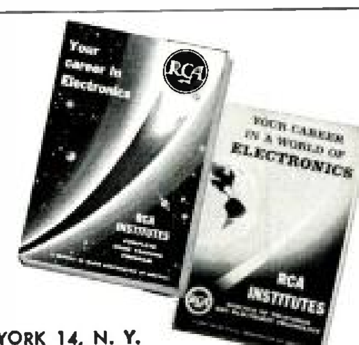

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RCA The Most Trusted Name in Electronics

New Audio Test Report

(*Continued from page* 24)

cps to 15,000 cps (limits of our test).

These fine results are achieved because of a well-engineered but basically simple circuit. The front-end is a cathode-coupled twin-triode with the input grid circuit tuned and with the second section grid grounded. Although the theoretical noise figure of the popular cascode front-end is lower, external noise pickup usually prevents the full use of extremely low noise figures. In actual use, the front-end circuit used in this tuner demonstrates excellent sensitivity (as the above figures prove) and good signal-to-noise ratio. The mixer-oscillator stage is temperature-compensated and this, coupled with the wide-band design, obviates the need for a.f.c. Next there are four i.f. stages which also act as limiters at high signal levels. Special attention was paid to minimizing phase shift across the entire passband by using undercoupled i.f. transformers. This has the added advantage of simplifying i.f. alignment because peak tuning is used and there is no need for sweep alignment.

A wide-band balanced ratio detector is used with its two crystals mounted inside the discriminator transformer. In the audio section, the de-emphasis filter is isolated from the high-impedance detector by a cathode-follower. This follower's output is then applied through a volume control to a plate-follower, which delivers tuner output.

The tuning mechanism uses a planetary drive on the tuning capacitor and a rear-lighted tuning dial, making it convenient to pick out your favorite station. A simple calibrated scale in front of the tuning eye makes it easy to detect slight changes in tuning and signal level. All in all, the tuner incorporates many fine design features and does its job very well indeed. The FM-1 is available for $79.95 in kit form, including metal cover-case, or for $119.95, factory-wired. ▲

"Those twenties dry yet, Muggsy?"

THE "BANANA" COLOR TUBE

By PATRICK HALLIDAY

Details on a new color TV display device recently shown in London by Mullard.

AN entirely new form of TV color display was demonstrated in London recently using the "banana" color tube. Although not at present a practical system for domestic color TV receivers, owing to the need for rather elaborate associated electronic and mechanical equipment, it was shown that excellent results could be achieved under laboratory conditions.

The new tube, which produces only a single horizontal line of light instead of a complete raster, is mounted inside a special lens drum which is rotated at a fixed, synchronized rate to provide the vertical scanning. The resulting complete color picture is viewed as a virtual image in a parabolic mirror mounted above the slim cabinet of the color receiver.

Wine-Bottle Shape

Heart of this system is a slender tube which resembles a wine bottle rather than a straight "banana" after which it has been named in order to continue the fruit sequence initiated by the *Philco* "Apple" tube. The banana tube contains a length of tri-color phosphor stripe producing red, green, and blue light and mounted along the main axis of the tube. An electron beam from the gun in the neck of the "bottle" is made to sweep up and down the phosphor stripe by means of deflection coils mounted on the narrow neck. The electron beam is "spot-wobbled" at radio frequency so that it strikes each of the parallel phosphors in sequence. The beam is switched on and off by means of gating circuits so that each color is reproduced in accordance with the video information. For instance, by applying appropriate signals to the gating circuits a single line of red, green, or blue light can be produced; or alternatively any single line of a normal color picture. As already described, the field or vertical scanning element is then provided mechanically.

Although we are unlikely to see this new system in use for domestic color receivers for some time to come, the *Mullard* research team, headed by Dr. P. Schagen, who have developed the tube, consider that the complications which remain to be solved are not those of the actual banana tube which would be a simple and economical device to manufacture. An advantage to the viewer is that the picture appears as a completely flat virtual image. ▲

Impedance Matching in P.A.

(*Continued from page* 41)

so it draws half the available power (20 watts). Each 4-ohm speaker is one-fourth of the total load impedance and draws one-fourth of the power.

Parallel Arrangement: When speakers of like impedance values are placed in parallel, each loudspeaker draws the same amount of power from the amplifier. In other words, if the amplifier in Fig. 6 were rated at 30 watts, each of the three 16-ohm loudspeakers in parallel would be driven to a 10-watt level. When loudspeakers of different impedance values are connected in parallel, the speakers receive unequal amounts of power as was the case in Fig. 8 but the distribution of power here differs in that the speakers with the higher impedance voice coils receive less power.

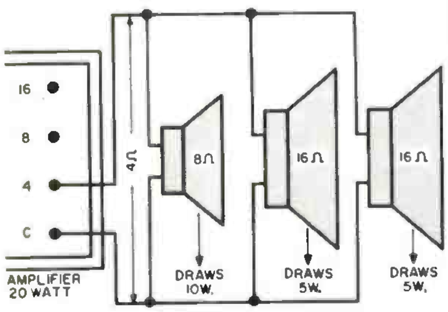


Fig. 9. Loudspeakers having different impedance values connected together in parallel.

Referring to Fig. 9, we find two 16-ohm loudspeakers and one 8-ohm speaker connected in parallel. The combined impedance of this arrangement is determined by adding the reciprocals of the individual loudspeaker impedance values and then taking the reciprocal of their sum. In this instance, the resulting impedance is determined as follows:

$$\frac{1}{16} + \frac{1}{16} + \frac{1}{8} = \frac{1}{4} \text{ ohm.}$$

The reciprocal of $\frac{1}{4}$ is 4 ohms.

The 8-ohm loudspeaker in this system will receive twice as much power as each of the 16-ohm loudspeakers. From an amplifier rated at 20 watts, the 8-ohm speaker would draw 10 watts while each of the two 16-ohm speakers would draw 5 watts.

In this article we have been concerned largely with those simple systems which permit an amplifier to be connected to one or more loudspeakers over low-impedance lines without the use of line-matching transformers. More complex loudspeaker arrangements require a different approach and these will be explored fully in succeeding articles dealing with high-impedance lines and the constant-voltage distribution system.

(*To be continued*)

Below the Broadcast Band

(*Continued from page* 56)

the converter oscillator circuit. By adjusting the trimmer on tuning capacitor C_{19}, it should be possible to set the oscillator so that with C_{19} at maximum capacitance (plates all the way meshed) the receiver picks up the oscillator signal at 550 kc. and with the plates of C_{19} fully open, the oscillator signal should be found at or very near 1070 kc.

If the oscillator is working OK, we can now proceed to the adjustment of C_{11} which tunes the primary of transformer T_1. This adjustment can be performed with the aid of an r.f. signal generator or, lacking this, the oscillator signal can be used. When using a signal generator, remove the oscillator tube V_4 from its socket and couple the signal-generator output to one of the mixer tube plates by means of a small amount of capacitance. With the signal generator set at 540 kc. adjust capacitor C_{14} for maximum output from transformer T_1.

The output can be checked by connecting the receiver antenna terminals to the converter output connector (J_1) through a short length of coax cable and setting the receiver to 540 kc. If the receiver has an "S" meter, the correct setting of C_{11} will be indicated by a peak reading on the "S" meter.

The converter oscillator can also be tuned to 540 kc. by adjusting the trimmer on C_{19} and the same procedure followed, with the oscillator providing a signal to the mixer stage. Sufficient oscillator signal will pass through the mixer to provide a reading on the receiver's "S" meter. After adjusting C_{14} and restoring the converter oscillator to frequency (if used for adjustment purposes), set C_{19} for maximum capacitance. With the receiver still connected to the converter, tune the receiver until the oscillator signal is found on the dial. This should be near 550 kc. When the signal is located, observe the receiver "S" meter reading and adjust the mixer balance pot R_7 for a minimum "S" meter reading. This will indicate balance of the mixer and be the setting at which a minimum of oscillator and mixer input signal will appear at the output of the converter.

If the receiver does not have an "S" meter, a high resistance voltmeter, such as a v.t.v.m., connected to the receiver a.v.c. bus will provide a satisfactory indicator for adjusting mixer balance. In this case, balance would be indicated by the a.v.c. voltage dropping to a minimum point when proper balance is achieved.

The most satisfactory method of adjusting coils L_1 through L_4 is to use an audio signal generator although the coils can be peaked by making use of noise pickup by the antenna. In using an audio generator, connect the converter to the receiver and tune the receiver to 540 kc. Switch the converter bandswitch to Band 1 (10 to 20 kc.) and set the r.f. tuning capacitor (C_2) for maximum capacitance. Connect a short length of antenna wire to the converter antenna terminal and couple the audio signal generator loosely to the antenna wire. Set the audio generator to 10 kc. and set the generator output to maximum. Tune C_{19} to near its maximum capacitance. Somewhere near maximum the 10-kc. signal from the audio generator should be heard on the receiver. If not, set C_{19} to maximum and adjust the trimmer on C_{19} until the 10-kc. signal is heard. When the signal is heard in the receiver adjust the L_1 coil slug until, with C_2 set at maximum, the receiver "S" meter reading or a.v.c. voltage reading is maximum.

Follow this same procedure on Bands 2, 3, and 4 leaving the r.f. tuning capacitor set at maximum and making the adjustments at 20, 40, and 100 kc. respectively. Band 5 coil requires no adjustment.

Actually, using noise pickup from the antenna will be just about as good a source for performing the front-end adjustments as the audio generator. The generator may be more desirable if one wishes to calibrate the dial of C_{19}. The author tuned up his converter in any number of ways, usually using signals of known frequency for setting up the front end. In short, the converter can be aligned using the normal procedures for most any other converter except that the frequency range is somewhat different from the usual run of converters.

Listening for Signals

To get into business, all one has to do is connect from 50 to 100 feet of wire to the antenna terminal and a water pipe ground to the ground post. The author's antenna consists of about 75 feet of hookup wire stretched through a group of trees in the back yard. With this antenna some of the stations which have been copied with excellent signal strength are NPG (San Francisco) on 18.6 kc.; NSS (Washington, D.C.) on 15.5 and 88 kc.; NPM (Pearl Harbor) on 20 kc., and many other U.S. Navy and commercial stations.

Several foreign stations which have been received with fair signal strength are GBR (Rugby, England) on 16 kc.; GYC (Whitehall, England) on 78.2 kc.; and NHY (Port Lyautey, Morocco). In addition, on about 194 kc. one can hear TUK located at Nantucket, Mass. This station, which transmits a signal consisting of dots and dashes, can be used in conjunction with U.S. Navy Hydrographic Office charts to determine one's bearing. On the aeronautical range band, the author has received, with excellent signal strength, stations as far away as SJU in San Juan, Puerto Rico.

Considerable information concerning frequencies of operation and call letters of most of the long-wave stations is available from the Secretary General. International Telecommunications Union, Palais Wilson, Geneva, Switzerland. In addition, listings of U.S. aeronautical beacon stations are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. ▲

ELECTRONIC CROSSWORDS

By MARGARET LeFEVRE

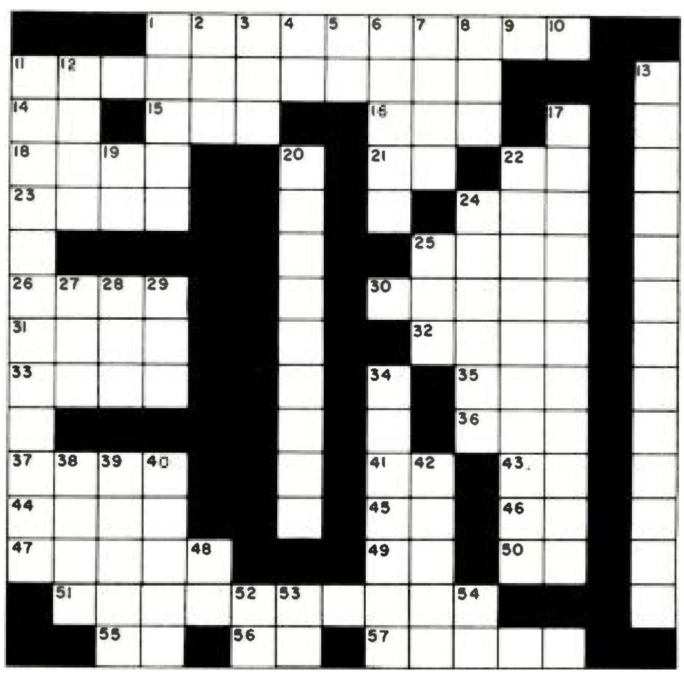
(*Answers on page* 118)

ACROSS

1. A system of color TV transmission in which the colors are transmitted one after the other.
11. The colors in colorcasting are carried by these.
14. Signal is applied to this terminal (abbr.).
15. Skill.
16. To decay.
18. Manner.
21. Schematic notation (abbr.).
22. Output current (abbr.).
23. Shoshonean Indians.
24. C.W. for final.
25. Roman statesman.
26. Tuned circuit used in TV receivers to keep audio out of video.
30. In color TV, a circuit which amplifies the primary colors from the matrix.
31. Greek combining form meaning "air."
32. Agricultural worker in feudal times.
33. Egg drinks.
35. Familiar schematic designation.
36. Salt.
37. Law of E=IR.
41. It's higher than a.f.
43. Transformer winding specs may carry this notation.
44. On top of.
45. Baseball loop (abbr.).
46. Graduate engineer (abbr.).
47. Girl's nickname.
49. Familiar Greek letter.
50. Physician.
51. Yoke.
55. 30 cycles (abbr.).
56. E=___ .
57. This kind of "talk" is most unwelcome in audio systems.

DOWN

1. What the beam in a CR tube does.
2. Natural hearing device.
3. "Q" signal meaning "stop sending."
4. Ancient Sumerian city.
5. Voltage-current (abbr.)
6. Coolness in the face of danger (colloq.).
7. Horse's gait.
8. Adherent (suffix).
11. Color TV transmission system in which primary colors are sent out at the same instant.
12. One.
13. Surfaces which emit electrons under light.
17. Surface sensitive to a single color.
19. He is a graduate engineer.
20. Substances used to coat CRT screens.
22. A method of scanning.
24. Multiple unit controls used in TV to change over from one camera to another.
25. Type of photocell.
27. Old-time auto.
28. South American country (abbr.)
29. Not "neg.".
34. Type of cartridge.
38. Attenuation network.
39. An image.
40. Inhale audibly.
42. Emit light during electron bombardment.
48. An elevated railway.
52. Voltage-current (abbr.).
53. Scope tube.
54. Negative answer.



Frequency Standard

(*Continued from page 36*)

Inductance L_1 may be a choke with a minimum of 10 millihenrys inductance. The coil shown in the photographs was a winding from a discarded ARC-5, 85-kc. i.f. transformer. To increase its inductance, a powdered-iron slug was cemented inside the form.

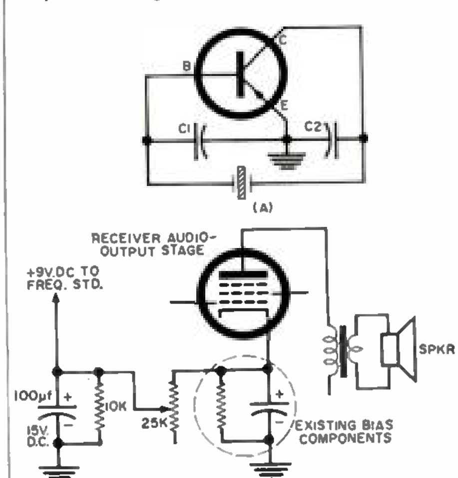
Adjustment

Transistors other than the one specified in the parts list may require different values for C_1 and C_2. The crystal is normally "pulled" to frequency by carefully adjusting the padder, C_1, while listening to a harmonic beating with WWV. Coil L_2 should then be adjusted for maximum output with the oscillator connected to the receiver antenna terminal and the dial set to 3.7 mc. Coil L_2 should show a definite, although broad, peak. If necessary, add or remove turns as indicated by the position of the iron-core slug. The adjustment of L_2 may result in a small frequency shift and the setting of C_1 should again be checked with WWV after adjusting the coil L_2.

Current drawn from a 9-volt battery will be around 1.5 ma. There will be a small frequency variation when the supply voltage is changed and it should be held as constant as possible.

The transistor frequency standard may also be used in vacuum-tube communications receivers if kept isolated from heat-producing components. A novel system of obtaining the supply voltage, without resorting to batteries, is shown in Fig. 2B. A voltage divider, consisting of a 10,000-ohm resistor and 25,000-ohm potentiometer, is placed across the cathode-bias voltage (usually between 10 and 15 volts) and the potentiometer is adjusted for 9 volts. A filter capacitor smooths out any audio variations. ▲

Fig 2. (A) The circuit may be redrawn to show a Colpitts-like oscillator configuration. (B) Novel method of obtaining +9 volts from an existing receiver. A portion of the audio output stage cathode bias voltage is used. Filter capacitor keeps audio signals from being fed to circuit.



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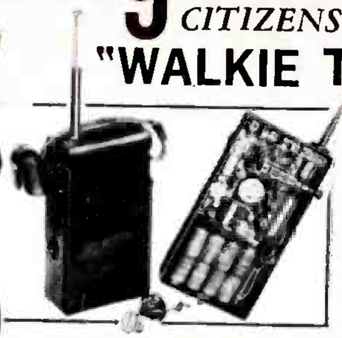

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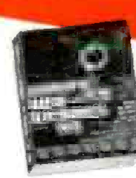

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New Horizontal Oscillator

(*Continued from page* 57)

hence the point of plate-circuit conduction, is substantially advanced in each cycle. Plate-current pulses begin sooner than in the conventional oscillator, and the interval between pulses is reduced, as shown. This means that frequency is increased somewhat.

More important than this increase is the fact that the firing point now depends on the slope of the *RC* discharge rate as well as on the amplitude of the sine wave. If the slope of the curve can be altered to change the starting time of plate-current pulses, frequency can be changed. How this is accomplished will be shown subsequently. Another peculiarity of the revised circuit, which may be observed in Fig. 2, will be discussed first.

The positive-going slope of each cycle of oscillation in a normal oscillator (waveform *A*) follows the familiar sinusoidal shape. However the waveshape as altered by the short time constant (waveform *B*) has a much steeper slope as it approaches the firing point of the tube. It is therefore less susceptible to being fired by a spurious pulse prior to the desired firing point. Thus the revised oscillator has another desirable feature: it has greater immunity to noise than earlier sine-wave circuits.

The schematic of Fig. 4 is the new circuit as used in *Motorola's* TS-436 TV chassis. The values of R_{507} and C_{505}, the grid-leak combination, are chosen to permit the desired capacitor discharge during each cycle. Oscillator coil L_{501} is adjusted so that the free-running frequency is the desired one, 15,750 cps. The composite grid voltage under this condition is shown by waveform *B'* in Fig. 3 and the corresponding discharge curve of the capacitor is shown as *B*.

We can now observe circuit action when a change in oscillator frequency occurs. Let us first assume that frequency tends to increase. Since this does not affect the time constant in the grid circuit, the total discharge time of C_{505} remains exactly what it was before. However phase detector E_{501} in Fig. 4, sensing the difference between the oscillator frequency and that of incoming sync pulses, produces a negative d.c. voltage.

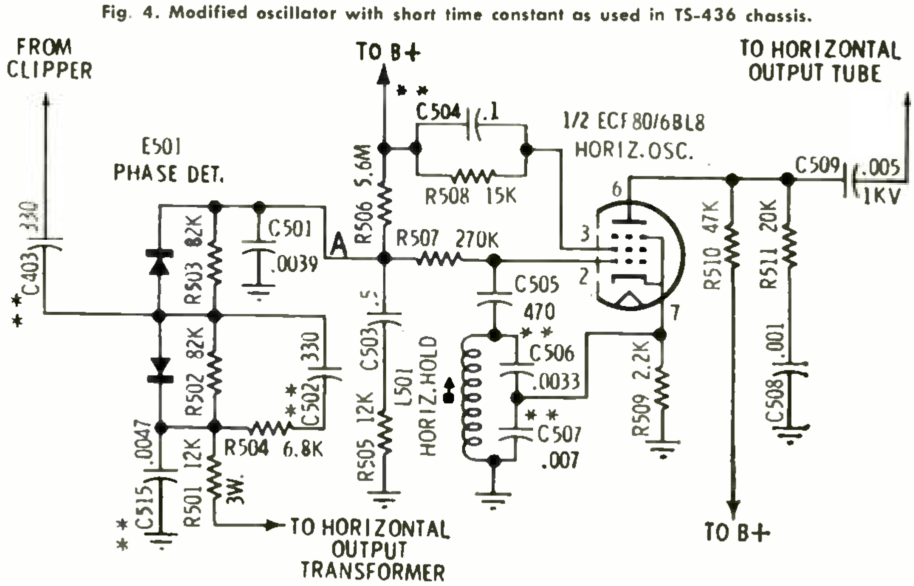
This potential, which appears at point *A* in Fig. 4, is inserted in series with grid-leak resistor R_{507}. Now capacitor C_{505} no longer discharges to zero, but rather to the negative potential. But, since the time constant remains the same as before, this discharge occurs in the same amount of time, as shown in trace *C* of Fig. 3. In effect, as can be seen from a comparison of traces *B* and *C*, the discharge slope has been reduced, or the *rate* of discharge has been slowed down.

Trace *C* is the new waveform for grid-bias variation. When it is added algebraically to the sine wave produced by the tank circuit in the grid, the resulting, composite waveshape is that of waveform *C'*. The latter reaches the tube's firing point later than is the case with waveform *B'*. The start of the plate-current pulse is somewhat delayed, reducing the frequency of the output pulse.

If oscillator frequency should slow down for some reason, action would be opposite to that just described. Phase-detector output would be a positive potential which, when added in series with the grid-leak resistor, would cause the capacitor to discharge at a greater rate during the same, pre-determined discharge time, showing the greater slope amplitude of trace *A*. The resulting composite waveform (*A'*) would advance the tube's firing point, causing output frequency to increase.

It is evident that output frequency is a function of the d.c. control voltage applied to the oscillator grid from the phase detector. This is achieved with no intermediate stages and the output is usable without succeeding amplification. At the same time, noise immunity is good and reliability is increased because the need for many additional circuit components is eliminated. ▲

Fig. 4. Modified oscillator with short time constant as used in TS-436 chassis.



Marine Electronics

(*Continued from page* 46)

mitting and detecting the pulses, they have a means for slowly moving the chart horizontally and for wiping a fine-wire stylus from top to bottom of the chart at a constant speed. Usually two separate motors are used for these purposes. Every transmitted pulse and every received echo cause the stylus to burn off the grayish-white coating of the chart, leaving a short, vertical black line. Since the chart is in motion, the record will appear as a series of closely spaced (usually touching) black marks, as shown in Fig. 4.

The speed of the stylus determines the spacing between the marks caused by the transmitted pulse and those caused by the echo. Note the analogy between the stylus speed on one hand and the rotational speed of the neon light in a flasher or sweep speed in a scope, on the other hand.

Depth calibration may be printed directly on the chart paper or on a transparent scale over it.

Scanners

Although not "depth" sounders and not yet widely used, a mention of scanners may be of interest because of the supersonic principles involved. Actually they are detection and ranging devices used to reveal the presence of large schools of fish and hence useful to the commercial fisherman.

A pulse beam, sent out horizontally, sweeps a circular pattern (like a PPI radar transmission). The echoes are displayed on a scope with a circular sweep that is synchronized with a transmitted beam. This makes it possible to determine the direction and distance of the fish or other source producing the echo.

Basic Arrangements

Once he knows what the instruments do, the technician can make sense of what goes into them. Before looking at details, he will want to know what fundamental functional elements go into depth sounders. Once familiar with these, he can identify them in a manufacturer's schematic with little difficulty.

The block diagrams of Figs. 2, 3, and 5 illustrate the combination of functional sections found, respectively, in flashers, recorders, and scopes. (A meter type of indicator, not shown here, was described in "Transistorized Fish Finder," ELECTRONICS WORLD, August 1959.) The relationship between the various electrical and mechanical elements in each type of unit is highlighted by showing how they are interconnected and also by indicating the paths for the transmitted pulses and the returned echoes.

In each there is a pulse generator whose output is applied to a transducer device. The latter element then converts the electrical pulses to acoustic signals that are radiated through the water, and also converts the returning echo pulses to electrical signals that are amplified and applied to the display device. For keying and synchronization purposes, the originally generated pulses are also applied to the display device. In the case of flashers and recorders, mechanical elements are also involved in obtaining the display.

A more detailed examination of the elements involved is in order. However, there is little point in dwelling at length on those that do not differ greatly from their counterparts in other electronic equipment, such as amplifiers and power supplies. Greater attention will be devoted to less familiar portions of the equipment.

Sounder Components

Transducers: The three types of transducers in general use are the magneto-striction, ceramic, and crystal. Their purpose is to convert electrical energy to supersonic vibration for pulse transmission and to re-convert the supersonic echo to electrical energy during pulse reception. In early sounders, separate transducers were used for transmission and reception; however this is rarely done today. Transducers may be mounted outside the hull, in a sea chest projecting through the hull, or inside in a cofferdam filled with water. A cofferdam is a water-tight enclosure projecting from the vessel.

The beam of pulses leaving the transducer is conical, the angle at the apex being in the neighborhood of 30 degrees; however some sounders, intended more for fish finding than depth determinations, may use transducers having an angle as much as 80 degrees.

Pulse Generators: The supersonic pulse may be produced by a vacuum-tube oscillator, by a capacitor discharge through a thyratron or cold-discharge tube, or by direct discharge of a capacitor through the keying contacts. The pulse frequency in commercial units ranges from 20 kc. to 175 kc. Figs. 6 and 7 illustrate the type of circuitry used. In these circuits, oscillation is "held off" by negative bias ("C−"), which is shorted or bucked out by the keying system at the desired pulse repetition rate. Thus this repetition rate or sounding rate, different from the oscillator frequency, is determined by the keying rate and may be as low as 60 or as high as 1800 pulses per minute. In general, the greater the depth range of the sounder, the lower will be the sounding rate in order to permit the returning echo to reach the amplifier before the next pulse is transmitted.

Pulse-duration time usually ranges from 1 to 10 milliseconds with various makes of sounders. Note that, in the case of the vacuum-tube oscillator, pulse duration is fixed by the dwell or closed time of the keying contacts, while in the other two types it is also affected by the size of the capacitor and the charging voltage.

Amplifiers: A high-gain voltage amplifier is required to build up the small amount of electrical energy created by the echo striking the transducer to a value which will light a neon lamp or burn the coating from the chart paper. Depth-sounder amplifiers may be impedance- or transformer-coupled, or may use a combination of transformer or impedance and resistance coupling. Three or more stages are used, one or more usually being tuned with a slug, but sometimes with trimmer capacitors.

Gain control is accomplished by varying the plate voltage applied to one or two of the intermediate stages, by varying the cathode bias and screen voltage, or by input attenuation.

Transistors are common in the small, shallow-water units designed for outboard boats.

Power Supplies: Most modern sounders have a built-in 6-, 12-, or 32-volt vibrator-transformer combination for plate and bias voltages, heaters being fed by d.c. These power supplies are similar to those in automobile receivers, with the exception that they may have a 117-volt tap on the plate-supply winding or an additional 117-volt winding. This 117-volt output, not rectified, is used where a.c. motors are incorporated in the sounder.

Bias voltage is obtained from one leg of the high-voltage winding or by a resistor between the center tap of the transformer and ground. The boat's batteries cannot be used for bias since the equipment must be adaptable to boats with either positive or negative ground systems.

Depth sounders having a transistorized power supply still require a vibrator to stabilize the frequency if a.c. motors are used.

Some sounders are designed for 117-volt a.c. input. They include a transformer, rectifier, and filter combination for plate voltage; the heaters are supplied with a.c. Unless the boat has an a.c. generator, such units require an external power pack supplying the necessary 117 volts. This may be of the vibrator type or an inverter.

Next in the order of discussion are the circuits and other elements used in keying, displaying, and phasing depth indications. Since there is great variety here and much of the material is unfamiliar, that subject will be treated in the concluding portion of this article, which will also go into considerable detail concerning troubleshooting.

(*Concluded next month*)

FINDLAY HAMFEST

THE Findlay Radio Club, W8FT, will hold its annual hamfest on Sunday, September 10th at Riverside Park in Northeast Findlay, Ohio. Families will be welcomed and excellent playground and picnic facilities are provided. Concessions will be open at the Park.

Two main door prizes, each an Elmac AF68, will be awarded as well as a number of other prizes. There will be a Ladies' Bazaar plus other prizes for the XYL's.

Transmitter will be on 3812 kc. for those mobiling to the Park. Advanced registration is $1.00 with the price $1.50 for tickets at the door.

For tickets and any additional information contact Clark E. Foltz, W8UN, 122 West Hobart, Findlay, Ohio. ▲

Electrophoresis

(Continued from page 53)

the filter-paper strip and strikes the measuring photocell. The output voltage thus generated is proportional to the depth of the pigmentation and varies accordingly as the strip is scanned. Light from the same lamp also strikes the balancing photocell and produces an output voltage. The amount of light striking the balancing photocell is determined by the position of the balancing cam. The outputs of the two photocells are compared. Any difference between them is amplified and used to rotate a servomotor which is coupled to the balancing cam. The direction of rotation is always such as to move the cam to a position where the two photocell outputs will be in balance.

A recording pen connected to the cam shaft traces a line on a sheet of graph paper. Fig. 5 shows a typical curve produced in this manner. The shape of the balancing cam determines how far the pen will travel for a given density of color. This cam is specially designed so that the curve will be linear with concentration of the proteins.

The area under each peak is proportional to the concentration of the particular protein to which it corresponds. A numerical determination of the concentration can be made by counting the squares enclosed by each peak on the graph paper and comparing the number with the total area under the curve. This process is done automatically by some densitometers. You will notice, toward the bottom of Fig. 5, a second line composed of irregularly spaced saw-tooth indentations. The area under any part of the curve can be found simply by counting the corresponding indentations. One saw-tooth is equal to 0.1 square centimeter.

Troubleshooting

A number of filter-paper strips are usually processed at the same time, all treated with the same sample. This permits better control of the experiment, since any irregularities caused by a malfunction of the equipment can be more readily detected in this way. Many irregularities can be explained simply. If the migration is greater for strips at one end of the cell, the cell may be on a slant and the liquid level too low to keep the strips at the high end saturated. Or one end of the cell may be exposed to heat or a draft. Short migration on just one strip, with the others normal, is usually caused by improper contact with the wick.

Sometimes unequal migration will be observed between two cells operating in parallel from the same power supply. Unequal ionic strength in the buffer used in the cells is the usual cause. It can be prevented by dividing a single mixture of buffer solution between the two cells.

A partial short-circuit across one of the cells will also produce unequal migration. This can be prevented by checking before placing the paper strips into position by pouring buffer into the cell, putting on the cover, and connecting to the power supply. The current should read zero.

Poor contact between the power-supply connector plug and the cell can also cause irregular migration. This is detected by wiggling the connector plug while the apparatus is in operation. A fluctuation in the current (indicated by needle fluctuation on the meter) indicates poor contact.

Troubles in the power supply are easier for an experienced radio technician to find than those associated with the chemical processes. The troubleshooting procedure is standard. If there is no current or voltage and the pilot light is out, check for a blown fuse (which can be caused by a short-circuited cell) and make sure there is continuity between the power outlet and the power supply. If there is voltage but no current, check the cell connections, the buffer solution level, and electrical wiring for possible breaks.

If the power supply will not cover the voltage and current range for which it is intended, the first step is to check all the tubes. If this doesn't turn up the trouble, make a careful check of voltages against a wiring diagram in order to spot the defective component.

Because of the number of mechanical parts, troubleshooting the densitometer is a task for a specialist. Routine maintenance, however, goes far towards making repairs unnecessary. It is important that the components in the optical path be kept clean and free of dust and fingerprints. These components include the windows of the photocells, the lenses, and the surface of the lamp bulb. A drop or two of light machine oil is used every six months to lubricate the armature shaft of the servomotor. The gear train is not lubricated. The amplifier, like the power supply, presents no unusual problems and can readily be kept in top operating condition by an electronics technician. ▲

SLOWING DOWN THE SEMI-AUTOMATIC KEY

By DONALD E. BEATY, W6WNR

HAVING graduated to the use of a semi-automatic key, many radio amateurs are distressed to find that they sometimes need to send at speeds slower than those at which their bugs will normally operate. This need may arise when contacting the new Novice down the street or when working the DX signal heard when the band is barely open.

The time-tested method of wrapping solder around the weights will slow things down to a walk, but this expedient is awkward and difficult to apply on the spur of the moment.

Most amateurs have on hand the coax fitting that is used to reduce the PL-259 coaxial cable plug to the diameter of the smaller RG-58/U. The inside diameter of this device is just right to fit snugly over the end of a standard alligator clip. This combination has just the right mass to reduce the speed of the key and can be clipped on or removed in half the time it takes for that DX station to sign his call. ▲

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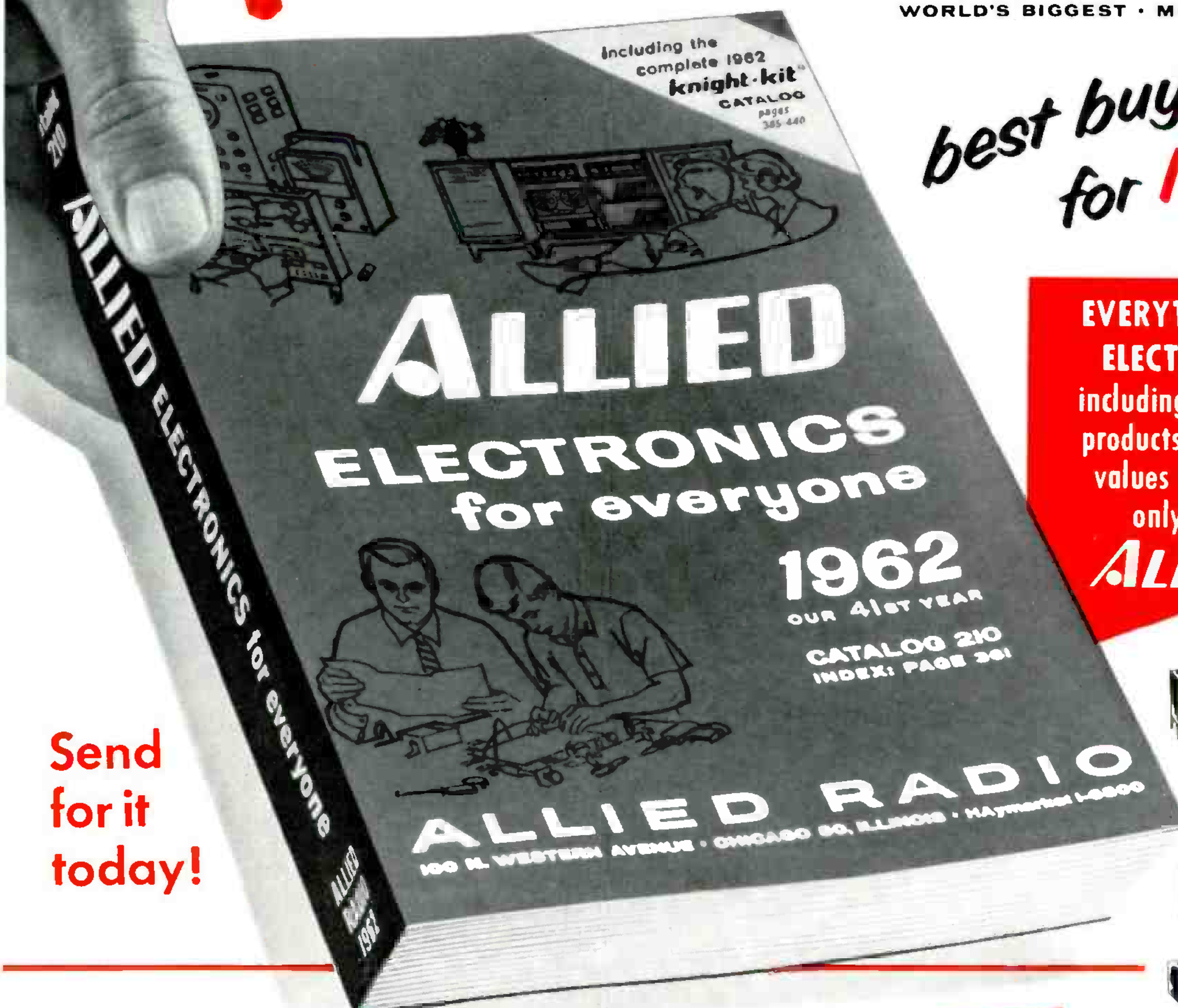

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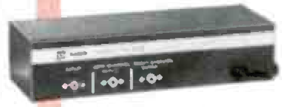

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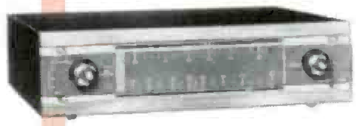

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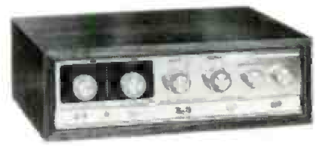

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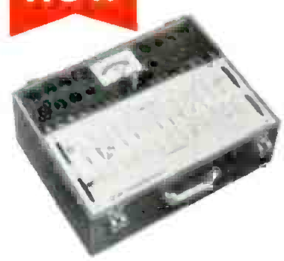

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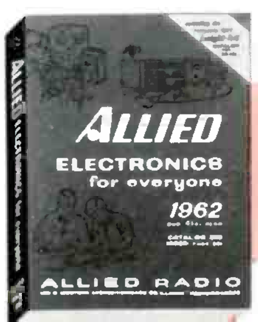

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Time-Constant Chart

(*Continued from page* 37)

that must be set on the middle scale.

Let's see how it works on some specific problems. Take the case of a photo strobelight unit: If source voltage is 450 volts and the flashtube will fire whenever the capacitors are charged to more than 400 volts, how often can the unit be fired if $C = 1000$ µf. and circuit resistance = 10,000 ohms?

This is a problem in which both voltages are specified and the unknown quantity is time. Start by setting *E1* (charging-capacitor voltage) to 400 and *E2* (source voltage) to 450—dividing both by 100 to "normalize" the values. Read time from the center scale as about 2.2 time-constants.

Now multiply 10,000 ohms by 1000 µf. to get 1 time-constant = 10 million microseconds or 10 seconds. You read 2.2 time-constants as the required time, so 2.2 × 10 = 22 seconds. The unit will fire every 22 seconds.

Another type of problem is the discharge time of a big filter capacitor. Let's take the case of a power supply, rated at 700 volts, which has 500 µf. of capacitance in it and a 50,000-ohm bleeder resistor. What will be the voltage on the capacitors 10 seconds after the power is turned off? How long will it take to discharge the capacitors completely through the bleeder?

Since this is a discharge problem, *E1* represents original voltage and *E2* final capacitor voltage. Divide 700 by 100 to "normalize" the value at 7 and set this on *E1*. Calculate the time-constant (500 µf. × 50,000 ohms = 25 million µsec. or 25 seconds) and divide the specified time (10 seconds) by one time-constant (25 seconds) to obtain the "normalized" time value of 0.4 time-constant. Set this value on the center scale. Read the final-voltage value of 4.71 from *E2*. Since *E1* was divided by 100, this value must be multiplied by the same factor. The voltage at 10 seconds is 471 volts.

Since the chart reads only to a normalized value of 100 volts in this problem, getting the second half takes a few more steps.

By repeating the original process, we can determine that the capacitor voltage will have dropped to about 100 volts at the end of 2 time-constants or 50 sec.

Now, normalize the 100 volts to 10 and repeat the process. This tells us that in another 50 seconds the capacitor voltage will be down to about 13.8 volts.

The capacitor is thus discharged to this low voltage 100 seconds after power is cut off. Actually, it will never be completely discharged, but at the end of 5 time-constants only 0.007 of the original charge will remain—and another 5 time-constants later this will be down to 0.000049 of the original, or 49/10,000 of one per-cent, far less than can be measured by any known instrument.

With a little practice, the technician or ham can find many uses for this chart. ▲

New Products and Literature for Electronics Technicians

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 120.

VARIABLE OUTPUT TRANSFORMER

1 Magnetico, Inc. is now offering a variable output transformer which provides any selected output from 1 to 120 volts. Operating with a line cord plugged into a 115-volt, 60-cycle or 400-cycle outlet, output voltage up to 120 may be selected in 1-volt steps.

The Model VOT-1 is compact and includes a line cord, fuse, output receptacle, and "on-off" switch. Output is rated at one amp continuous with input isolated from the output.

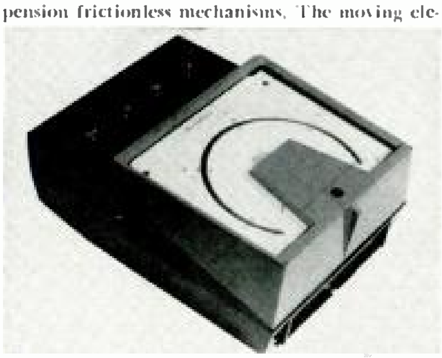
COMMUNITY TV SYSTEM GEAR

2 Jerrold Electronics Corporation has introduced an extensive line of microwave equipment specifically designed for community TV antenna system applications.

Among the new items are the Model SCA-213 high-output amplifier for channels 2 through 13; Model CCG carrier-control generator; Model AGC-213 a.g.c. unit; the Model FT-100 antenna-site FM tuner used for adding FM radio to the system; the Model AT which permits FM to be added on unused TV channels; and a complete line of coaxial cable fittings for such service.

PORTABLE INSTRUMENT LINE

3 Westinghouse Electric Corporation is now offering a new line of portable a.c. and d.c. ammeters and voltmeters that feature taut-band suspension frictionless mechanisms. The moving element of this new system is suspended between bands of high-strength metal ribbon which are supported on springs at each end.

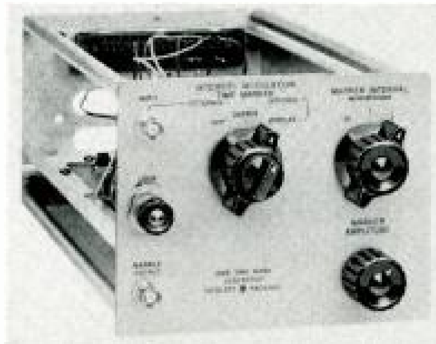


Since friction is eliminated, there is no wear between moving parts and maintenance is greatly reduced, according to the company. An added advantage is that as portable instruments they can withstand much rougher handling since there are no delicate pivots or jewels to crack or wear.

MARKER GENERATOR

4 Hewlett Packard Company has just released its new Model 166B marker generator which gives intensity-modulated time markers synchronized to the oscilloscope trace of its Models 160B and 170A scopes. The Model 160B functions in the d.c. to 15-mc. range and the Model 170A in the d.c. to 30-mc. range.

The Model 166B provides marker intervals of 10 μsec., 1 μsec., or .1 μsec. with interval accuracy



of ± 0.5%. Presentation is in the form of trace-intensifying marks. Marker duration is a function of adjustable intensity, but is always less than 40% of the marker interval.

MAINTENANCE TOOL KITS

5 James Cunningham, Son & Co. has announced the availability of two new instrument and tool kits designed specifically for the maintenance of complex electromechanical switching devices. The kits are useful for the general maintenance of devices such as relay matrices, stepping-switch systems, spring-leaf commutators, slip-rings, and cam-operated switches.

The SF-80 kit is intended for use with the company's Types A and F crossbars while the SF-90 kit can be used with the Types P and T crossbars.

Each kit contains, in addition to suitable gram gauges and dial indicators, a rocker adjusting tool, an interposer eyelet tool, a probe, needle-nose pliers, penlite, tweezers, shims, an assortment of wrenches, and a set of screwdrivers.

DECADE LINE CORRECTOR

6 The Superior Electric Company has recently introduced the "Powerstat" decade line corrector, Type DLC1005, especially designed for laboratory, test and inspection applications. Consisting of three "Powerstat" variable transformers individually connected to three buck-boost fixed-ratio transformers, the unit has 5-way binding posts with jumpers so that outputs can be inserted in the line or removed as desired.

Output voltage adjustments can be made in any combination or individually as desired. Input rating is 125 volts maximum, 50/60 cycles single-phase. Output rating is 5 amperes.

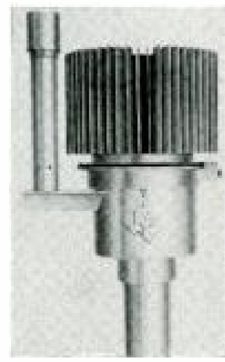
DIFFUSED-JUNCTION DIODES

7 International Rectifier Corporation has announced the availability of seven new subminiature mesa diffused-junction general-purpose glass diodes providing high forward conductance (to 300 ma.), low voltage drop (.9 volt @ rated current @ 25 degrees C), low leakage characteristics (100 μa. maximum reverse current @ 150 degrees C), and low unit cost.

Designated as Types 3G05 through 3G30, the new units can be used in relay circuits for both d.c. operation of an a.c. relay and arc suppression and in power supplies. All units have an operating temperature range from −55 to +150 degrees C and feature glass-to-metal hermetic sealing.

THERMOELECTRIC GENERATOR

8 Texas Instruments Incorporated has announced the immediate commercial availability of an 8-watt thermoelectric power generator for industrial field applications.



The unit contains no moving parts and will operate from natural gas, propane, or butane, making it suitable for remote unattended field instrumentation. Initial applications are expected to be in the operation of valves on transmission lines or petroleum production facilities and for the cathodic protection of buried or submerged metal. The new units weigh 65 pounds and measure 12" x 17".

FAST-HEATING CATHODE

9 Amperex Electronic Corporation has announced the development of a fast-heating cathode which has been designated as the "Harp Cathode." Capable of delivering full power in 100 msec., the new component is being incorporated in a full line of tubes to be used in r.f. power output stages in transistorized mobile and airborne equipment.

The directly heated harp cathode consists of a rectangular frame across whose length many very fine wires are strung parallel to each other. The use of extremely thin wires in the emitting element makes possible a high surface-to-volume ratio, resulting in fast warm-up time and thermal equilibrium.

VARIABLE-VOLTAGE SUPPLY

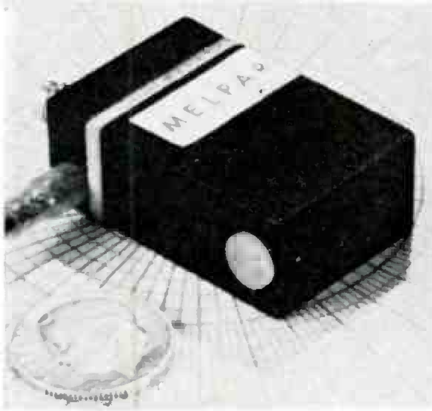
10 Lafayette Radio is now marketing a new variable-voltage a.c. supply which provides continuously variable output from 0 to 140 volts a.c. with regulation of ± .6% at 75 watts and 3% at maximum output. Maximum no-load output is 142 volts r.m.s. The illuminated front-panel meter reads 0-150 volts with 1% full-scale accuracy.

The Model TR-114 is housed in a rugged steel chassis which can be wall or bench mounted. A

fused circuit and two output receptacles make it adaptable for a variety of applications. The unit measures 9⅜" x 4⅞" x 5½" and comes complete with a six-foot, two-conductor line cord.

PHOTOELECTRIC READER

11 Melpar, Inc. has announced development of a highly sensitive, miniaturized photoelectric reader, approximately ¾ of a cubic inch in



volume. Known as the Model 150 reader, the device combines a light source, lens, and photocell in a single unit and was designed for use in automatic control systems using electronic circuits which operate as a function of reflected light.

NOISE-FIGURE TEST SET

12 Kay Electric Co. has developed a new wide-range noise-figure measurement test set which is being marketed as the "Auto-Node." The unit provides precise noise figure measurement from 0 to 15 db at frequencies from 5 to 2000 mc.

Suitable for production-line test work, the unit contains all the necessary equipment for making

noise figure measurements. An i.f. range of 7.5 to 150 mc. (with required input noise level of —10 db to 0 dbm over a 3-mc. bandwidth) is provided. The a.g.c. has a dynamic range of 12 db.

The unit measures 16" x 7" x 14" and weighs 26 pounds.

SILICON POWER TRANSISTORS

13 RCA's Semiconductor and Materials Division is now in production on two new 150-watt silicon "n-p-n" power transistors which are characterized by very low saturation resistance (.25 ohm maximum), high betas (7.5 minimum @ Ic = 10 amps and 15 to 50 @ 5 amps), and an operating temperature range of —65 to + 200 degrees C.

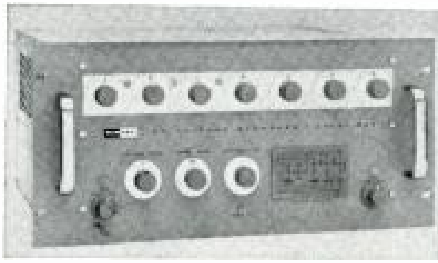
The Types 2N2015 and 2N2016 are in the JEDEC TO-60 package and can be used to replace germanium transistors of comparable power ratings in such applications as power switching for d.c.-to-d.c. connectors, inverters, choppers, and relay control equipment, oscillators, regulators, pulse-amplifiers, class A and class B push-pull a.f. and servo amplifiers.

D.C. VOLTAGE STANDARD

14 Kin Tel Division has developed a new d.c. voltage standard which provides a compact source of precision adjustable voltage for laboratory and industrial use.

The Model 303 has seven panel dials to provide full seven-digit resolution in three ranges from 0 to more than 1000 volts, positive or negative.

Output voltage is accurate to within .01% of the dial setting and stable within 50 parts per million. Equipped with a fully guarded and floating output, the new unit has available out-



put currents up to ± 25 ma. Noise and ripple are less than .0001% peak-to-peak of the dial setting. Power inputs are 105 to 125 volts, 210 to 250 volts, 50 or 60 cps, 125 va.

DECADE COUNTER

15 Raytheon Company's Industrial Components Division is in production on a low-cost decade counter which requires less space than previous models. Having the same electrical characteristics as the CK6476, the new CK7978 is a 13-pin bi-directional ring stepping type and is 1.5" shorter and ⅜" smaller in diameter than the CK6476. Maximum dimensions are 2.3" high and 1.16" wide.

The cold-cathode, gas-filled tube operates up to 5 kc., featuring a visual neon read-out or electrical read-out available from each of the ten cathodes. Total anode current ranges from .30 ma. to .60 ma.

MASTER TV AMPLIFIER

16 Benco Television Associates, Ltd. is now offering a broadband amplifier for master TV systems which provides up to 35 db gain and is modestly priced. The "Pacemaker" is

designed for indoor use and has a power rating of less than 50 watts. It may be used outdoors if a weatherproof container is provided. It will operate with as many as 100 TV and/or FM sets at a time. Output capacity is 2 volts per band. Separate inputs are provided for high band and low band but a link allows the unit to be used with combined high-band/low-band inputs.

HI-FI—AUDIO PRODUCTS

MULTIPLEX SIGNAL GENERATOR

17 Crosby-Teletronics Corp. has just introduced a new stereo multiplex signal generator for the testing of multiplex FM adapters and complete stereo FM receiving systems.

The Model SG-292 is crystal-controlled and self-

calibrating. It provides, from two externally supplied a.f. signals, a composite output signal consisting of a main channel (audio), a subcarrier channel, and a pilot carrier signal.

The main channel consists of the sum of two inputs, A + B; the subcarrier channel is a double sideband suppressed carrier signal at 38,000 cps, modulated by the difference of the two input signals, A – B. The pilot carrier signal is at 19,000 cps ±1 cps. Frequency range is 30 to 15,000 cps.

CONDENSER MICROPHONE SYSTEM

18 Electronic Applications, Inc. is handling the U.S. distribution of the AKG "walk-around" condenser microphone system which consists of a high-quality miniature condenser microphone (C 60) teamed with a transistorized rechargeable power pack (B 60) permitting use in locations remote from a.c. power lines. Although it can be used with a conventional a.c. power supply in a studio, the new unit was especially designed for field recordings, broadcast reportage, on-stage, and other situations requiring mobility and high audio quality.

The microphone is only 4 inches long and weighs 2 ounces. Response is smooth from 30-30,000 cps. It has two capsules—cardioid and omnidirectional—changeable in seconds. Accessories include a new type of windscreen, a light bamboo "fishpole," and extra-long cables. The companion power pack weighs just over a pound and provides 20 hours of service on a single charge.

STEREO TAPE-HEAD KIT

19 Fidelitone Microwave, Inc. is now offering a compact kit containing a quarter-track record and playback stereo tape head plus a 3" reel of

azimuth alignment tape, an electrical connector, and the necessary hardware for making the attachments.

STEREO TUNER-AMP

20 Clairtone Sound Corporation Ltd. has just introduced its Model C 100 R stereo receiver which features wireless remote control. Combined on a single chassis are a stereo AM-FM tuner with provision for multiplex adapter, a dual 35-watt stereo amplifier, and input facilities for wireless remote control.

The control unit enables the listener to adjust volume, tone, and stereo balance from his armchair as well as turning the amplifier and tuner on and off without approaching the set. The audio section contains two high-gain preamps equalized for RIAA curve. The push-pull power amplifier uses heavy-duty power trans-

formers, low-impedance voltage-doubler supply with silicon rectifiers, and a d.c. heater supply for the preamps and tone-control stages to prevent hum. Response is 20-35,000 cps. Harmonic distortion is inaudible and measures less than .5% at 1000 cps output. Hum and noise is 68 db below rated output in the phono position.

CORNER BAFFLES

21 Argos Products Company has added three new corner baffles to its line of audio enclosures and equipment.

Especially designed to reduce installation and service time, the units feature a "clip-in" front design which eliminates unsightly screws through the grille. To take the front off, only one screw is loosened through the bottom of the baffle and the entire front panel slips out.

The new line is available with a straight front, slanting front, and thinline straight front design. The various units are designed to accommodate 8" and 12" speakers.

AUTOMATIC EXPANDER

22 Fairchild Recording Equipment Corporation has developed a new device to recreate full dynamics in home playback equipment and is marketing the unit as its "Compander."

The unit continually scans the output level of the home playback amplifier and dynamically increases high-level signals in order to re-create

the full dynamics of the studio or concert hall performance. The expander does not affect low-level or medium-level passages.

The unit is self-contained and needs no a.c. source. It requires only simple connections to the output of the existing home high-fidelity amplifier and the input of the same equipment. All source material—tuner, tape machine, or turntable—is connected to the input of the unit—which comes complete with the necessary cables.

THREE-WAY SPEAKER SYSTEM

23 Fisher Radio Corporation is introducing a new three-way speaker system which eliminates the conventional bass speaker frame, frequently the cause of parasitic vibration. In its place, the Model XP-4 features unit construction. The bass speaker and the entire enclosure are a single, inseparable unit.

There are four speakers in the system—one 12" woofer, two 5" mid-range, and a 2" hemispherical tweeter. There is an infinitely variable balance control for the middle and high frequencies and a calibrated indicator plate which permits setting for average or "bright" room acoustics. There is a three-way crossover network. Output impedance is 8 ohms. The cabinet measures 24½" x

12½"x 14" and can be used horizontally or vertically. It comes in mahogany, cherry, and oiled walnut or in clear birch sanded finish ready for painting or staining.

LABORATORY FLUTTER METER

24 Amplifier Corporation of America has developed an extremely sensitive flutter meter which meets the standards set by the IRE for flutter and wow.

Designed to meet the need for a rapid and accurate method of visual indication of wow and flutter content of all types of tape recorders and playback equipment, the new unit will handle 33⅓, 45, and 78 rpm disc and 16 and 35 mm. sound film mechanisms. A built-in preamplifier and high-impedance (1 megohm) input attenuator will accept voltages ranging from 1 millivolt to 300 volts. Connection may be made directly across magnetic tape playback heads and across high-level circuits delivering up to 300 volts.

The Model 590-A-1 is assembled on a standard rack panel which measures 8¾"x 19"x 8". Net weight is 18 pounds.

SWEEP-FREQUENCY TEST RECORD

25 Pacific Transducer Corporation is now offering a new stereophonic sweep-frequency test record as an instantaneous method of checking frequency responses on all types of stereophonic equipment.

Used in conjunction with a cathode-ray oscilloscope, the record permits instantaneous response measurements. The disc has the recording of the left side of the groove on one side of the record and the right side of the groove on the flip side. The record is designed with all necessary correction factors included, hence no charts or graphs are necessary. This record is designed for 33⅓ rpm speed, .001" stylus, and stereo reproducing head. For mono systems the company is offering a second disc, the 102M audio-sweep frequency record.

TRANSISTORIZED TAPE RECORDER

26 Majestic International Sales is currently introducing the Grundig-Majestic all-transistor portable tape recorder which is completely battery operated and weighs just 8 pounds. The unit comes complete with microphone and tape and has a dynamic speaker with a frequency range of 80-10,000 cps.

The Model TK-1 "Attache" features simplified controls which are said to be virtually foolproof. The recorder measures 11¾"x 7"x 4½" and is available in a durable plastic case with leatherette covering and carrying strap.

PHONO PLUG LINE

27 Mandex Manufacturing Company, Inc. is now offering a new line of phono plugs and receptacles for the audio market.

Phono plugs can be furnished in a complete range of wire diameter and pin lengths. The shell is .016" cadmium-plated steel with controlled sizing for positive wiping action with mating point. The pin is formed from drawn brass with bright nickel finish. Standard insulating washer is 1/16" black fiber. A low-loss washer is also available.

The receptacles are cadmium-plated on all metal parts. Contacts of .0135% cadmium-plated brass are designed to meet all known insertion and retention specifications for ⅛" diameter phono-type plugs. Ground shells are .016" cadmium-plated steel. They are available in several single designs as well as in double and triple types.

CB-HAM-COMMUNICATIONS

TRANSISTORIZED CB UNIT

28 International Telephone and Telegraph Corporation has announced production of a fully transistorized CB transceiver which will operate on either 12-volt or 117-volt power merely by substitution of the proper power cord.

No bigger than a cigar box, the radio has full 5-watt input, with 2.5-3.1 watts into the transmitting antenna.

Accessories include selective calling, tone signalling, loud-ringing alarm for service trucks, and optional telephone-type handset.

COMPACT CB TRANSCEIVER

29 E. F. Johnson Company is now marketing a new and compact two-way, hand-held transceiver as the "Personal Messenger." This transistorized unit features a superhet receiver with exclusive tuned r.f. amplifier, two-stage transmitter circuit, push-pull audio output, automatic noise limiter, and a.v.c.

Additional features include heavy-duty printed-circuit chassis board, moisture resistant speaker/microphone, rugged high-impact case, socket-type battery contacts, and a silver-plated full wiping push-to-talk switch.

The transceiver can be operated with penlite batteries, with a rechargeable nickel-cadmium battery pack available as an accessory. There is also a cigarette lighter adapter available for powering the unit from 12-volt auto batteries. The instrument is supplied with crystals for one channel. Units with channels 5, 7, 11, 18, and 22 crystals are normally stocked with crystals for other channels available on order.

ANTENNA TESTER

30 Seco Electronics Inc. has announced a new antenna tester which is claimed to eliminate the complexity of antenna testing. Designated Model 520, the new unit has simple direct-reading scales which give all answers in numerical values.

Designed for use on 50-ohm coaxial transmission lines, the Model 520 has a precision-built dual cylinder type air coupler which will give accurate measurements up into the 150-mc. range.

There are three ranges (0-10 watts, 0-100 watts, and 0-1000 watts) which are available with switch selection. The dial scale is calibrated from .5 watt to 10 watts full scale.

The instrument can be used either at the base of the antenna or next to the transmitter.

CB-HAM TRANSCEIVER

31 Hammarlund Manufacturing Company, Inc. is currently offering a Citizens Band transceiver with built-in provision for ham-band operation. The Model HQ-105 TR combines an all-band receiver with a single crystal-controlled transmitter with 5-watt input. The transmitter can be easily retuned to 10-meter operation.

The receiver is continuously tunable from 540 kc. to 30 mc. Other features include push-to-talk or switch-to-talk operation, meter output and tuning indicator, separate "Q" multiplier and b.f.o., 11-tube superhet circuit, and built-in automatic noise limiter.

MANUFACTURERS' LITERATURE

SEMICONDUCTOR COMPONENTS

32 Semi-Alloys, Inc. has issued an up-to-date report to assist those concerned with semiconductor design and manufacture make enlightened choices with regards to the use of such components. Discussed in the report are such factors as availability, what metals or alloys, what type and size of spheres—to what tolerances and at what purities, discs, washers, cylinders, pellets, split rings, wire shapes, ribbons, and castings.

APPLICATION REPORT

33 Motorola Semiconductor Products Inc. has announced the availability of a report which describes a transistorized 120-mc. aircraft transmitter utilizing the firm's 2N1692 and 2N700 amplifier mesa transistors.

Entitled "Special Report Number 34," the publication discusses power specifications in AM transmitters, alignment of AM transmitters, as well as circuit description and performance of a 120-mc. AM transmitter.

ELECTRONIC SPEED GOVERNOR

34 General Electric Company has issued a two-page data sheet covering its electronic speed and load sensing governor. The publication, GEA-7231, describes the equipment which offers high accuracy and fast response characteristics for a wide variety of applications. The new all-solid-state design provides accurate load division during parallel operation and can be used with steam and gas turbines or diesel engines rated between 50 and 50,000 kw.

The bulletin describes the operation and includes a block diagram of the system.

STEREO EQUIPMENT CATALOGUE

35 Altec Lansing Corporation is offering copies of its stereo high-fidelity equipment catalogue, AL 1302-1, entitled "Altec the True Sound of Music."

Highlighted are the firm's stereo tuner and stereo tuner-amplifier as well as details on a stereo multiplex adapter. Also included are details on three new microphones for the serious audiophile along with information on the company's line of speakers, matched speaker components, and speaker systems. An illustrated section covers recommended stereo and mono system arrangements.

MICROWAVE ANTENNAS

36 Technical Appliance Corporation is offering complete technical data on a wide range of spun and mesh microwave antennas in a newly issued catalogue. The new booklet itemizes and describes plane and dual polarized parabolic antennas for use in u.h.f. translator, studio-transmitter link, government, operational fixed, re-

mote pickup, industrial service, and common carrier applications.

Engineers and buyers in these fields will find this catalogue a comprehensive source of information on available units.

INDUSTRIAL PUSH-BUTTONS

37 **General Electric Company** has just issued a revised version of its Bulletin GEA-7127A, covering a complete line of industrial miniature push-buttons.

This 12 page publication features four-color photos to show the many color combinations and added flexibility now available in this line. Photo and diagram explain the 40 per-cent space savings which may be realized in enclosures or panels by the use of these miniature forms. Cutaway photos depict such features as pressure-type terminals, double-break contacts, and multiple oil-seals. Ordering information is also given.

PRECISION RESISTORS

38 **Ward Leonard Electric Co.** has issued a four-page data sheet covering its line of molded metal film precision resistors which exceed MIL-R-10509D specifications.

The booklet covers features, applications, specifications and characteristics, design features, ratings, dimensions, temperature-coefficient code, and performance charts.

CONDENSED SWITCH CATALOGUE

39 **Donald P. Mossman, Inc.** has issued a four-page condensed catalogue covering its line of standard push-button, lever, and turn switches. Included are illustrations, ratings, dimensions, and ordering information.

MODULAR MICROPHONES

40 **University Loudspeakers, Inc.** is now offering a 12-page catalogue covering its line of modular microphones for the professional audio man. Included are details on response, dynamic features, styling, etc. for a wide range of omni-directional and cardioid microphones.

SEMICONDUCTOR DATA

41 **Semitronics Corp.** has just issued a complete catalogue describing its line of tested and guaranteed transistors, diodes, rectifiers, and service kits.

The 16-page catalogue contains much useful semiconductor information and numerous circuit diagrams illustrating typical transistor applications. The booklet also includes a Japanese transistor chart with the firm's recommended replacements. The listing of selenium and silicon rectifiers is cross-referenced with other manufacturers' products for easy on-the-job servicing.

ENCLOSURES AND SYSTEMS

42 **Argos Products Company** has issued a new six-page sound catalogue containing information on a wide variety of baffles, enclosures, and complete speaker systems. Featured for the first time are the firm's three new corner baffles introduced earlier this year.

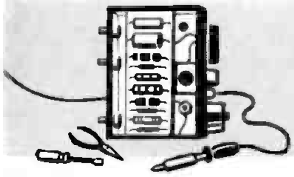
STANDARD RELAY DATA

43 **Potter & Brumfield Division** is now offering copies of its 8-page catalogue showing more than 40 standard relays available from the company. Descriptions, dimensions, technical specifications, and prices are given for more than 450 variations of the basic relays.

Power, general and special purpose, plate circuit, sensitive and telephone types are listed. Eight new relays have been added to the line and are included in this catalogue.

TEMPERATURE TRANSDUCERS

44 **Trans-Sonics, Inc.** is offering a four-page bulletin describing a complete line of resistance "Weld-On" temperature transducers. With a range of from −435 degrees F to +1900 degrees F, these transducers are designed to meet the severe operating environments found in missile applications. ▲



ELECTRONICS MARKET PLACE

RATE: 60¢ per word. Minimum 10 words. November issue closes September 1st. Send order and remittance to: ELECTRONICS WORLD, One Park Ave., N. Y. C. 16, N. Y.

ELECTRONICS ENGINEERING & INSTRUCTION

ENGINEERING Education for the Space Age. Northrop Institute of Technology is a privately endowed, non-profit college of engineering offering a complete Bachelor of Science Degree Program and Two-Year accredited technical institute curricula. Students from 50 states, many foreign countries. Outstandingly successful graduates employed in aeronautics, electronics, and space technology. Write today for catalog—no obligation. Northrop Institute of Technology, 1183 West Arbor Vitae Street, Inglewood 1, California.

ELECTRONICS! Associate degree—29 months. Technicians, field engineers, specialists in communications, missiles, computers, radar, automation. Start September, February. Valparaiso Technical Institute, Dept. N, Valparaiso, Indiana.

USED Correspondence Courses and Books sold and rented. Money back guarantee. Catalog free. (Courses Bought.) Lee Mountain, Pisgah, Alabama.

EARN $150 Week as Electronics Draftsman. Send $2 first lesson, or $25 complete home study course. Prior, Inc., Dept. 123, 23-09 169 Street, Whitestone 57, New York.

USED Correspondence Courses. Books Bought, Sold, Rented. Catalog Free. Vernon, Summerville, Ga.

HIGHLY Effective Home Study Review For FCC Commercial Phone Exams. Free Literature. Wallace Cook, Box 10634, Jackson 9, Mississippi.

FOR SALE

TV Tuners—Rebuilt or Exchanged $9.95 complete—all types—fast, guaranteed service. Send tuner with all parts to: L. A. Tuner Exchange, 4611 West Jefferson Blvd., Los Angeles 16, California.

TUBES—TV, Radio, Transmitting And Industrial Types At Sensibly Low Prices. New, Guaranteed, 1st Quality, Top Name Brands Only. Write For Free Catalog or Call WAlker 5-7000. Barry Electronics Corp., 512 Broadway, New York 12N, N. Y.

DIAGRAMS for repairing radios $1.00. Television $2.00. Give make, model. Diagram Service, Box 672-E, Hartford 1, Conn.

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Parabolic Reflectors, Picture Catalog 10¢. Meshna, Malden 48, Mass.

RADIO & TV Tubes at Manufacturer's prices! 100% Guaranteed! Brand New! No re-brands or pulls! United Radio, Box 1000-W, Newark, N. J.

GOVERNMENT Sells Surplus: — Electronics; Oscilloscopes; Transceivers; Test Equipment; Radar; Sonar; Walkie-Talkie; Boats; Jeeps; Aircrafts; Misc.—Send for "U.S. Depot Directory & Procedures"—$1.00—Brody, Box 425(RT), Nanuet, New York.

PROFESSIONAL Electronic Projects—Organs, Timers, Computers, Industrial, etc.—$1 up. List Free. Parks, Box 1665 Lake City, Seattle 55, Wash.

BEFORE You Buy Receiving Tubes or Hi-Fi Components send now for your giant Free Zalytron current catalog—featuring nationally known Zalytron First Quality TV-Radio Tubes. Hi-Fi Stereo Systems. Kits. Parts, etc. All priced to Save You Plenty—Why Pay More? Zalytron Tube Corp. 220 W. 42nd St., NYC.

"SURPLUS Electronics, Optics. Free Catalog. Thermoelectric Devices, Inc. 302 Massachusetts Ave., Cambridge, Mass."

CITIZEN-Band Crystals—Direct from Manufacturer. Guaranteed .005% Tolerance. Send only $1.75 for Each Crystal with Equipment Mfg. Name, Model No. and Channel No. to Michigan Crystal Co., Inc., Box 413 (C), Lansing, Michigan.

ELECTRIC Engraver permanently engraves tools, any metal. $2.00 postpaid. Relco, Box 10563, Houston 18, Texas.

SUPERSENSITIVE directional microphone picks up a whisper at great distances. Hears through ordinary walls. Used by investigators. Easily built for about $6.00. Plans $2.00. Dee Company, Box 7263, Houston 8, Texas.

HI FI Tuners, Amplifiers, Speakers, Walkie Talkies, Radios, Telescopes, Microscopes, Cameras. Top Quality Imports, Low Prices. Free Catalog. GM Photoelectronics—623 Gay—Knoxville, Tennessee.

PRECISION Resistors. Carbon Deposited Guaranteed 1% Accuracy. Millions in Stock. ½ Watt—8¢, 1 Watt—12¢, 2 Watt—15¢. Leading manufacturers, Rock Distributing Co., 902 Corwin Road, Rochester 10, N. Y.

TERRIFIC Bargains—Electronic components—Books. Free list. ST Labs, 438 Third Ave., Newark 7, N. J.

FREE Fluorescent Catalog. Includes midget fluorescent fixtures, fixture kit bargains, parts. Shoplite, 650 E. Franklin, Nutley 10, New Jersey.

WANTED

QUICKSILVER, Platinum, Silver, Gold. Ores Analyzed. Free Circular. Mercury Terminal, Norwood, Massachusetts.

CASH Paid! Sell your surplus electronic tubes. Want unused, Clean radio and TV receiving, transmitting special purpose, Magnetrons, Klystrons, broadcast types. Want military and commercial lab test equipment such as G.R.H.P., AN UPM prefix. Also want commercial Ham Receivers and Transmitters. For a Fair Deal write: Barry Electronics Corp., 512 Broadway, New York 12, N. Y. (Walker 5-7000).

INVENTIONS Wanted for immediate promotion! Patented, unpatented. Outright cash; royalties! Casco, Dept. BB Mills Building, Washington 6, D.C.

TRIGGER—W9IVJ We Buy Shortwave Equipment For Cash. 7361 W. North, River Forest, Ill. Phone PR 1-8616. Chicago TU 9-6429.

TAPE & RECORDERS

TAPE Recorders, HI-FI Components. Sleep Learning Equipment. Tapes. Unusual Values. Free Catalog. Dressner, 1523 EW Jericho Turnpike, New Hyde Park, N.Y.

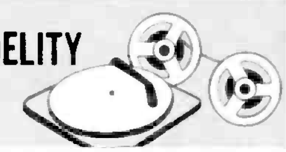
RENT Stereo Tapes—over 2,000 Different—all major labels—free catalog. Stereo-Parti, 811-G, Centinela Ave., Inglewood 3, California.

DON'T Buy Hi-Fi components, kits, tape, tape recorders until you get our low, low return mail quotes. "We Guarantee Not To Be Undersold." Wholesale catalog free. Easy time payment plan, 10% down—up to 24 mos. to pay. Hi-Fidelity Center, 220NC E. 23 St., New York 10, N. Y.

SELF-Hypnosis. New concept teaches you quickly by tape or LP-record. Free literature. McKinley Publishers, Dept. T6, Box 3038, San Bernardino, California.

AMPEX, Bozak, Citation, Concertone, Crown, Magnecord, Presto, Norelco, Tandberg, Sherwood, Thorens, Scott, Shure, others. . . . Trades. Boynton Studio, Dept. RT, 10 Pennsylvania Ave., Tuckahoe, New York.

HIGH-FIDELITY



SOUNDTASTIC! That's what our customers are saying upon receiving our prices on our latest High Fidelity Stereo and Monaural, amplifiers, tuners, turntables, speakers, tape recorders, kits. All brand new with factory guarantee. Individual quotations only. No catalogues. Audio World, 2057 Coney Island Avenue, Brooklyn 23, New York. Dept. HR

PROMPT Delivery, We Will Not Be Undersold. Amplifiers, Tape Recorders, Tuners, Etc. No Catalogs, Air Mail Quotes. Compare. L. M. Brown Sales Corp., Dept. W, 239 E. 24 St., N. Y. 10, N. Y.

DISGUSTED with "Hi" Hi-Fi Prices? Unusual Discounts On Your High Fidelity Requirements. Write. Key Electronics, 120 Liberty St., New York 6, N. Y. Cloverdale 8-4288.

SAVE on recording tape, stereo components. Tape, first quality, no-splice, brand new, 1800' Plastic $1.49, 1800' Mylar $1.89, 10/$18.00, 2400' Mylar $2.95, 10/$27.50 Cartridges, G.E. GC-7 diamond stereo $4.95, G.E. GC-5 diamond Stereo $5.95, G.E. Diamond monaural VR II $9.95, Ronette diamond stereo $7.95, Altec-Lansing 8" speakers $8.95, Garrard type "A" w/shure M7D $79.51, Diamond stylii $3.95. Money back guarantee. Write for quotation on other items. S and F Electronics. 7959 Melrose, Los Angeles 46, Calif.

RECORDERS. Components. Free wholesale catalogue. Carston 125-R. East 88. N.Y.C. 28.

PRICES? The Best! Factory-sealed Hi-Fi Components? Yes! Send for free catalog. Audion, 25T Oxford Road, Massapequa, N.Y.

REPAIRS and SERVICING

REPAIR On Surplus Meters—Test Equipment. Bigelow Electronics, Bluffton, Ohio.

RECORDS

GET The Latest issue of the Schwann Long Playing Catalog at your record dealer's now. A complete monthly 256-page guide to all widely available recorded music, it lists over 25,000 monaural and stereo records, including over 550 new releases each month. If your record dealer doesn't carry it, send 35¢, with your name and address and name and address of your dealer to W. Schwann, Inc., 137 Newbury St., Boston 16, Mass.

ADULT Party Record & Catalogs: $1.00. DRC, 11024 Magnolia, No. Hollywood, Calif.

GOVERNMENT SURPLUS

JEEPS $278, Airplanes $159, Boats $7.88, generators $2.68, typewriters $8.79, are typical government surplus sale prices. Buy 10,001 items wholesale, direct. Full details, 627 locations, procedure, only $1.00. Surplus, Box 789-C9Z, York, Penna.

PATENTS

PATENT Searches, $6.00. For free Invention Record, and "Information Inventor's Need," Write: Miss Heyward, 1029 Vermont Avenue, N.W., Washington 5, D.C.

MISCELLANEOUS

CONVERT any television to sensitive, big screen oscilloscope. Only minor changes necessary. Plans $2.00. Relco, Box 10563, Houston 18, Texas.

"HOW To Become Outstanding In The Field Of Electronics." Free Literature. W. Cook, Box 10634, Jackson 9, Mississippi.

SHOPPING GUIDE
Classified

A HANDY GUIDE TO PRODUCTS, NOT NECESSARILY ELECTRONIC, BUT OF WIDE GENERAL INTEREST.

PHOTOGRAPHY—FILM, EQUIPMENT, SERVICES

SCIENCE Bargains—Request Free Giant Catalog "CJ"—144 pages—Astronomical Telescopes, Microscopes, Lenses, Binoculars, Kits, Parts. War surplus bargains. Edmund Scientific Co., Barrington, New Jersey.

PHOTOMURALS Individually Made Any Size or Color Your Negative Or Choose From Our Thousands. Brochure 50¢. Al Greene Associates, 1333 South Hope Street, Los Angeles 15, California.

STAMPS & COINS

MILLION Foreign Stamps! 2¢ each! Send for thrilling, giant approvals! ABC, Box 6000-KZ, San Francisco 1, California.

TERRIFIC Stamp Bargain! Israel-Iceland-San Marino—plus triangle set—Plus Antigua-Borneo-Virgin-Scouts-Congo-Russia—Plus large stamp book—all four offers free—Send 10¢ for mailing cost. Empire Stamp Corporation, Dept. Z2, Toronto, Canada.

SELLING entire personal stamp collection. All foreign. Good condition. Assorted packets of 50—25¢ and self-addressed, stamped envelope. Electronics World, Box 573, One Park Avenue, New York 16, N. Y.

BUSINESS OPPORTUNITIES

FREE Book "990 Successful, Little-Known Businesses." Work home! Plymouth-455R, Brooklyn 4, New York.

MAKE $25-$50 Week, clipping newspaper items for publishers. Some clippings worth $5.00 each. Particulars free. National, 81-0G, Knickerbocker Station, New York.

A Second Income From Oil Can End Your Toil! Free Book and Oilfield Maps! National Petroleum, Pan-American Building—PP, Miami 32, Florida.

I Want A Man who wants a business of his own. I will train you, supply the equipment, help finance you, start you rolling. This is not a risky-get-rich-quick scheme. It is a legitimate business, an exclusive protected franchise, proved successful by hundreds throughout the country. Send name and address and phone number. Marion Wade, 2117 North Wayne, Dept. 454M, Chicago 14, Illinois.

BECOME a telephoneman, experience unnecessary, details free. Occupations Unlimited, 1100 Reeve, Santa Clara, Calif.

HELP WANTED

HIGH Paying Jobs in Foreign Lands! Send $2.00 for complete scoop! Foreign Opportunities, Box 172, Columbus 16, Ohio.

EARN Extra money selling advertising book matches. Free Samples furnished. Matchcorp. Dept. MD-91, Chicago 32, Ill.

TRANSLATOR, technical, free-lance, home assignments, must type. State language, technical specialty, experience, rates. Berlitz Translation Service, 630 Fifth Avenue, New York 20, N. Y.

MISCELLANEOUS

WRITERS!—Free Sample copy of Pink Sheets listing top-notch USA markets for short stories, articles, books and plays available to you upon request. Write today! Literary Agent Mead, 915 Broadway, New York 10, N.Y.

HANDMADE Shoes, Boots your specifications; $12.75 up information How-Hoo Shoes, 3108 Kallin, Long Beach, Calif.

ELECTRONICS WORLD HAS A BUYER FOR YOUR USED EQUIPMENT OR COMPONENTS!

The 245,000 purchasers of ELECTRONICS WORLD are always in the market for good used equipment or components. So if you have something to sell, let EW readers know about it through our classified columns. It costs very little: just 60¢ a word, including name and address. Minimum message: 10 words.

For further information write: Martin Lincoln, ELECTRONICS WORLD, One Park Avenue, New York 16, N. Y.

Tape Loops for Language Labs

(*Continued from page* 61)

with the recorded material. After this, if the machine is turned off following a short period of sympathetic repetition, it is found that the listener has completely memorized the material.

From a class experiment in a local school, it was found that, having once learned a verbal conjugation pattern with the technique described here, the group still remembered this material readily three months later, with no intermediate practice. Similar results have been observed with other groups in learning trigonometric formulas. Any material requiring memorization of short patterns is ideally suited to this technique.

Storage Problems

Practical considerations must not be forgotten. What about the clumsiness and inconvenience of storing the tape loops? Such problems can be avoided by re-recording the repetition exercises on conventional tape reels. Output from the machine on which the loop is being played is simply fed to another, reel-equipped recorder. If materials so stored are carefully logged, instructors or technicians in charge of language laboratories can prepare tape lessons containing various kinds of drills and ending with five minutes of repetition for the effective memorization of essential patterns.

Many applications and variations of the loop technique can be developed readily for use in both the home and the language laboratory or audio classroom. With this electronic means, memorization becomes effortless and almost automatic. ▲

PHOTO CREDITS

Page	Credit
31 (Fig. 2), 33, 48, 49, 96	Motorola Inc.
38-39 (top)	DuKane Corp.
39 (right), 40	Bogen-Presto Div.
49 (top)	General Electric Co.
52, 53	Beckman/Spinco Div.

Answer to Puzzle on Page 92

■	■	■	S	E	Q	U	E	N	T	I	A	L	■	■
S	U	B	C	A	R	R	I	E	R	S	■	■	■	P
I	N	■	A	R	T	■	■	R	O	T	■	C	■	H
M	I	E	N	■	■	P	■	V	T	■	I	O	■	O
U	T	E	S	■	■	H	■	E	■	F	N	L	■	T
L	■	■	■	■	■	O	■	■	C	A	T	O	■	O
T	R	A	P	■	■	S	■	A	D	D	E	R	■	C
A	E	R	O	■	■	P	■	■	S	E	R	F	■	A
N	O	G	S	■	■	H	■	C	■	R	L	I	■	T
E	■	■	■	■	■	O	■	E	■	S	A	L	■	H
O	H	M	S	■	■	R	■	R	F	■	C	T	■	O
U	P	O	N	■	■	S	■	A	L	■	E	E	■	D
S	A	O	I	E	■	■	■	M	U	■	D	R	■	E
■	D	E	F	L	E	C	T	I	O	N	■	■	■	S
■	■	L	F	■	I	R	■	C	R	O	S	S	■	■

ADVERTISERS' INDEX SEPTEMBER, 1961

Advertisers listed below have additional information available on their products in the form of catalogues and bulletins. To obtain more detailed data, simply circle the proper code number in the coupon below and mail it to the address indicated. We will direct your inquiry to the manufacturer for processing.

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The coupon below can also be used to obtain additional information on the new product items shown on pages 108 through 116 as well as on the ads as listed above.

VOID AFTER SEPT. 30, 1961 5

NAME ______________________

STREET NO. ______________________

CITY ______________ ZONE ______ STATE ______________

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200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239

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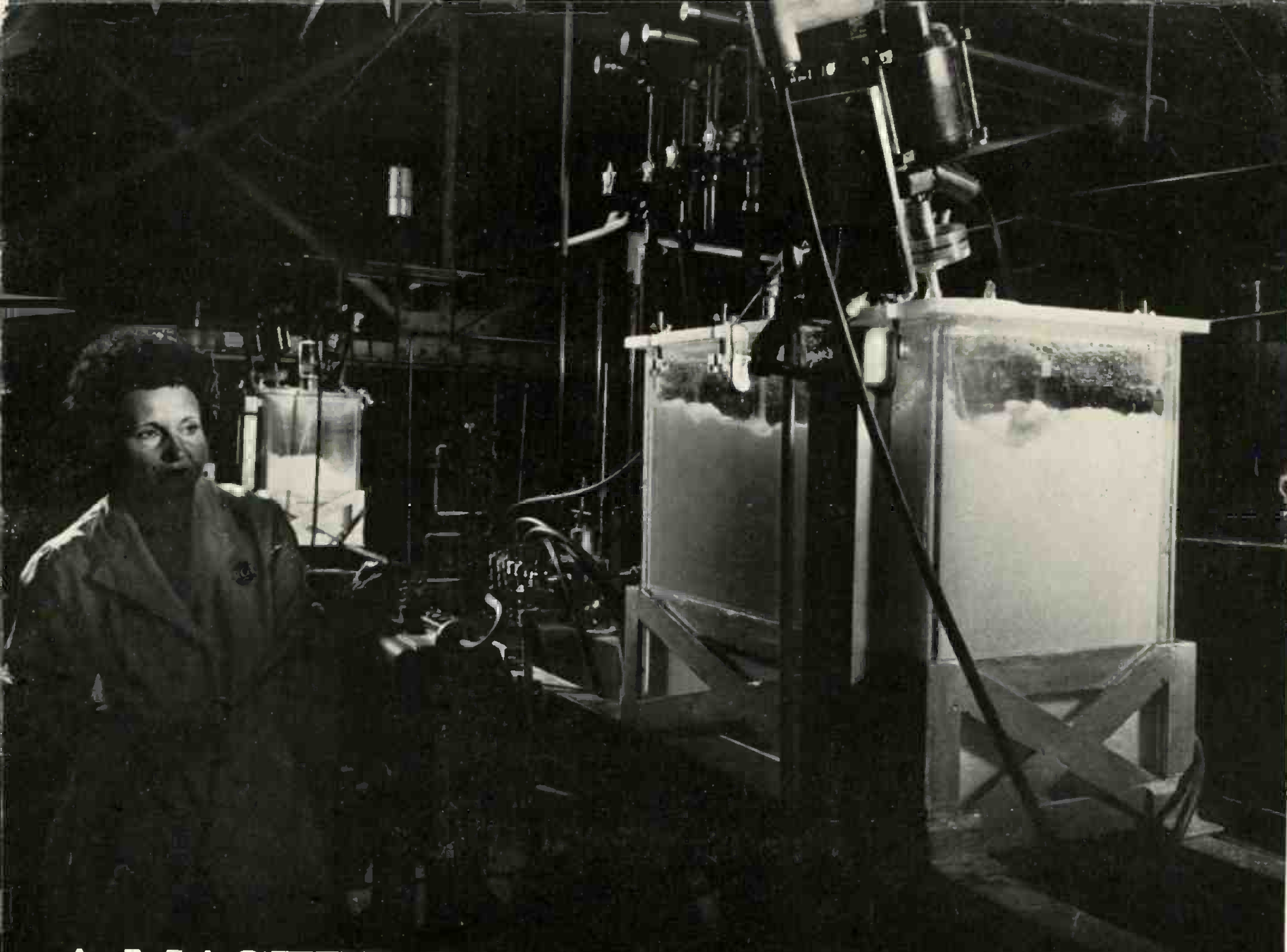

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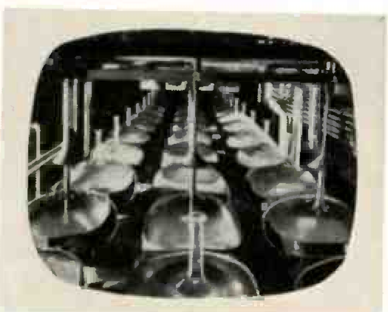
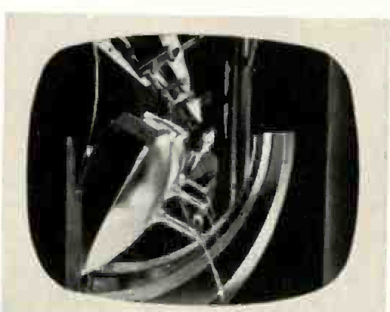
Here RCA Silverama Picture Tube screens have their beginning. Phosphor in a solution of demineralized water (impurity level: less than 1 part per million!) is continuously agitated by electric blenders to maintain uniform suspension. When mixing is complete, solution is sprayed into Silverama's glass envelope which has been scrubbed and rinsed until it is chemically clean. Then with tube on slow-moving, vibration free settling belts (below), phosphor settles evenly over the entire faceplate to provide the smooth, grain-free screen for which Silverama is famous.

This same painstaking care goes into every part of RCA Silverama picture tubes. It is your assurance that every Silverama is the finest replacement picture tube modern science and technology can produce. It contains a precision electron gun—the finest parts and materials, plus a thoroughly clean and inspected reused envelope. Such built-in quality means a better picture in your customers' sets—and therefore, more business, fewer call backs and valuable word-of-mouth advertising for you. See your Authorized RCA Distributor this week.



Settling belt moves at less than 10 inches per minute to give ample time for gradual settling and smooth adherence of phosphor to faceplate.



When settling is complete, excess liquid is poured slowly and gently from neck of envelope to avoid disturbing smooth phosphor coating.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

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