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w/p 88

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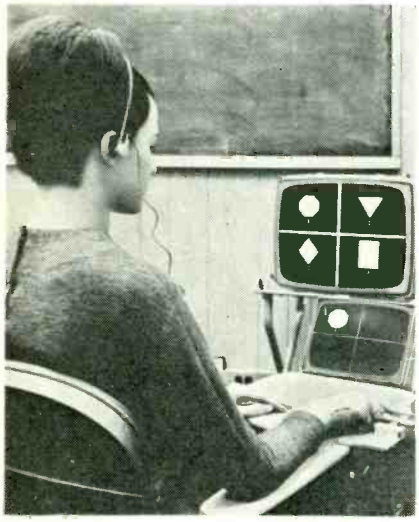
NEWS BRIEFS



Student presses the right button in a lesson on driving safety. The large set could be a classroom monitor for the teacher or an ordinary TV—the smaller one a special monitor for students' use.

STUDENTS CAN PARTICIPATE IN TV-FM TEACHING SYSTEM

A new system of teaching by television was introduced by New York's uhf TV station WNYC-TV, channel 31, in a recent experimental broadcast. In sharp contrast to older "one-way" educational television, the new system encourages student cooperation and provides immediate correction for an unlimited number of students while the lesson is being televised.

A problem scene is shown on the television screen. At a given point the picture disappears and the screen displays an image of four numbered quadrants, each one with a question.

Besides the TV set, the student is provided with a monitor that receives a quadruplex signal from a FM station operated in conjunction with the TV transmission. The student presses one of four buttons on his "response unit" —the one corresponding to the quadrant on the screen to which he thinks has the right answer. The button switches in one of the four signals on the FM "sound track." If the student is correct, he is told so, with a little further explanation to reinforce his conclusion. If he is wrong, he is corrected, and the correct answer is given, with reasons.

The system, developed by Educasting Systems of New York City, is programmed by International Correspondence Schools.

Variations of the method have been tried experimentally by WFUV, Fordham University, New York City, and WUSV, Scranton, Pa. These variations include classroom setups where only one special FM monitor receiver is used (with individual response units for each student), student-paced types of instruction, and methods of instructing the illiterate. An all-sound system, which requires only special four-track tape recorders and playback units, has also been developed, as well as one with a modified TV receiver, in which only one of the four quadrants occupies the full screen when a response button is pressed.

EIA BACKS UP MOBILE PLEA WITH FIGURES

The Electronic Industries Association, long troubled over congestion in the land-mobile radio bands, has hit the FCC with statistics generated from the FCC's own files.

The computer-processed data showed that, excluding 916,000 common-carrier units, 133,600 base stations and 1,949,723 mobile units were licensed by the end of June 1963—a total of 2,083,323 transmitters. This figure does not include nearly 300,000 transmitters for which the FCC lacks exact geographical data. The computer "mapped" the allocations to show relative crowding in various parts of the country.

The EIA concludes that the problem will get worse if the FCC licenses more mobile radios. Solutions presently being proposed, and which the EIA's statistics should help evaluate, are to use unallocated TV channels, or to continue splitting and reshuffling existing channels. Neither is considered a long-term answer.

NEW RADAR SYSTEM GOES ESKIMO

Installed in low-silhouette, igloo-like structures to withstand nuclear blasts, this advanced experimental radar (below) is designed to detect, track and identify missile warheads and to activate nearby anti-missile sites against them. Designed by Sylvania Electric Products, Inc., it is undergoing evaluation tests at White Sands, N.M.

The new system, which performs simultaneously as a search and acquisition, a tracking and a discrimination radar, uses no mechanical drive system or rotating antennas. Instead, the energy is steered electronically by shifting the electrical phase of the individual antenna elements.

RUSSIANS PATENT ELECTRONIC SLEEP-INDUCER

Three Russian engineers were granted a patent (No. 3,160,159) for an electronic sleep machine such as that described in the cover story "Electrical Anesthesia," RADIO-ELECTRONICS, February, 1965. The machine is under clinical investigation before marketing here. Patents on improvements made by United States engineers are pending.

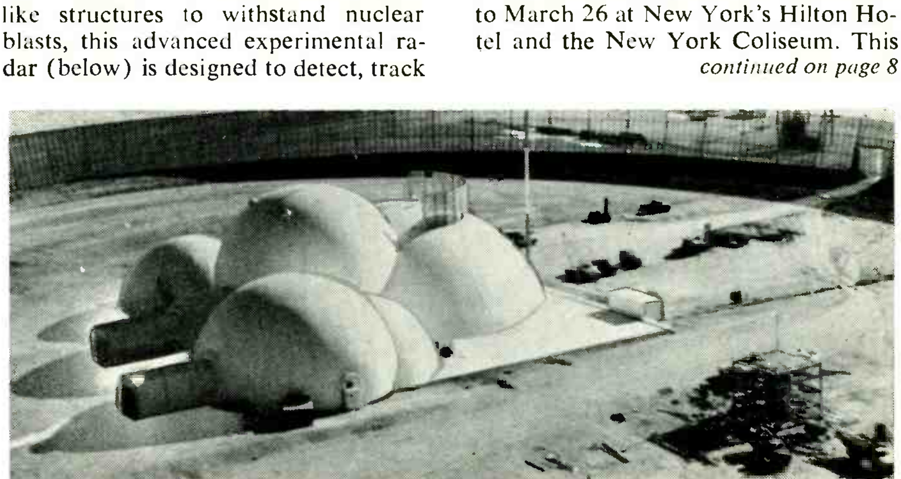
ANOTHER RECORD SPEED ANNOUNCED

A new Phonobook record to play at 8⅓ rpm has been announced by CBS Labs. The two sides of a 7-inch record will play for 4 hours. Intended chiefly for voice, frequency response is good up to 5,000 cycles. The stylus radius is only 0.3 mil.

MORE TECHNICAL PAPERS AT IEEE CONVENTION

More than 400 papers covering breakthroughs in all areas of electrical and electronics engineering are being presented at the 1965 IEEE International Convention, held from March 22 to March 26 at New York's Hilton Hotel and the New York Coliseum. This

continued on page 8



NEWS BRIEFS continued

is a 25% increase over last year. The 400 papers, presented in 80 technical sessions, range from "Progress in Semiconductor Lasers" to "The Challenge of Replacing Human Parts and Functions."

More than 70,000 engineers an scientists from at least 40 countries are expected to attend the world's largest technical meeting and exhibition.

The convention has been extended to five days for the first time, previous conventions running only four days. Exhibits, however, will continue on the four-day schedule from Monday, March 22, through Thursday, March 25. More than 1,000 exhibitors will display $20 million worth of the latest electrical and electronic equipment. This year, electrical and electronics exhibits will be fully integrated, with no attempt to separate them.

COURT OK'S BOPPING TRANSISTOR NUISANCE

A Philadelphia grand jury refused to indict a college professor accused of hitting a woman with a radio she allegedly refused to turn down as both were riding a bus.

According to Dr. Ivan Rudnitsky, a history instructor, he had asked the woman to turn down the volume on her radio, which she was playing at a high level. Instead of doing so she turned the volume up and moved to a seat closer to him. The woman then alleged that he grabbed the radio and struck her over the head with it. Professor Rudnitsky stated that he attempted to seize the radio and turn it off, and that in the struggle it hit the woman on the head.

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CALENDAR OF EVENTS

Los Angeles Hi-Fi Music Show, Mar. 7–15; Ambassador Hotel, Los Angeles, Calif.

IEEE International Convention, Mar. 22–25; Coliseum and New York Hilton Hotel, New York, N.Y.

National Electronics Week (1965 Electronic Parts Distributors Show), Mar. 29–Apr. 4; New York Hilton Hotel & Americana Hotel, New York, N.Y. (Trade show—not for the public)

Colloque International sur les Techniques des Memoires (International Symposium on Techniques of Memories), Apr. 5–10; Paris, France

International Exhibition of Electronic Components, April 8–13; Parc des Expositions (Fairgrounds), Porte de Versailles, Paris

National Telemetering Conference, Apr. 13–15; Shamrock Hilton Hotel, Houston, Tex.

1965 Electronics & Instrumentation Conference & Exhibit, Apr. 14–15; Cincinnati Gardens, Cincinnati, Ohio

R. A. HEISING PASSES

Raymond A. Heising, famed radio pioneer, died Jan. 16, at the age of 76. Holder of 117 patents in vacuum-tube technology, oscillators, multiplex-carrier line and radio transmission, he is best known as the inventor of a standard system of modulating telephone transmitters—the Heising modulation system.

Born in Albert Lea, Minn., Heising studied at the University of North Dakota, Notre Dame and the University of Wisconsin (from which he received a Doctor of Science degree in 1947). He was a fellow and at one time president of the Institute of Radio Engineers, a member of several other learned societies and recipient of numbers of awards and medals.

Dr. Heising worked with Western Electric Co. from 1914 to 1925, then with Bell Labs to 1944, when he became a patent lawyer. He went into semi-retirement in 1953, continuing to act as consultant and patent agent.

ELECTRONIC ARM GUIDED BY MUSCLE CURRENTS

A remarkable electronic arm has been developed in Russia. Grasping

continued on page 14

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299	Sparton	658	Sylvania
300	RCA Victor	660	Bradford
305	Hoffman	663	Zenith
314	RCA Victor	665	Curtis Mathes
320	Sentinel	670	Coronado
323	Magnavox	673	RCA Victor
324	Airline	678	General Electric
327	Capehart	680	Airline
344	Sentinel	683	Philco
346	Philco	685	Packard-Bell
353	RCA Victor	688	Zenith
357	Westinghouse	690	Westinghouse
358	RCA Victor	693	Sylvania
371	Motorola	695	Motorola
378	Raytheon	698	Philco
382	Truetone	700	Airline
383	Admiral	703	Admiral
385	Hoffman	705	Zenith
386	Packard-Bell	708	Magnavox
388	Silvertone	710	Magnavox
399	RCA Victor	713	Silvertone
412	Emerson	715	Setchell-Carlson
433	RCA Victor	716	Truetone
437	Westinghouse	717	Penncrest
459	RCA Victor	719	Emerson
495	Admiral	721	Motorola
517	RCA Victor	722	Zenith
540	Admiral	724	DuMont
546	Packard-Bell	726	Coronado
565	General Electric	727	Muntz
576	DuMont	729	General Electric
584	Silvertone	731	Olympic
588	Magnavox	732	Electrohome
592	Emerson	734	Andrea
596	Olympic	736	RCA Victor
599	Zenith	737	Catalina
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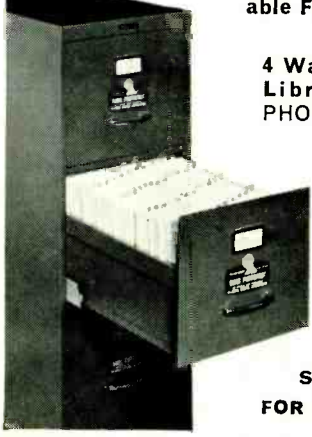

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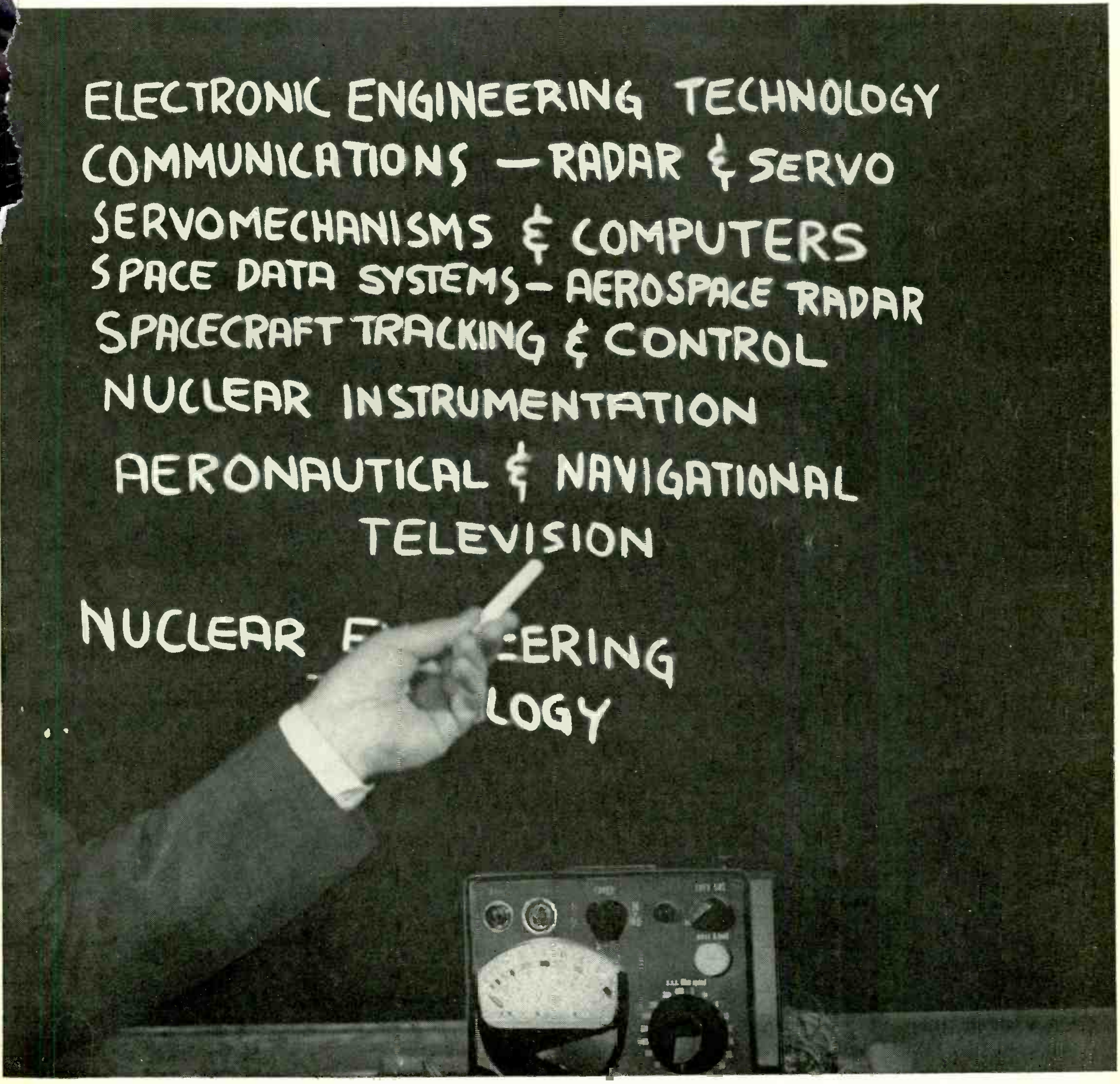


NEWS BRIEFS continued

with most artificial limbs involves muscles relatively distant from the forearm, but with the electronic arm the fingers are moved by a tiny reversible dc motor and guided by electric nerve and muscle currents in the upper part of the forearm. About 200 Russians have been fitted with these electronic arms, and a British foundation has recently paid $30,000 for rights to the device.

DIRECT-DIAL MOBILE PHONE DEVELOPED BY BELL LABS

Awaiting FCC approval is a new direct-dialing mobile radio system demonstrated successfully in Harrisburg, Pa., by Bell Labs.

With the new MJ Mobile Radio Telephone System, a user in a car picks up the handset and dials, even long-distance, just as with an ordinary phone. Operation is "full duplex," again like an ordinary phone, so the caller need not switch back and forth between transmit and receive. Up to 11 channels (in the 150-mc band) will be allocated to serve such phones. A mobile set not in use continually hunts for an unused channel, so that it will instantly be ready for an incoming or outgoing call.

IEEE HAS NEW OFFICERS

Dr. Bernard M. Oliver, vice president of research and development, Hewlett-Packard Co., is president of the Institute of Electrical and Electronic Engineers for 1965.

The vice presidents will be Dr. W. G. Shepherd, professor and head of the Electrical Engineering Department of the University of Minnesota, and Mr. Hendley Blackmon, engineering manager, association activities, Westinghouse Electric Corp. Haraden Pratt of Pompano Beach, Fla., will continue to hold the office of secretary for 1965, and the treasurer is Seymour Herwald, vice president of Westinghouse Electric Corp.

BRIEF BRIEFS

At 0000 hrs UT Jan. 1, 1965, (1900 hrs EST, Dec. 31, 1964) CHU time signals were retarded 100 milliseconds, it was announced from Ottawa.

Hi-fi engineers have been quoted as saying that manufacturers of high-fidelity equipment appear more interested in designing with field-effect transistors than with integrated circuits. Integrated circuits haven't replaced conventional tubes and transistors in hi-fi sets because at present they are difficult to cool, are more expensive and don't provide a high enough power output.

Raytheon Co. is adding 66 new types to its replacement television tube line. Of these, 10 are used in imported radios and hi-fi units. END

CORRECTION ✓

The item "Do-It-Yourself Parallel-R, Series-C Nomogram" in the *Try This One* department of our February issue contained an erroneous formula. The series-capacitance formula printed on page 102 should of course read:

$$C_T = \frac{C1C2}{C1 + C2}.$$

With the formula as printed, using the nomogram would be a *great deal* quicker—even *with* simple, small numbers! END

Correspondence

HARDLY A BREAKTHROUGH?

Dear Editor:

As startling indeed as a tremendous breakthrough is Peter Sutheim's article "At Last—Wireless Power Transmission" on Raytheon's demonstration of a helicopter powered by microwave energy (R-E, January 1965).

In the same mail delivery with your January issue is the Jan. 12 issue of *Look,* which features the Kitty Hawk pictures of the Wrights' first flights and another of Ford's first automobile, both of which in retrospect encouraged the thrilling speculations that microwave-powered flight was just around the corner, given a decade or two of refinement.

But, like Icarus, my enthusiasm fell to earth when I computed the power efficiency, from the 5 kw transmitted to the ⅕ hp (150 watts) delivered, as only 3%! It sank even deeper with the realization that the distance was only 50 feet, and that microwave beams do not converge, but diverge at appreciable distances, with consequent great decrease in received power, whereas laser beams of coherent radiation have very small divergence.

Were this demonstration as persuasive as the Wrights' first flights, or as Henry Ford's first Tin Lizzie, my enthusiasm over this article would still be high. Nevertheless I have only the best wishes and hopes for the ultimate success of this project.

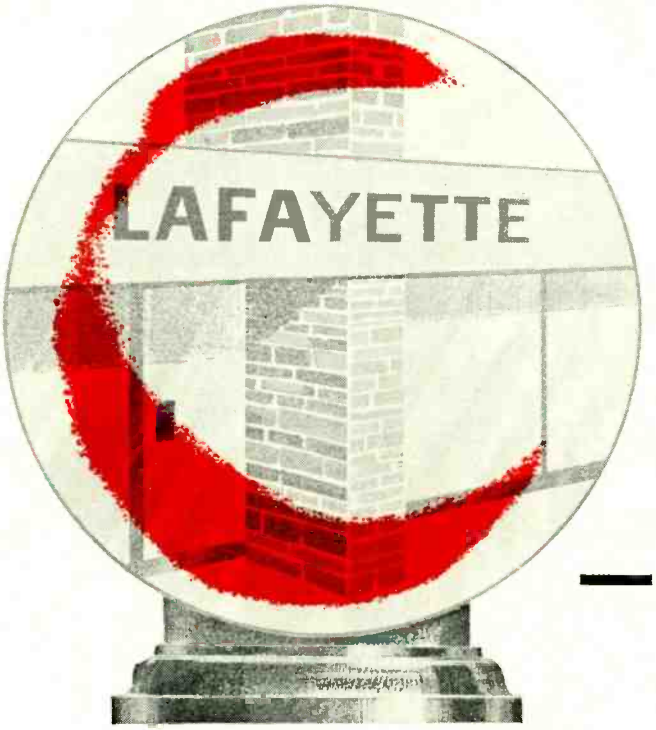
BENJAMIN F. MIESSNER
Miami Shores, Fla.

The author replies:

The demonstration, according to Raytheon, was intended to suggest potential, rather than to display a perfected system. The Wright brothers' first flight covered 120 feet and carried only the pilot, who had to lie prone on the lower wing. Sixty years later, we hail that as a tremendous breakthrough, as did some farsighted people then. But many, confronted with the modest achievement of that first flight (a later one that same day

continued on page 20

NO ONE CAN GUARANTEE YOUR FUTURE



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If you have a basic knowledge of radio, TV or electronics, you owe it to yourself to investigate the Lafayette Associate Store Program.

This Is What We Offer You:

1. Business Stability — Lafayette has been in business 44 years. You'll cash in on this established reputation.

2. Product Diversification — You can sell everything Lafayette offers . . . hi-fi stereo, citizens band, tape recorders, radios, tools, and much more. You'll attract more customers than you ever thought possible.

3. Advertising Support — Year 'round advertising, publicity, public relations and promotional campaigns have established Lafayette and its franchised dealers as America's Hi-Fi and Electronics Centers.

4. Protected Territory — Yours will be the only franchised Lafayette Radio Electronics Associate Store in your marketing area.

5. Marketing Guidance — We'll help you set up a complete operation to build a successful future, and maintain it. We will always be available to help you in any way possible.

We are looking for a limited number of men who want to become a part of the Lafayette Associate Store Program . . . . men who are willing to invest $10,000 to $30,000 to make a new business career for themselves.

Mail the coupon for complete information without obligation.

Lafayette Radio Electronics Corporation
Dept. ASJC-5
111 Jericho Turnpike
Syosset, L. I., N. Y. 11791

Mr. Robert Laub:
Please send me full information on how I can own my own profitable business. I understand there is no obligation.

Name..........

Address..........

City.......... State.......... Zip..........

16

have heard one objection to multiple-transistor units that I have not seen discussed in your magazine: since the transistors are in series, they must switch off one at a time.

I don't know how much difference this could make in practice. However, I tried a slightly modified version of the unit that appeared in the June, 1963, *Popular Electronics,* both with and without a high-turns-ratio coil. I am now using a single-transistor unit on a 1956 Ford Six. I noted no difference in performance (no high-speed tests), nor any improvement in gasoline mileage. The car has been outside in below-zero weather and started easily.

However, I don't believe my present unit is more costly than Mr. King's Zenerless unit (R-E, September 64, p. 34). Mine uses a Delco DTG-2400 transistor, protected by a PolyPak Zener ($1.49). I used a Motorola ballast resistor for the transistor ignition, a Jones plug arrangement for switching back to conventional, a relay as suggested in the May, 1964, *Electronics World,* and a 250:1 coil purchased from a local supply house for $2.95. The entire cost including separate chassis boxes for the relay and the transistor unit was about $16. McGee Radio sells a kit for Mr. King's unit for $16.95.

I would like to see some discussion of the question raised in the first paragraph, also of the relative merits of a capacitive-discharge system.

LOYD FIGHT
Kansas City, Kan.

THEM DAYS IS GONE FOREVER

Dear Editor:

Reading Matt Zahner's "Listen to Europe on Your Broadcast Radio" I remember that we in Germany listened to American radio stations as early as 1928. For Europeans the transmitting hours are more favorable than the other way. Thirty-six years ago I often heard WGY with a six-tube superheterodyne (battery-operated) and a frame antenna. To check the reception, we got W2XAF and W2XAD in the short-wave band, which at that time carried the same program as WGY.

Today reception of American medium-wave stations is impossible. There are more than a thousand broadcasting stations here in the medium band and many of them operate the whole night through.

DR. ADOLF RENARDY
Stolberg-RHL, Germany

[There are more than 4,000 AM broadcast stations in the U.S. and Canada. Many broadcast 24 hours a day, too. That's why a selective receiver is desirable for trans-Atlantic reception. The weekly silence from midnight to 5 AM on Monday mornings, a habit of many stations, is a break for the dx'er—*Editor*]

WATCH FOR AUTO ELECTRICAL TRANSIENTS

Dear Editor:

With reference to the transistor ignition system in RADIO ELECTRONICS, December 1964, I have found that leaving one leg of the coil and capacitor connected for emergency purposes is not feasible.

The primary of the original coil should be disconnected completely. A car's electrical system is so full of transients that any voltage change charges the capacitor. When it discharges, it induces a current through the coil. The secondary voltage builds up and feeds back through the system, making even higher transients; thus the danger of breaking down the transistors and possibly other components. This may occur either by grounding the secondary or leaving it open.

E. F. KRUMEL
Omaha, Neb. END

SERVICE CLINIC

By JACK DARR Service Editor

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

Serving the Audiophile

Hi-fi service can mean extra income for a TV technician. You already have most of the equipment: scope, vtvm, signal generators. Distortion meters, IM analyzers, etc. can be added as you go—even built from kits (Heath and Eico). I'm speaking of real Golden-Ear type hi-fi, not the cheap stuff, but the types with about $500 or more of really high-quality audio equipment. These people have bought the best, and they want the best service on it. Also, they are willing and able to pay a premium service charge to get good work. So, give it to 'em. Truthfully, most of us enjoy a chance to do a real "gung-ho" service job anyhow, without trying to hold down the bill!

First, you have to know the equipment. If you don't have complete service data, get it. Most of the better units come with full schematics. Ask the owner for them, if he didn't bring them along. Learn the language of the hi-fi bug: "presence," "separation" and so on. Most real hi-fi fans know a surprising lot about how their equipment works, so you can talk to them in your own technical language. More important, even without the technical knowledge, they know how they want the rig to *sound,* so don't ever argue with them. If they say "It still doesn't sound right!" believe them, and keep on working until it does.

Be thorough: don't skip *anything.* On every one of these jobs, you ought to: check the B+ voltage, all plate and screen voltages; check all tubes, especially for grid emission or shorts; check ripple with a scope; run a square-wave test on at least two frequencies, 50 and 10,000 cycles, say. With a sine-wave input, check at various input levels for any sign of clipping or parasitic oscillation. The square-wave tests will also check the action of tone controls or compensating networks (Fig. 1).

In the higher-power amplifiers, from 10 watts on up, *never* turn the amplifier on unless the speaker is connected! A suitable resistor can be substituted (and you'd better have at least a *50-watt* unit for the bigger ones). Very important in transistor power amps, and you can blow a $35 output transformer out of a tube amplifier in about 5 seconds, if the output is open. The plate-voltage-plus-signal-voltage rises to such high peaks that the transformer flashes over internally. In transistor amplifiers, avoid *shorting* the output—even for a moment. Some can take it, but most can't.

Don't trust your tube tester on power output tubes. Experience has shown that distortion and other troubles can be due to power tubes that "test good." Often as these tubes get older, their IM distortion goes up. The best tester for a tube is the equipment it is used in!

Total power output can be checked

continued on page 25

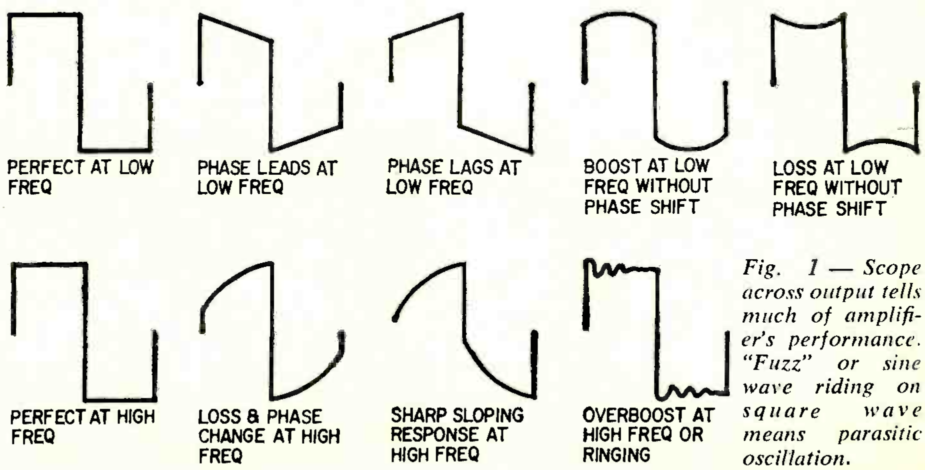


Fig. 1 — Scope across output tells much of amplifier's performance. "Fuzz" or sine wave riding on square wave means parasitic oscillation.

The World's first all-channel VHF/UHF/FM/Stereo antenna (with single Down-lead) is here. (And only JFD has got it!)

You can't satisfy today's complex VHF/UHF/FM reception needs with yesterday's antennas. Today's "VU" TV sets call for a single all-powerful all-band antenna that delivers the signals you need for picture-perfect reception on all channels 2 to 83—plus FM Stereo.

That's why smart installers and dealers are switching to the new JFD LPV-VU. This newest antenna advance from the JFD Champaign, Illinois R&D Laboratories, teams (1) the acclaimed JFD Log-Periodic concept with (2) a totally new antenna design principle—the *capacitor-coupled electronic dipole.*

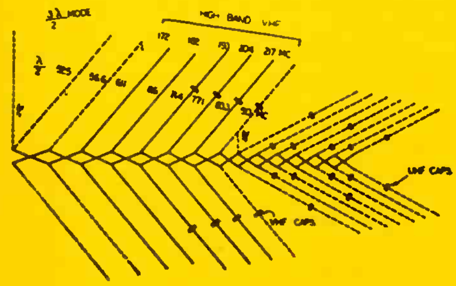
Result? More driven elements than ever before possible for the most efficient performance ever on VHF, UHF, FM/Stereo—from *one* antenna, **with one lead-in.**

And you can choose from five gold alodized LPV-VU Log-Periodics to satisfy every location, any budget: model LPV-VU-18, LPV-VU-15, LPV-VU-12, LPV-VU-9 and LPV-VU-6.

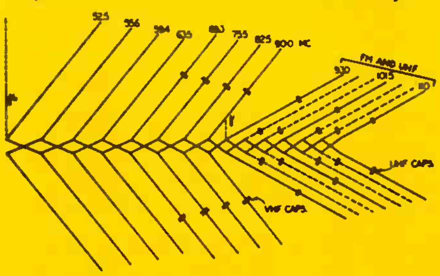
New from JFD—another outstanding advance in dipole design, the *capacitor-coupled electronic dipole!*

By introducing parallel plate capacitors into predetermined positions along the dipoles, and by precisely adjusting the value of each capacitance:

1. *More* dipoles are made to resonate on the high VHF band with a corresponding increase in gain.



2. *Higher mode* operation in UHF band achieves higher gain on channels 14 to 83—equal or better than that of parabolics. Improves FM stereo performance.
3. *More uniform* gain across each band, with narrower beamwidths. High front-to-back ratios greatly improve ghost rejection—insure excellent color fidelity.

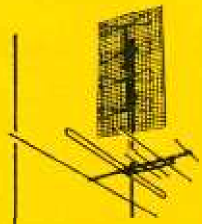


PLUS . . .

1. *Patented frequency independent Log-Periodic design* maintains same high performance efficiency regardless of station or band tuned in.
2. *Only one downlead needed.* A JFD AC80 splitter, included with each LPV-VU, permits you to tie directly into VHF, UHF and FM set inputs.
3. *New low-impedance twin crossarms* function as crossed feeder harness. Step up gain and improve signal transfer.

LPV-VU OFFERS NEW *MECHANICAL* ADVANCES, TOO!

■ Twin square aluminum crossarms. ■ Stainless steel terminals. ■ Oversized unbreakable Celanese "Fortiflex A" insulators. ■ Solid aluminum bus bar transformers. ■ Tubular crossarm supports on larger LPV-VU's. ■ Double U-bolts with 4 serrated-gripping profiles for 6-inch gripping span. ■ Electrically conductive gold alodizing.



INSTALLER BEWARE!

Don't spoil your VHF reception!

Addition of a separate UHF antenna to a present VHF installation may cut the VHF signal being delivered to your set. Incoming signals from a VHF transmitter may be scattered from the UHF antenna. Scattering produces less signal and multiple signals which cause ghosts.

SO WHY USE TWO WHEN ONE *LPV-VU* WILL DO?

Install the *all*-channel JFD LPV-VU and get the best VHF and UHF from *one* antenna with *one* down-lead!

A SPACE-AGE PRODUCT OF THE WORLD'S GREATEST TV/FM ANTENNA LABORATORIES

This newly completed laboratory, located on a ten acre site in Interstate Research Park, in Champaign, Illinois (home of the University of Illinois) marks a milestone in antenna history. It is dramatic proof of JFD leadership in antenna technology. Its fully staffed and equipped engineering staff, under the supervision of Dr. Paul E. Mayes, is blazing new trails in antenna design. This priceless know-how is built into each LPV-VU you sell.

The JFD LPV-VU is adapted from the geometrically derived Log-Periodic antenna formula developed by the Antenna Research Laboratories of the University of Illinois.

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CORRESPONDENCE continued

made 852 feet), must have been skeptical about suggestions that heavier-than-air flight would transform military strategy forever and permit crossing the continent in armchair comfort at approximately the speed of sound.

All that seems necessary for a technological development to succeed as a commercial device is that it fill a need or a desire, at a price people are willing to pay. Apparently there is great promise that microwave power transmission, even in its earliest stages, may do just that.

PETER E. SUTHEIM

CANADIANS CAN'T AFFORD THIS HOBBY!

Dear Editor:

I have enjoyed your magazine for several years. I have seen a number of excellent projects that I would like to build. However, most of the people in Canada can't afford to construct equipment because parts are too expensive. The prices in our own wholesale catalog run from 300% to 600% higher than the estimates some of your authors place on their projects.

The import duty for receivers, parts, etc., is approximately 40%. To this, add 10% for the Canadian dollar exchange, plus shipping charges, and you get a nice round figure of about 200% above American retail prices. Even this markup is too much, but where does the remaining 100% to 400% come from?

Tubes are not so bad—they may run twice the American price; but some of the less commonly used transistors are almost 10 times as high as the American prices. Most completed amplifiers, tuners, etc., are also available for only a little more than double the American prices.

I believe that, somewhere along the way, someone is using duty as a coverup for jacking the prices sky high. This sounds an awful lot like unlawful price setting to me. Don't you Canadians think it's time we did something besides cry in our milk? How about writing your MP about it? What about you unemployed smugglers? Can't you see a good thing when it comes along? Let's wake our Government up, one way or another.

D. DAWSON

Penny, B. C.

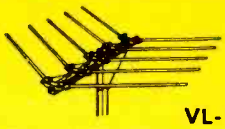
TRANSISTOR IGNITION QUESTIONS

Dear Editor:

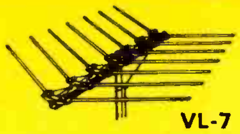
I have followed the articles and correspondence concerning transistor ignition with considerable interest. I

Finco's Color Ve-Log challenges all competition on color or black and white reception and stands behind this challenge with a "Guarantee of Supremacy". The swept element design assures the finest in brilliant color and sharply defined black and white television reception — as well as superb FM monaural and stereo quality. FINCO precision-engineered features make these advanced-design antennas indispensable to good home sight-and-sound systems. And, of course, they carry the famous unconditional guarantee from the leading manufacturer in the field — FINCO. Promote the Color Ve-Log Antennas with pride, sell them with confidence, and profit handsomely.

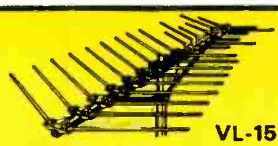
Featuring Finco's Exclusive Gold Corodizing



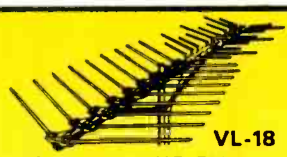
VL-5
5 element VHF-FM
5 driven elements
List price $16.95



VL-7
7 element VHF-FM
7 driven elements
List price $23.95



VL-15
15 element VHF-FM
9 driven elements
6 parasitic elements
List price $46.95



VL-18
18 element VHF-FM
9 driven elements
9 parasitic elements
List price $54.50

The FINNEY Company • 34 W. Interstate Street • Bedford, Ohio

Write for color brochure #20-307, Dept. RE

with the load resistor. Two 8-ohm 50-watt resistors will take care of 8-ohm outputs (singly), 4-ohm (in parallel) and 16-ohm (in series). By feeding the right input signal into the amplifier, the actual audio power dissipated in the resistor can be measured by measuring the rms voltage across the resistor and using E^2/R to get the power. (Don't try to pick up the resistor when you get through, either! It'll be *hot!*)

Check all coupling capacitors for leakage. Even a very slight leakage can cause clipping and a very severe distortion. Be sure that all filter capacitors are in perfect shape, to keep out even a trace of hum.

Test records and tapes are essential. They are the only practical way to check stereo separation, balance, etc., in a complete system.

It is important to be able to check distortion and frequency response, not just maximum power. An amplifier owner will often want to know whether his amplifier "meets specs." He'll love you if you can present him with a sheet of graphs that show him that it does. [For help in making and interpreting audio measurements, try two books, available in paperback from Gernsback Library (154 West 14th St., New York, N.Y. 10011): *Audio Measurements* by Norman Crowhurst (G-L No. 73), and *Maintaining Hi-Fi Equipment* by Joseph Marshall (G-L No. 58). The latter has an index arranged especially for troubleshooting.—*Editor*]

So, that's about all it takes: patience, test equipment and a bit of salesmanship. Scope tests are very useful. They not only give you the information you need, but they impress the customer, who is probably leaning over your shoulder while you work, another characteristic of the breed! Let him; he likes it, and he's sincerely interested in what you're doing.

Just don't forget to charge 'em extra to make up for the extra work. They'll appreciate it a lot more if you do. They'll have pure tones in the music, and you'll hear that pure tone of the jingling in your pocket!

Grundig "Einlander" tape recorder

I brought back a Grundig TK-30 tape recorder from Germany. It worked on 50-cycle current there. How can I convert it to work on 60-cycle current here?—R.D., Fort Hood, Tex.

You're out of luck, I'm afraid. There are recorders, the TK-30 and TK-35, that were made to operate *only* on 50-cycle current *in Germany*. The export models have phasing capacitors and special tapped motors to allow them to work on either 50- or 60-cycle supply.

To find out, check your motor. If it is a number 7882-022, it is strictly a 50-cycle motor, and the motor, phasing capacitor and quite a few other things will have to be changed to make it work on 60 cycles. Sorry.

Too much B+ on amplifier

I've got a good amplifier with a burned-out power transformer. I'm trying to use a junked TV power transformer on it. Works OK, but I've got too much B+ voltage! Got about 400 volts instead of the 300 or so I want. I tried a series resistor to drop it, but it gets too hot! Any ideas?—L.W., Oak Park, Ill.

About your best bet would be to change your filter system. Using the capacitor input circuit you have now, you're going to get the ac transformer-secondary voltage plus about 25%; the input filter capacitor charges to almost the peak voltage (Fig. 2-a).

Try changing this to a choke-input filter circuit. Add about a 4-6-henry

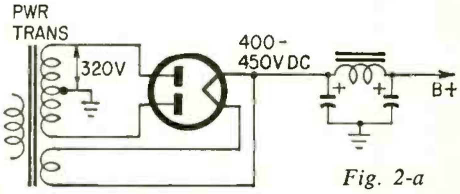


Fig. 2-a

See Jour-P 14

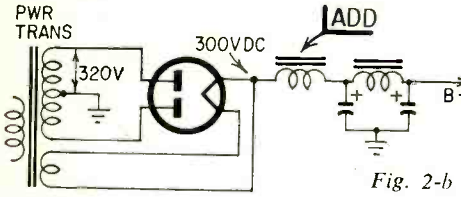


Fig. 2-b

choke rated at 200 ma, as shown in Fig. 2-b. The choke-input circuit will not develop as much B+ voltage and, in addition, it has much better regulation. So you gain both ways.

Vertical foldover in Philco D-181

I've got a bad vertical foldover in a Philco D-181 deflection chassis.

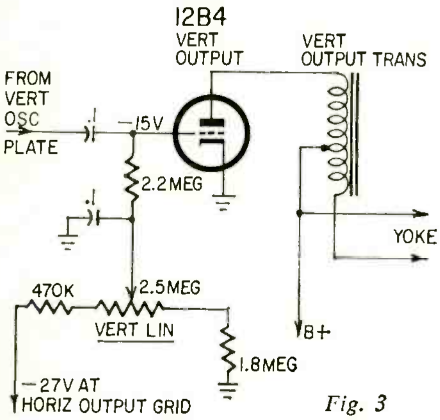


Fig. 3

What causes this?—H.H., McAndrews, Ky.

Usually, some trouble in the grid circuit of the vertical output tube (a leaky coupling capacitor, maybe, although it can come from other things).

In this chassis, check the coupling capacitors between the sync separator and vertical oscillator, and between vertical oscillator and output (Fig. 3). Also, look out for this grid bias supply circuit. As shown in Fig. 3, the negative voltage for the vertical output tube grid originates at the *horizontal* output tube's grid.

So, check through this circuit with a vtvm and be sure there are no drifted-value resistors or leaky capacitors. That 0.1-μf bypass at the bottom of the grid resistor, for example.

Intermittent damper blowout

I've got an RCA that blows a damper tube about one every 4-6 weeks. On the bench, it works fine. I've checked everything I can think of.—R.S., Painesville, Ohio

There might be one thing you haven't thought of: the difference between your shop line voltage and that in the owner's home. I'd check, just to be sure.

Try running the set on the bench at fairly high line voltages. As a last resort, replace the original 6AU4 damper tube with one having a higher peak-inverse rating: for instance a 6AX4-GTB, 6DE4, etc., which have 5,000-volt ratings compared to the 6AU4's 4,400 volts. Not really the *right* cure, but sometimes it helps. END

Grand Music Festival Tour is Top Prize in Audio Contest

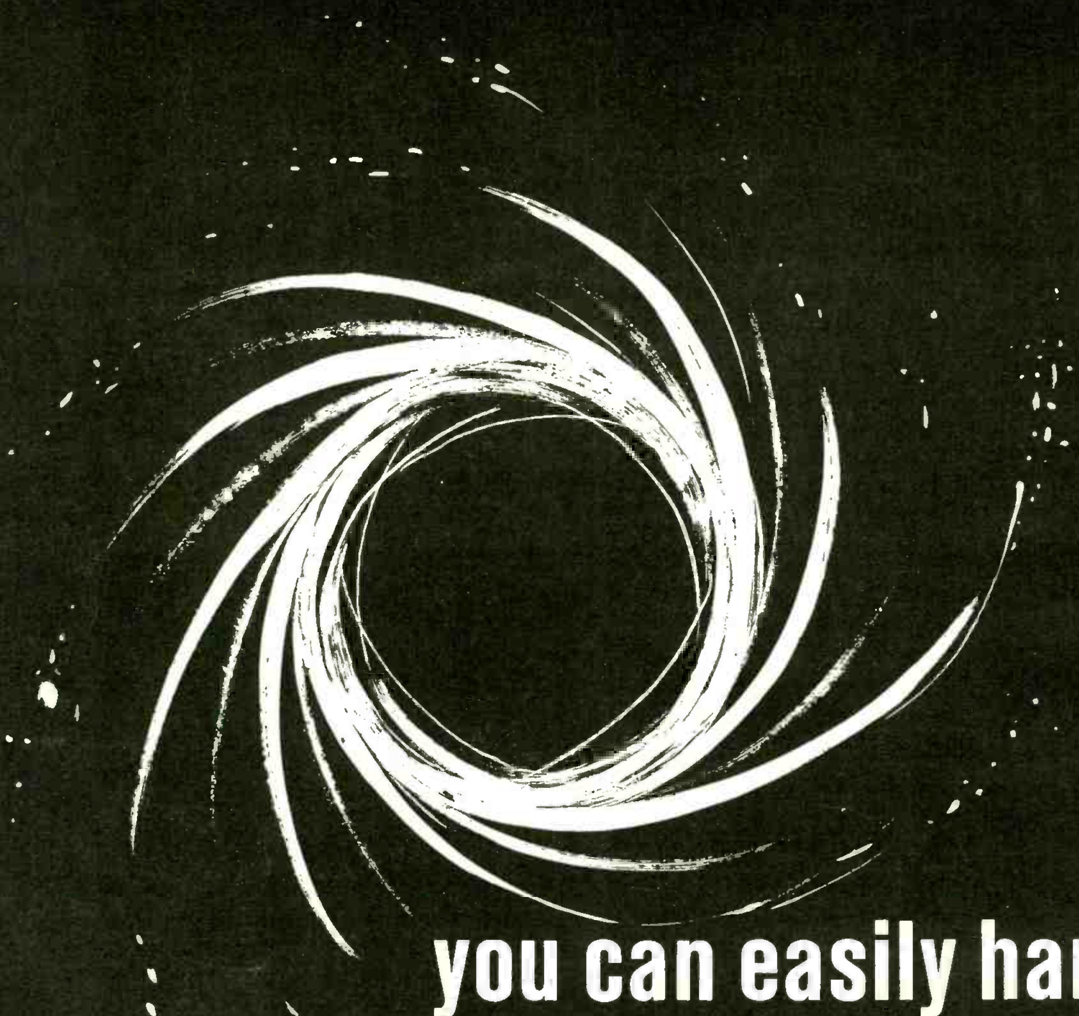
Empire Scientific Corp., maker of high-fidelity speakers, pickups and turntables, is sponsoring a contest—open to anyone—which features as its first prize a 21-day, all-expenses-paid European tour of music and drama festivals. The trip is for the winner and one guest.

To compete, you must arrange 10 advertised features of the Empire "Royal Grenadier" speaker system in order of importance. Late last year, a panel of audio experts compiled a master list. The person whose list most nearly matches the master arrangement wins the trip. (There are 3,628,800 possible permutations of the list, so don't rely on guesswork alone!)

There are 50 second prizes—each a Deutsche Grammophon Gesellschaft album of the nine Beethoven symphonies conducted by von Karajan.

You can pick up entry blanks and instructions at audio dealers. Be sure to have your entry in the mail before June 1, 1965.

MORE EXCITEMENT FROM QUAM!



you can easily handle any auto radio speaker replacement

New Quam Multi-Tap Speakers in 5"x7", 6"x9", and 4"x10" sizes. Taps for 10, 20, and 40 ohm impedances.

QUAM

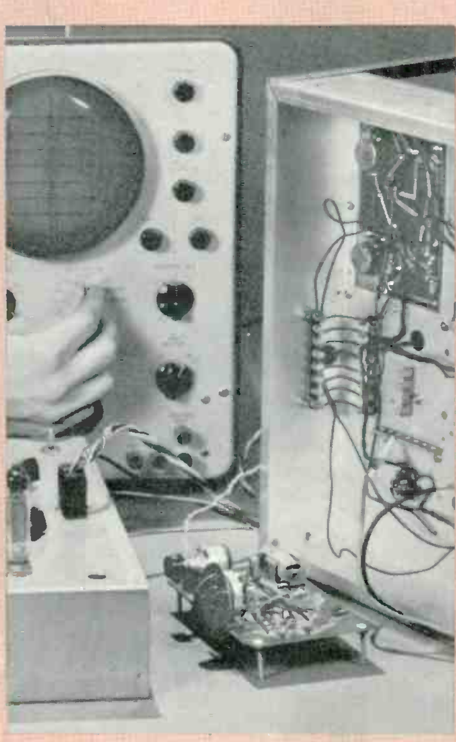
with Quam speakers and rear seat kits— multi-taps and exact replacements—

Eight speaker *sizes* handle virtually any auto radio replacement—but size alone is not enough. You need the right voice-coil impedance—and QUAM has it! Choose multi-tapped models for stocking convenience; or, for specific applications, one of the 25 Quam *exact* replacements. (In addition, any Quam speaker may be special-ordered with any voice-coil impedance for an extra $1.00 list. This service is a QUAM exclusive.)

Write for your free copy of the Quam Auto Radio Speaker Replacement Guide, which gives you complete replacement information on front and rear seat speakers for auto radio models from 1955 to 1963.

QUAM-NICHOLS COMPANY, 234 EAST MARQUETTE ROAD, CHICAGO, ILLINOIS 60637

BUILD, EXPERIMENT, EXPLORE, DISCOVER WITH NRI CUSTOM-DESIGNED TRAINING KITS



BUILD YOUR OWN PHONE/CODE TRANSMITTER

Here is one of seven training kits you get in the NRI Complete Communications Course. With it, you get *actual practice* in building a crystal-controlled phone/code transmitter and putting it on the air, actual practice in many aspects of commercial transmitter operation (modulation, "clamping" circuits, key filters, etc.). This kit—as with all NRI kits—features the most modern circuits and parts. It complies with FCC regulations and can be put on the air simply by attaching to an antenna. Be a part of the "life line" of the Space Age. Enroll for NRI's Complete Communications training.

BUILD ACTUAL ANALOG COMPUTER CIRCUITS

Industry, business offices, the government and military all need trained Electronics Technicians. In NRI's Complete Industrial Electronics Course you progress through 10 custom-designed training kits, topping off your studies by building this analog computer with which you solve simple mathematical problems, experiment with feedback control systems and digital logic elements. This kind of practical experience as you train prepares you to step into a good paying position ready to do your knowledgeable best. Prepare now the NRI way for Industrial Electronics.

BUILD A CUSTOM-ENGINEERED TELEVISION RECEIVER

Want to make $3 to $5 an hour in your spare time? Want your own full-time or part-time business? NRI's complete course in Radio-TV Servicing offers these money-making opportunities. NRI starts you with the ABC's of Electronics. You learn how to install, maintain and service stereo hi-fi, radios, PA systems and TV sets (including color). Included in your training are eight NRI-designed training kits; the final one is this complete, custom-designed table model TV receiver you build yourself. You learn servicing procedures you will use on the job—and earn *extra money* as you train. Enroll now.

SEE OTHER SIDE ▶

10 NRI Home-Study Plans to Choose From—Mail Card

Whatever your interest in Electronics . . . whatever your education . . . whatever your need . . . before you decide on any school you'll want to investigate NRI's extensive list of training plans and practical, thorough, absorbing training methods. NRI training equipment and "bite-size" programmed texts are the finest money can buy, the finest highly skilled instructors and engineers can design and perfect for you. Mail the postage-free card for your copy of the NRI catalog. NATIONAL RADIO INSTITUTE, Electronics Div., Washington, D.C. 20016.

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The day you enroll with NRI we send you this remarkable, new Achievement Kit, worth many times the small amount you invest to start your training. And it's only the start, only the first example of the unique ability of NRI to apply 50 years of leadership in home-study Electronics training to the technical challenges of today. What's in the Achievement Kit? You get your first group of lesson texts in the NRI course of your choice; a rich, vinyl desk folder to hold your work; preprinted lesson answer sheets; your NRI Student Identification Card; the industry's most complete Radio-TV Dictionary; valuable reference texts; envelopes; imprinted pencils; pen; engineer's ruler and even your first postage. Start your training this exciting, absorbing way. No other school has anything like it. Pick the field of your choice from NRI's 10 training plans and mail the postage-free card for your NRI catalog. Do it now.

Join the thousands who gained success with NRI

"I want to thank NRI for making it all possible," says Robert L. L'Heureux of Needham, Mass., who sought our job consultant's advice in making job applications and is now an Assistant Field Engineer in the DATAmatic Div. of Minneapolis-Honeywell, working on data processing systems.

His own full-time Radio-TV Servicing Shop has brought steadily rising income to Harlin C. Robertson of Oroville, Calif. In addition to employing a full-time technician, two NRI men work for him part-time. He remarks about NRI training, "I think it's tops."

Even before finishing his NRI training, Thomas F. Favaloro, Shelborne, N.Y., obtained a position with Technical Appliance Corp. Now he is foreman in charge of government and communications division. He writes, "As far as I am concerned, NRI training is responsible for my whole future."

"I can recommend the NRI course to anyone who has a desire to get ahead," says Gerald L. Roberts, of Champaign, Ill., whose Communications training helped him become an Electronic Technician at the Coordinated Science Laboratory, U. of Illinois, working on Naval research projects.

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DR. PETER C. GOLDMARK
PRESIDENT AND
DIRECTOR OF RESEARCH,
CBS LABORATORIES

Radio-Electronics
Hugo Gernsback, Editor-in-Chief

What Is High Fidelity?

Guest editorial by DR. PETER C. GOLDMARK

One could probably get as many definitions of high fidelity as the number of times the question is asked. I hope the editors of RADIO-ELECTRONICS will not regret letting me choose this controversial subject—I am about to share with you my own experiences in high fidelity, both as a physicist and a musician.

First, let's operate on the phrase "high fidelity" and remove the "high". What is left reminds one of "realism," which is what I believe we should strive for in sound reproduction. Even the word "fidelity" is inconclusive without asking the question: "Fidelity to what?" To the original composition as conceived in the composer's mind? To a specific concert-hall performance? Or fidelity to some rendition by someone's high-fidelity equipment?

Let us take a typical case. Mr. and Mrs. A (mostly Mr.) decide to buy a high-fidelity system. Mr. B, whom Mr. A admires as an expert, proposes the purchase of the XY turntable with a tone arm and cartridge of unsurpassed performance. The stereo amplifier by Z is a must, especially since it has a flat frequency response far into the video band and the power output is practically limitless; all this without the slightest trace of distortion. Conceivably amplifier Z may consist of a power amplifier and a preamplifier, which makes the whole thing more hectic.

Born in Budapest in 1906, Dr. Peter C. Goldmark received a doctorate in physics from the University of Vienna. He joined CBS in 1936 to work on television development. Perhaps his greatest fame rests on his invention of the long-playing record, introduced nearly 17 years ago. A musician (pianist and cellist) as well as a scientist, Dr. Goldmark's contributions to sound reproduction are vast and profound: synthetic reverberation, tape cartridge systems, Talking Book records for the blind, the 360 phonograph and its recent cousin, the Stereo 360. His work in other fields includes underwater sound communications and color television.

Then come the speakers. The range of choice varies tremendously when one considers electrostatic speakers, moving-coil speakers, woofers, tweeters, air-damped enclosures, large baffle or bass-reflex mounting. Horns of all dimensions and shapes are also included.

By now, many hundreds of dollars have been invested in this equipment and the day of installation has arrived. A place for the turntable and amplifiers has been located in the listening room and two sets of speakers are put in opposite corners along one wall, with the speakers facing the listeners. A stereo record with plenty of highs and lows is brought out, and the equipment is turned on. Mr. B urges Mr. and Mrs. A, the proud owners, to sit in two chairs placed in the middle of the room, halfway between the speakers. All wait breathlessly for the first sounds from the newly acquired equipment. Mr. B, the expert, makes a number of adjustments on the equipment, since there are a great many controls available for this purpose, and declares the system operational. The record is jazz, and is played at practically full volume. Mrs. A would now like to listen to one of her recent acquisitions, the Meistersinger Overture, played by the Cleveland Orchestra, and Mr. B obligingly puts the record on for her and smiles expectantly. Soon after the first chords, Mrs. A sadly shakes her head and says: "There is a lot of sound, but it isn't music." And here ends this sad tale, which is repeated many times in many homes.

What happened? Why didn't this very expensive and elaborate installation produce "music?" First, we have to try to define what the average music lover, who frequently hears live concert performances, would want to hear in his home. The answer is "realism"—a kind of music which approaches the sound one hears at a concert, and which to some extent reproduces the concert hall environment.

At this time, let us try to trace what kind of sound the composer intended the audience to hear. This depends, of course, on the type of music. In the 18th century, when chamber music first became fashionable, it was performed mostly in private homes or small auditoriums. Orchestral compositions were played in concert halls smaller than today's auditoriums. The composers of orchestral works wrote their music keeping in mind that part of the audience was located at a distance from the orchestra, since only a relatively small percentage of the total audience would necessarily be sitting close. Thus the sound perceived by a majority of the concert-goers contains a relatively small percentage of direct sound from the individual instruments. The larger portion of sound arriving at the audience's ears is composed of reflections and reverberations, the quality of which depends on the materials and architecture of the walls, ceilings and floors of the auditorium, and also on the size of the audience.

Thus a strictly stereo effect, such as produced by two speakers in the home when playing a stereo record, is uncommon in the concert hall. There, the sound image of the source is much more diffused. One obtains an impression of spaciousness, and, for at least half of the audience, the apparent loudness is not as great as in most hi-fi installations. The quality of sound reproduced by the latter more closely resembles that heard by the conductor of the orchestra,

continued on page 86

BUILD THE T-40/40

80-Watt All-Transistor Stereo Amplifier

You need no special transformers to build this amplifier—all parts are catalog items. 40 to 50 watts continuous rms per channel from 20 cycles to 20 kc at 1% harmonics!

By DANIEL MEYER

THIS AMPLIFIER IS THE RESULT OF A LONG SEARCH FOR A SUITABLE transistor replacement for my Cook–Langevin tube type power amplifier. Total parts cost of $100 is still considerably below even kits of comparable amplifiers.

The circuit is a single-ended push-pull type, first described by Peterson and Sinclair [1] in 1952 using vacuum tubes. A similar transistor circuit, described by C. H. Lin in 1956,[2] has appeared in the G-E Transistor Handbook for several years in various forms. This particular circuit is called *quasi-complementary*, because only n-p-n transistors are used in the output stage.

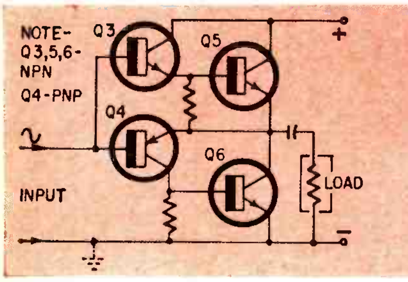
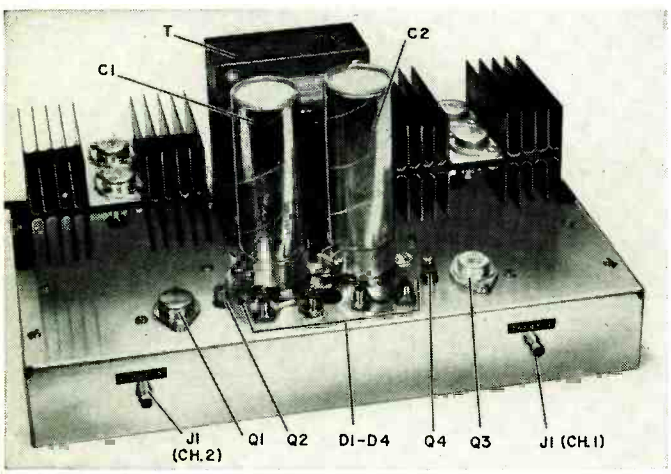
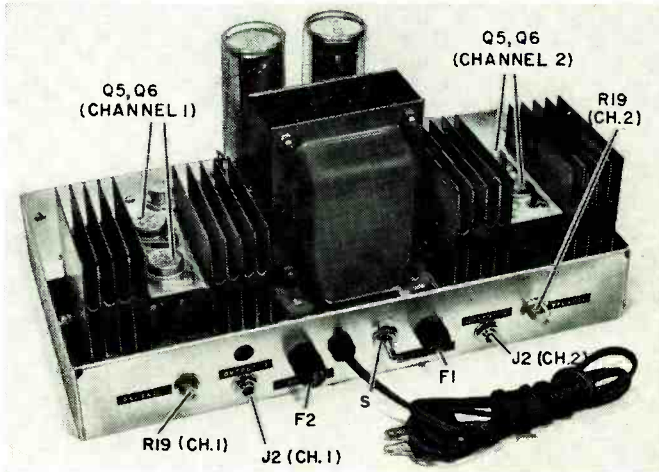


Fig. 1—Basic single-ended push-pull, asymmetrical output stage. By using dual power supply, author's version eliminates coupling capacitor between transistors and load (speaker).

The output circuit consists of two series transistors (Q5, Q6 in Fig. 1), driven by another series pair (Q3, Q4) which are *complementary* (Q3 n-p-n, Q4 p-n-p). Although the bases (inputs) of Q3 and Q4 are connected together, the upper cascaded pair (Q3, Q5) amplifies positive swings of the input as a common-collector stage, while the lower pair (Q4, Q6) amplifies negative swings as a common-emitter stage. This is not a symmetrical push-pull circuit. Q5, with no voltage gain, needs a high drive voltage, while Q6, which has voltage gain, needs much less drive. The output impedances of the two halves are also unequal.



Front view of T-40/40 chassis shows principal power-supply components.



Rear view shows output transistors on heat sinks, balance controls, output jacks, fuses and on-off switch.

The 180°-out-of-phase driving voltages for the two output transistors are provided by the complementary (p-n-p, n-p-n) driver stage. In the schematic (Fig. 2), Q3 and Q4 are the complementary drivers for output transistors Q5 and Q6. The driving signal for Q6 is taken from the collector of Q4 to get the phase inversion required for push-pull operation. The unequal output impedances are brought down to nearly equal low values by negative feedback from the output to the input of the amplifier.

Although this circuit has many desirable features, it was not widely used for high-fidelity amplifiers because of the thermal-stability and frequency-response problems of germanium power transistors that had high enough voltage and power ratings to be useful. When silicon power transistors with good enough frequency response and power ratings became available at a reasonable price, the situation quickly changed. Thermal stability is no longer a problem, because of the much lower leakage of silicon transistors, and frequency response can easily be brought up to 20 kc and higher with the diffused type transistor construction.

Thermal stability can be even better with a technique suggested by Daugherty and Greiner.[3] The only satisfactory method of quiescent bias stabilization for this type of amplifier is to put resistance in the base or emitter circuit of the output transistors. Unfortunately, this results in a great power loss if these resistors have a high enough value to be really effective. This problem can be solved by putting a diode across the resistor so that it conducts when the transistor is driven. Although that circuit is nonlinear, its nonlinearity is not serious as long as the values of the emitter resistors are kept below that of the speaker impedance. Without negative feedback, such a circuit would have up to 4% or 5% distortion. The 20 to 25 db of negative feedback reduces this to less than 1% total harmonic distortion.

The other major change from the original circuit is elimination of the capacitor in series with the speaker, shown in

[1] *Peterson and Sinclair, "A Single Ended Push-Pull Amplifier,"* Proc. IRE, *January 1952.*

[2] *H. C. Lin, "Quasi-Complementary Transistor Amplifier,"* Electronics, *September 1956.*

[3] *Daugherty and Greiner, "Low Distortion and High Thermal Stability in Transistor Audio Power Amplifier,"* IEEE Transactions on Audio, *March-April 1964.*

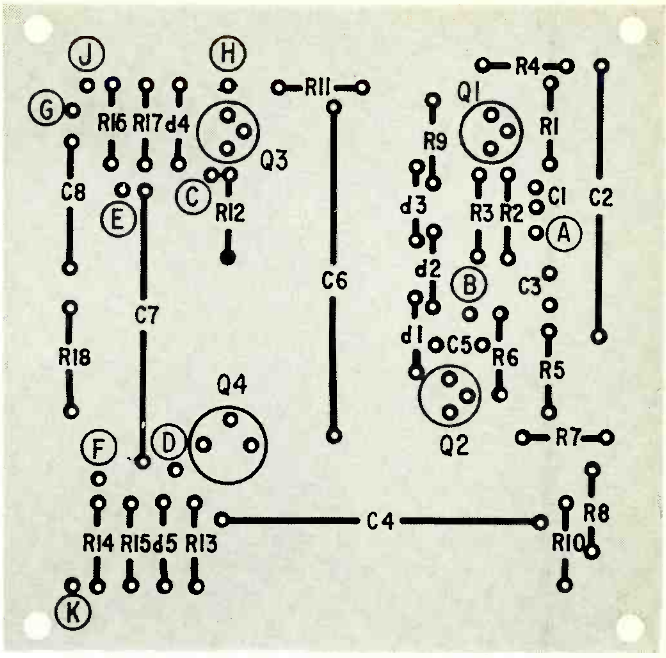
See APRIL P 92, AUG P 62

Fig. 1. This capacitor is necessary if a single power supply is used. By using silicon transistors with a dual-voltage regulated power supply, it may be eliminated. This makes coupling between speaker and output transistors truly direct, with no reactive components in series with the speaker. The result is good phase linearity and high damping factor down to 10 cycles or so. Damping factor vs frequency is shown in Fig. 3.

Fig. 4 shows amplifier distortion vs power output at three frequencies. Distortion at two power levels is plotted in Fig. 5. What power rating is assigned to this amplifier depends entirely on how and where you choose to do your rating. Some manufacturers prefer to use 1 kc and IHF "music power" ratings, or even peak power of both channels added together. Gives a higher number, you know. *The ratings shown in Fig. 4 and 5 are continuous sine-wave ratings.* Using the customary 1-kc rating would give this amplifier a power output figure of 60 watts at 1% distortion. If you were really critical, you might rate the amplifier at the point where distortion reaches 1% anywhere in the bandpass. This would give a rating of about 10 watts, due to the increase in distortion at lower frequencies (mostly hum and line noise and not nonlinearity). I have choosen a rating of 40 watts per channel as a conservative compromise.

The remainder of the circuit is more or less straightforward. Transistor Q1 (Fig. 2) is an emitter follower, included to bring the input impedance up to a point where the amplifier may be driven by any preamp. Q2 is a voltage amplifier stage. Both input signal and feedback are introduced at its base. The collector circuit is direct-coupled to driver transistors Q3 and Q4.

Diodes D1, D2 and D3 provide forward bias for the driver and output stages to prevent crossover distortion. If the voltage across the emitter resistors of the output stages is 0.1 or higher, D3 can simply be replaced with a jumper wire. Diodes are used for forward biasing because they have the same temperature characteristics as the transistor junctions.



Special printed-circuit board is available pre-etched and stamped with part locations. See parts list for ordering information.

C6 supplies feedback to the top of load resistor R9 for Q2. This decreases the loading effect of R9 by making it

Amplifier Parts List
(one channel only; double all items for stereo amplifier)

C1—10 μf, 15 volts
C2—20 μf, 50 volts
C3—100 μf, 15 volts
C4—500 μf, 6 volts
C5—22 pf, ceramic
C6—20 μf, 150 volts
C7—20 μf, 50 volts
C8—0.1 μf, 50 volts ceramic or paper
All capacitors electrolytic except C5 and C8
D1, D2—general-purpose silicon diodes (1N645 or equivalent)
D3—germanium rectifier 1N91 (G-E) (see text)
D4, D5—1N3193 (RCA)
J1—phono jack
J2—open-circuit phone jack
Q1—2N3053/40053 (RCA)
Q2, Q3—2N2102 (RCA)
Q4—2N1183-B (RCA)
Q5, Q6—2N3055 (RCA)
R1—47,000 ohms
R2—100,000 ohms
R3, R5, R7—2,200 ohms
R4—10,000 ohms
R6—22,000 ohms
R8—220 ohms
R9—4,700 ohms
R10—33,000 ohms
R11, R12, R13—1,000 ohms
R14, R15, R16, R17—4.7 ohms
R18—22 ohms, 1 watt
R19—pot, 50,000 ohms
All resistors ½ watt, 10% except R18
Printed-circuit board (optional) —order from DEMCO, Box 16041, San Antonio, Tex. 78216. $2.50 each postpaid.
Chassis, 7 x 13 x 2 inches (one only for entire stereo amplifier and power supply—Bud AC409 or equivalent)
Heat sinks (2)—Delco 7281366 (from Delco distributors, or from Harvey Radio, Inc., 103 W. 43 St., New York, N.Y. 10036; $1.75 each plus postage)
*Silicone grease for heat-sink washers—Dow Corning 340
*Mica insulating washers (6) for TO-3 style transistors; 4 for 1N1613 rectifiers
*Extruded insulating washers for transistor mounting (12)
Miscellaneous hardware
***Quantity given is for complete two-channel amplifier.**

Power Supply Parts List
(for two channels)

C1, C2—2,000 μf, 50 volts, electrolytic (Sprague 36D1107T, Mallory CG23U50C1 or equivalent)
C3, C4—100 μf, 50 volts, electrolytic
C5, C6—500 μf, 50 volts electrolytic
D1, D2, D3, D4—silicon rectifier, 5 amperes, 100 piv (RCA 1N1613 or equivalent)
D5, D6—Zener diode, 33 volts, 5%, 1 watt (Texas Instruments 1N3032-B or equivalent)
F1, F2—fuse, 2 amperes, slow-blow
Q1—2N3055 (RCA)
Q2—2N3053/40053 (RCA)
Q3—2N1073 (Bendix) For name of local distributor, contact your Bendix Semiconductor Sales office or write to Bendix Semiconductor Div., Holmdel, N. J.
Q4—2N1038 (Texas Instruments)
R1, R2—1,000 ohms, 1 watt, 10%
R3—470 ohms, ½ watt, 10%
S—spst toggle switch
T—power transformer, secondary 60 volts ct, 2.5 amps Thordarson 24R105 or Stancor RP-2500, Newark Electronics Corp., 223 W. Madison St., Chicago, Ill. 60606; stock No. 5F2068, $10.50 plus postage)

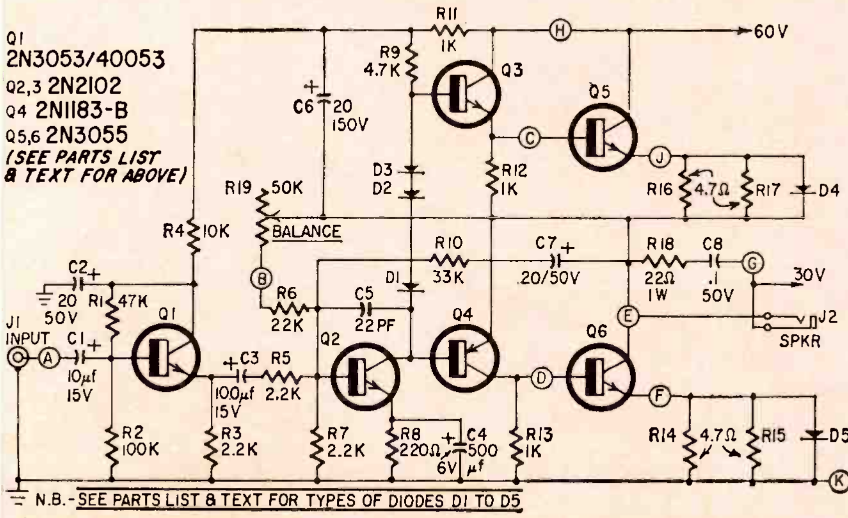
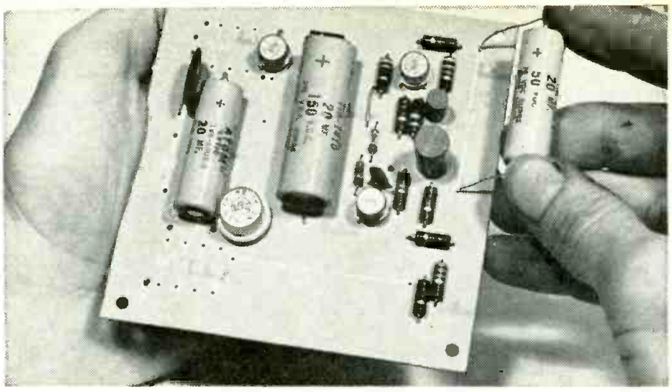


Fig. 2—Circuit of the T-40/40 (one channel only). All transistors except Q4 are silicon. Power supply (Fig. 6) feeds both channels. Letters in circles match similar lettered points on circuit board.

appear a much larger resistor as far as the signal is concerned.

After drilling the chassis (use the photos as guides), mount the balance controls, input and output jacks, terminal strips, power transformer and C1 and C2. Mount the two power-supply power transistors (Q1 and Q3) with mica insulating washers, and extruded fiber or Teflon washers on



Most of the small-parts wiring is done simply by inserting parts into pre-etched circuit boards and soldering.

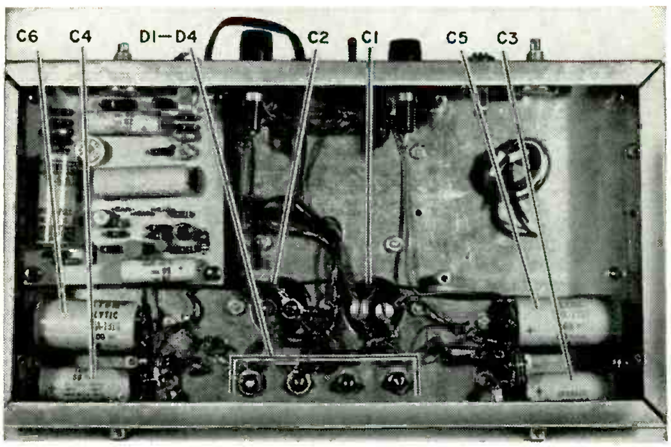
the mounting bolts. Put a thin coat of silicone grease (Dow Corning 340) on both sides of the mica washer. This is important. Failure to do so may cause the transistors to overheat.

Wire the power supply (Fig. 6) and install the remaining parts on the terminal strip as shown in the photograph. When wiring is complete, check the circuit with an ohmmeter to be sure that there is no connection to the chassis from any point in the supply. The only connection to the chassis should be at the input jack.

After the power supply is wired, plug the amplifier in and turn it on. Check the voltage from the emitter of Q3 (these numbers refer to Fig. 6) to the junction of C1 and C2. It should be 30 to 32 volts. Check the voltage from the emitter of Q3 to the emitter of Q1. It should be 60 to 64 volts. If everything checks, turn the amplifier *off* and proceed with construction.

Mount the output transistors on the two heat sinks. The heat sinks specified are predrilled, but the mounting screw holes will have to be enlarged to ¼ inch to allow insulating the transistors from the heat sinks. Mount the transistors with the hardware provided with them and 6-32 x ½-inch screws. Be sure to use silicone grease on the mica washers. Mount a lug under one of the mounting screws for each of the transistors to act as a tiepoint for the collector lead. Connections to the base and emitter pins are made by soldering wires to pins broken out of a 7- or 9-pin miniature tube socket. Slip a piece of insulating tubing over the pins to guard against short circuits. Push the leads attached to the power transistors through the grommets under the heat sinks and bolt the heat sinks down.

The remaining portion of the amplifier is built on



Amplifier nearly completed. Power supply is wired and channel-one circuit board is in place. Knotted leads in upper right corner will connect channel-2 output transistors to circuit board.

Radio-Electronics' Audio Editor, who ran the T-40/40 through rigorous listening tests and measurements, found that the author's claims were not at all exaggerated. His specifications are extremely conservative. The amplifier sounds clean even at high power levels, driving a pair of low-efficiency speaker systems. It is not the least bit "fussy"—during tests it was run at full output at various frequencies for up to 10 minutes at a time, with no evidence of dangerous heating anywhere. The power transformer remained cool.

SPECIFICATIONS (see Figs. 3, 4 and 5)

Frequency response: ±0.5 db, 10 to 30,000 cycles

Power output: 40 watts rms per channel into 8-ohm load (roughly 20% higher into 4-ohm load, and about 40% lower into 16-ohm load).

Power bandwidth (half-power—3-db—points): below 18 cycles (limit of generator used for tests) to above 15,000 cycles (full-power operation at 15 kc or higher for more than a few seconds will blow fuses).

Input impedance: 25,000 ohms

Sensitivity: approximately 2.5 volts rms for full output. (Can be increased to 1.5 volts rms for full output by changing R10 in Fig. 2—see text.)

Hum and noise: 80 db or more below full output

Effective output impedance: less than ½ ohm from 20 to 20,000 cycles (damping factor = 16 for 8-ohm speaker)

Distortion: Maximum total harmonics 1.25% at any frequency from 20 to 20,000 cycles, at 40 watts output per channel

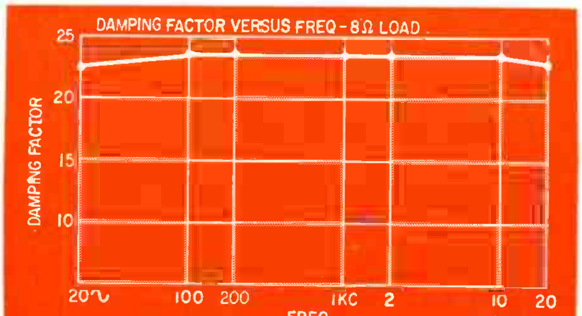


Fig.3

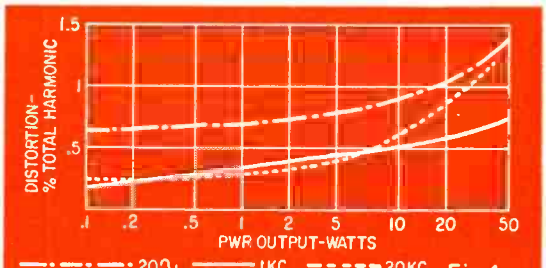


Fig.4

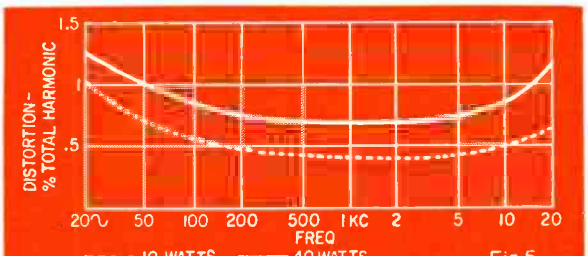


Fig.5

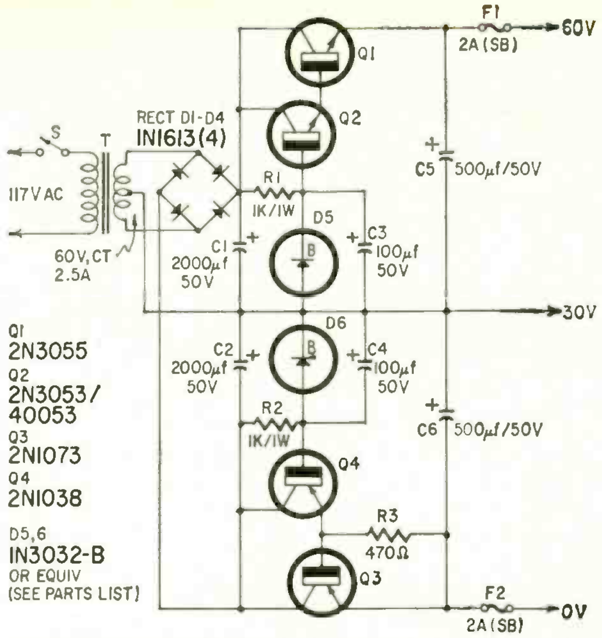


Fig. 6—Power supply for both channels. It must not be grounded to chassis at any point. D1 through D4, and Q1 and Q3 must be insulated from chassis with mica washers.

Etch pattern for the printed circuit board.

printed-circuit boards (Fig. 7). These boards are available to anyone who wants them (see the Amplifier Parts List). This simplifies construction and insures that there will be no wiring errors in this part of the circuit. Part code numbers are printed on the boards, as shown in the photographs. Simply install the parts at the locations indicated, bend the leads over on the copper side of the board and trim the leads so they do not stick out past the copper pattern. Solder the leads to the copper with a small soldering iron and good rosin-core solder. Heat both the pattern and the lead until the solder flows, then remove the iron. Excessive heat can cause the copper pattern to lift from the plastic base material and may also damage other components.

Be sure that all connections have been made and that there are no cold joints. A bad connection or wiring error can cause almost instant disaster here, due to the low impedances and high current supplies. A bad connection between D1 and D2 on the first prototype of this amplifier caused a short, unhappy life for transistors Q3 and Q4.

Connections are made to the board at the points indicated by letters on the board and the schematic. Solder approximately 6-inch leads to points B, K and H. Solder the inside conductor of a 6-inch piece of shielded cable to point A and solder the shield to the ground strip running next to point A. Lay the board vertically against the back of the chassis and make the connections to the power transistor leads. Connect the other leads to the proper points in the power supply and on the output jack. Note that a phone jack is used as the output jack. This minimizes chances of shorting the speaker leads together, or to the chassis. The frame of the output jack is at + 30 volts with respect to the chassis and must be mounted with insulating washers.

After making all connections to the circuit board, mount the board in the chassis with four ½-inch threaded spacers. Now wiring should be complete. Go back and check *all* connections for errors. The parts you might save will be your own. If everything looks right, turn the power on.

Connect a voltmeter (any vom or vtvm will do) between the chassis and the frame of the output jack. When the power switch is turned on, the meter should come up to 25 to 35 volts (dc) in about 3 to 4 seconds. If it does not come up, or goes on up to 60 volts, turn the amplifier off *immediately*. Check for bad transistors, wrong connections, etc. If the voltage is in the correct range, connect your voltmeter from the junction of C1 and C2 (power supply) to the tip contact on the output jack. Adjust the balance control for a zero reading on the meter's lowest dc scale. This adjustment can be a volt or two off balance without any harm. The only result will be a slight dc voltage across the speaker. Once set, this adjustment will be correct over almost any normal temperature range, due to the stability of silicon transistors.

The amplifier should now be ready for use. If you wish to make tests before installing it, one warning is in order. The output transistors are not as efficient at high frequencies as at low frequencies, and draw more current as a result. If the amplifier is made to operate at full output above 15,000 cycles for more than 5 or 10 seconds, one of the fuses will probably blow. Take this as a warning and quit until the output transistors have had a chance to cool. Full output at frequencies below 10 or 15 kc may be maintained for as long as you wish.

The input signal required to drive this amplifier to full output is 2.5 volts. If your preamp will not deliver that much, you can increase the amplifier's sensitivity to approximately 1.5 volts for full output by changing R10 to 47,000 ohms, at the expense of slightly more distortion (approximately 0.5% more).

When you connect this amplifier into your system, be prepared to hear all the turntable and record rumble that is there. Put on your favorite test record, preferably one with some good solid low bass. If you have not used a transistor amplifier before, you probably will not believe that the record is the same one you have been hearing. This amplifier will bring out the best (or worst) in a speaker's low-frequency response. The direct coupling of the speaker to the output insures that there will be no loss of damping or phase shifts due to reactive components in series with the speaker. The highs should be crisp and clean with no coloration other than that caused by the speaker and pickup. In short, this amplifier should have no noticeable influence on the music, until better records, pickups and speakers are developed. Any coloration or noise can safely be attributed to some other part of your system. END

HOW TAPE RECORDERS WORK

A rock-bottom basic explanation for those who want to know what happens when sound is recorded on tape and restored later as sound.

By RAYMOND C. SMITH*

This article—the simplest on the subject we have seen for a long time—is ideal for answering the questions of the new tape enthusiast. And—if recording has not been your main field, and you have found yourself a bit vague in your answers to some of those questions—you might find it well worth while to read it carefully yourself.

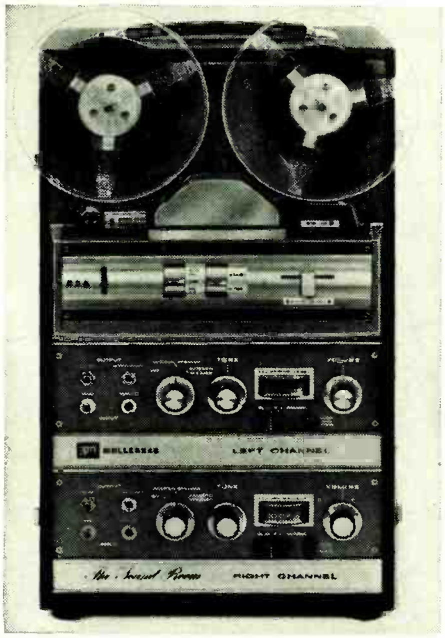
MAGNETIC RECORDERS HAVE ADVANCED A long way toward sophistication in the past 20 years. The wire recorders used during World War II have yielded to tape-cartridge models that automatically thread tapes and rewind them after play. The bulky German Magnetophones used to record Hitler's speeches in Europe have evolved into smart-looking studio recorders with flashing lights, switches, locking devices, potentiometer controls and speed selectors. How do they work?

Sound travels through the air in waves, or surges of energy. A sound wave, and an electrical wave, too, can be diagrammed in terms of its amplitude, or height, and the number of times it repeats itself in a second (Fig. 1). The height of a sound wave determines the intensity, or loudness, of a sound, while the number of complete wave cycles per second determines pitch. The more wave cycles per second, the higher the pitch.

Intensity of a sound wave is measured in *decibels* (db) while intensity of an electrical wave is measured in *voltage*. The number of waves per second—the frequency of the wave—is measured in cycles per second for both sound and electricity.

A low-pitched tone, for example, causes the air to vibrate slowly—perhaps only 30 times a second. The frequency of the tone is therefore 30 cycles (per second).

When the vibrating air waves reach the sensitive diaphragm in a microphone (or in the human ear), they make it vibrate at the same frequency—30 times a second. As the microphone diaphragm moves in, it creates a positive current, and, as it moves out, it creates a negative current, or vice versa. In this way, the microphone translates the 30-cycle sound wave into a 30-cycle electrical wave called an audio frequency—a wave of current which alternates from positive to negative and back to positive 30 times a second.



A recent stereo tape recorder (Wollensak "Sound Room") that can run vertically, as shown, or horizontally like most portables.

The intensity of the waves is also faithfully reproduced in terms of voltage or current. The microphone translates a loud sound into a strong current; a softer sound results in a weaker current.

Magnetic patterns

The waves of alternating current go from the microphone through several stages of amplification and then into the recording head, which is actually an electromagnet.

An electromagnet—in its simplest form—is made by wrapping an iron bar with wire to form a coil. When current flows through the wire, the bar becomes a magnet. One end, or *pole,* of the bar is a North pole. The other end is a South pole. If the direction of the current flow changes, the polarity of the electromagnet is reversed.

Around any magnet is an area of magnetic force, or "field," which is illustrated in Fig. 2 by *lines* of magnetic force. The more closely spaced the lines, the stronger the force. These lines of magnetic force also have direction. Physicists have arbitrarily agreed that they go from North to South outside the magnet, then complete their circuit by going from South to North inside the magnet.

In the recording head, the bar is bent into a more-or-less circular shape with the poles almost touching—as little as .0001 inch, or 1/10 mil, apart. This distance is referred to as the "gap" of the head.

Unlike a permanent magnet, or the magnetic oxide on the tape itself, which is made from a magnetically "hard" material so it will hold its magnetism indefinitely, the core of the recording head

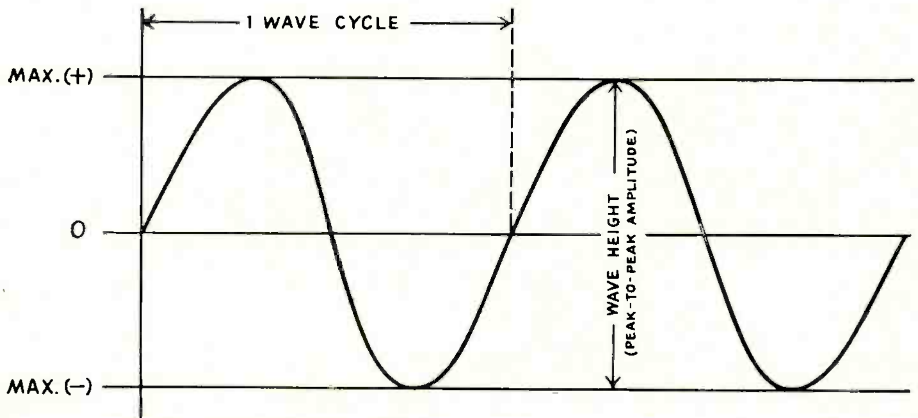


Fig. 1—Any kind of periodic (regularly recurring) wave—sound or electric—can be diagrammed this way. Frequency, or rate of recurrence, determines pitch; amplitude, or height, determines loudness or intensity.

*3M Co., St. Paul, Minn.

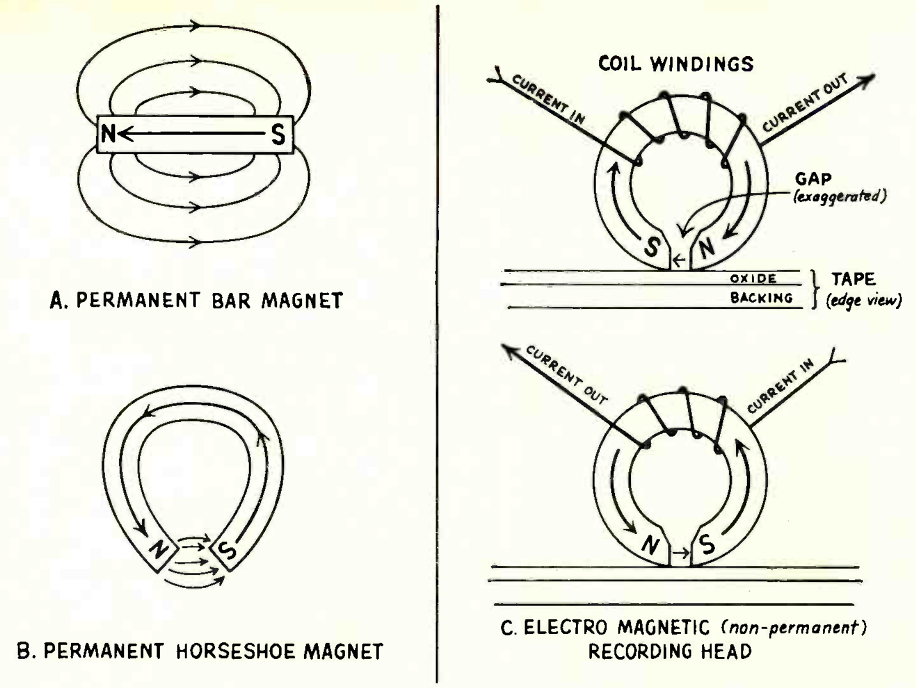


Fig. 2-a—A bar magnet. By convention, lines of force circulate from north to south and complete their path from south to north inside the magnet. b—A horseshoe magnet is really the same thing in different shape. c—Wrap a coil around a specially shaped "horseshoe" core and you have the basic recording head. These drawings show how magnetic polarity changes with current reversal.

is magnetically "soft." Therefore, it becomes magnetized easily and instantly when current flows into the coil, but—just as rapidly—loses its magnetism when the current stops.

A relatively strong current produces a relatively strong magnetic field, while a weaker current results in a correspondingly weaker field. Similarly, a high-frequency (rapidly alternating) current causes each pole of the electromagnet to change through one complete cycle in polarity from North to South and back to North at the same rate, very rapidly, while a low-frequency (slowly alternating) current causes the polarity to change more slowly.

Whenever a surge of positive current from the microphone goes through the coil, it magnetizes the recording head in one direction. When the current alternates and sends a surge of negative current into the coil in the opposite direction, the head is magnetized in the opposite direction. The polarity of the magnetized head must change with each alternation of current.

When the iron-oxide-coated tape is in contact with the recording head, it offers an easier path for the magnetic lines of force to follow than does the air gap. Therefore, most of the magnetism gets across the gap by flowing through the iron-oxide-coated tape.

While the magnetically "soft" iron ring of the electromagnet loses its magnetism when the current stops, the magnetically "hard" coating on the tape retains its magnetism, and the magnetized area becomes a small bar magnet itself. Because the lines of force left inside the tape point in one direction, that direction must necessarily be North. The other end of the area, therefore, becomes South. This is shown in Fig. 3 at A.

At B, the current entering the coil is zero at its point of alternation and, consequently, does not create a magnetic field at that time. As a result, the tape moves a fraction of an inch without being magnetized any further.

However, at C, when a surge of negative current comes into the coil, a magnetic field is set up, in the opposite direction, causing the polarity of the electromagnet to reverse itself. Now the tape is permanently magnetized again, but this time in the opposite direction.

At D, the tape has again moved, but, since the current is not flowing, no new lines of force are set up at that point.

As a result, the surges of alternating current leave the tape permanently magnetized by setting up a series of flux lines of opposite polarity, creating a row of bar magnets on the tape.

Because the tape is moving at a constant speed, the poles are spaced along it in a definite pattern. The frequency at which the current alternates, and the speed at which the tape moves, determines the distance between poles. The strength of the current in the head-coil determines the magnetic strength of each pole.

Revere M-20 cartridge tape-recorder/player. Sequence of loading, threading, playing and rewinding is automatic.

As a result, when the 30-cycle note reaches the recording head as 30-cycle alternating current, it changes the polarity of the electromagnet from North to South to North 30 times a second.

The magnetic pattern on the tape therefore consists of 30 magnetic fields pointing toward South, alternated with 30 magnetic fields pointing toward North.

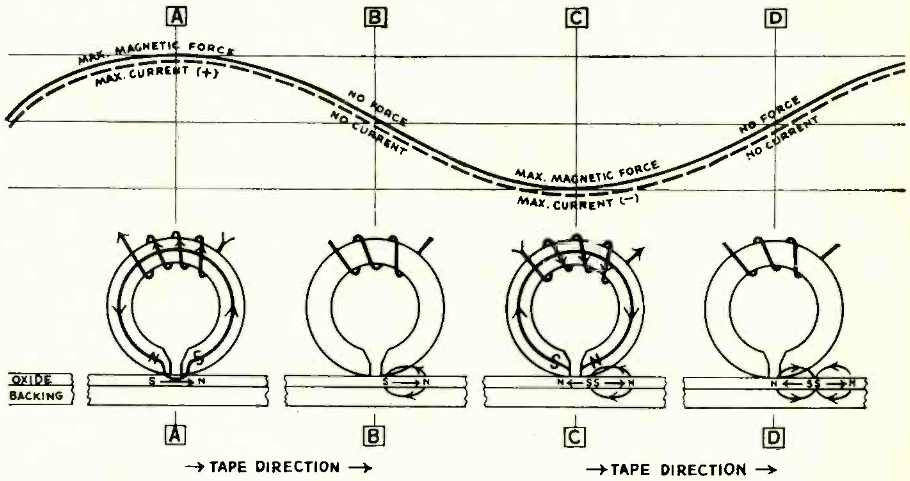


Fig. 3—What happens when you record. Magnetic force in the head, transferred to the tape, alternates in exact step with current in head coil.

In effect, the oxide coating of the tape is broken into 60 individual bar magnets, laid end to end, every second the tape moves across the gap. On a tape recorder operating at 7½ inches per second, one of the most common speeds, the 60 bar-magnet patterns would cover a distance of 7½ inches along the tape. A 100-cycle note would be represented on the tape as 200 patterns in the same space of 7½ inches. This is true only with a steady tone. If the pitch changes, the magnetic pattern changes. Complex waveforms of music and speech generate complex patterns.

Magnetic patterns on tape can be made visible by a simple process. A short piece of recorded tape is dipped in a solution of lighter fluid and carbonyl iron. As the lighter fluid evaporates, the very fine particles of carbonyl iron will remain magnetically attracted to the tape in patterns visible to the naked eye.

The heavily magnetized intervals on the tape—the poles—attract the most carbonyl iron particles and will appear as narrow lines across the tape. The stronger the pole, the heavier the line. The lower the frequency of the current, the greater distance between lines. The actual wavelength of the original tone is equal to twice the distance between the lines.

In summary, then, sound waves pulsate through the air, and cause the diaphragm in the microphone to vibrate accordingly. This produces corresponding electrical pulsations in the mircophone which are strengthened by an amplifier. The amplified pulsations are fed into the recording head, where corresponding magnetic fields are created. They in turn leave their magnetic patterns on the tape.

Playback

In playing a recorded tape, the recording process is repeated in reverse. During recording, an electric current in a coil created a magnetic field. In playback, a magnetic field moved through a coil creates an electric current.

A basic electrical principle is that a surge of current can be generated by moving a bar magnet (or its surrounding magnetic field) through a coil. By moving a series of magnets (or their fields) through a coil, a series of electrical currents will be produced. In recording, the tape was figuratively broken up into just such a series of short, permanent bar magnets.

What actually produces the current is a *change* in the magnetic field. The peak surge of current comes at the moment the field is changing most rapidly. Thus maximum current is produced at the point where the polarity of the head is reversing.

In the playback, the bar magnets on the tape are not actually moved through the coil of the electromagnet. Part of the magnetic field of each, however, is. The iron ring of the electromagnet playback head temporarily routes the bar magnet's field through the coil.

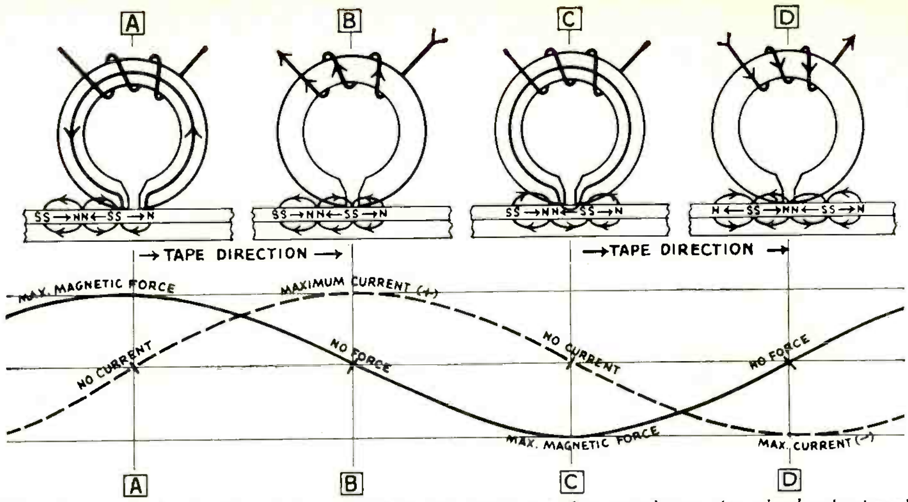


Fig. 4—In playback, the change of magnetic force is what produces the playback signal current. When magnetic force on the tape is at a maximum, no current is induced in the head. When the force is zero, its rate of change is most rapid, and current in head is highest. Hence, magnetic pattern and resulting electric current are shifted 90° (one quarter of a cycle) apart.

In Fig. 4 at A, a North and a South pole are on either side of the gap. Normally the lines of magnetic force stay close to the tape, but it is easier for the magnetic field to follow the iron ring (a much better magnetic conductor) than jump the air space at the gap, so it does just exactly that.

At A, therefore, the magnetic force in the head is maximum, but current is zero.

When the tape has moved a fraction of an inch farther, as at B, a strongly magnetized line—a South pole—this time is at the gap. The iron ring of the electromagnet serves no useful purpose to the field, so it ignores it, and magnetic strength in the head is reduced to zero. However, since the strength of the magnetic field through the coil is changing most rapidly, maximum current is produced.

But, at C, one pole is on one side of the gap, and an opposite pole on the other. As in A, the magnetic field again takes the easiest route and flows through the soft-iron ring, again causing maximum magnetic strength in the head, but no current, since the strength of the magnetic field is changing very little. This is the point of alternation in the current wave from positive to negative.

At D, polarity of the head is again at the point of reversal, and consequently the rapid change in magnetic force results in the maximum surge of current. Since the surges of current alternate between positive and negative with the same frequency as that recorded on the tape (as long as the tape is moving at the same speed), they can be amplified and fed into a loudspeaker to reproduce the original sounds.

Those who are not very familiar with the behavior of electricity can find this current vs magnetic force quite confusing. But a little study will quickly set things right.

As shown by Fig. 4, the maximum current is created *only* when the magnetic force is increasing or decreasing. The maximum magnetic force flowing through the head from the tape creates no current because there is no change. It is the sudden switch from full magnetic force to zero and then back again in the opposite direction that makes current flow in the coil wires.

Engineers call this current *90° out of phase* because the current and force do not match. During recording, the magnetic force and the current that produces it are in phase, as Fig. 3 shows. But on playback, where the motion of the magnetic force must create the current, it is a quarter cycle (90°) ahead of the current it creates.

Once you understand the theory you can see how it affects practical results. Dirty heads impede the flow of the magnetic force by keeping the tape away from the gap, lowering the current and giving poor results. Worn heads may increase the gap width, allowing one of the bar magnets on the tape to fall short of producing the maximum current flow or allowing the magnetic head to span several at once.

This, then, is a basic explanation of the mechanics of recording an audio frequency on magnetic tape. One important factor remains: *bias.* Every tape recording system superimposes a high-frequency alternating current (usually 50–100 kc) on the signal to be recorded. Doing that reduces distortion and noise, but it in no way alters the basic recording process just described, which holds true whether the tape is recording music, speech, digital data for a computer or beeps from a satellite. END

PLAY YOUR RECORDS IN A VACUUM?

By PETER E. SUTHEIM
ASSOCIATE EDITOR

WIPING YOUR RECORDS BEFORE YOU PLAY THEM, WHETHER with a dry cloth or a damp one, doesn't do a thing for them except to make them noisier in the long run. So says Percy Wilson, Technical Editor of *The Gramophone* (London), who spoke on "Record Contamination: Cause and Cure" before the Audio Engineering Society's 16th Annual Meeting in New York Oct. 12–16.

Mr. Wilson and his associates have spent a great deal of time over the past 3 or 4 years studying dirt, dirty records, how to clean the records and how to keep the dirt off them from the start. The conclusions go pretty much against accepted record-cleaning practices, but they make good sense.

There are three categories of record contamination, says Mr. Wilson: discrete particles, like soot, dust, grit and cosmetic powders; crusty deposits left by some solid carried in a liquid that has evaporated, as from household sprays *and from blowing on records,* and condensates from fumes, like tobacco smoke, vehicle exhaust and cooking vapors. All these usually get together in the groove and, after being thoroughly mixed by the stylus, form a deposit that is apparently very difficult to remove. *Wiping with a damp rag, before or during playing, does an even more thorough job of making sludge!*

What puts the dirt in the grooves? Two things, fundamentally, aside from the obvious ones like fingers or dirty cloths and turntable mats. The best known is static electricity. Vinyl is easily charged and holds its charge for a long time. (Try rubbing a record with a dry cloth—silk, if you have it; then bring a suspended thread or string near it and watch how the record "grabs" the thread and holds it.)

But there's a very simple way to overcome that static-charge problem: cut a piece of household aluminum foil into a circle the size of the record and place it on the turntable so that it touches any record you put on the turntable on top of it. The foil carries away the static charge. (Conductive rubber turntable mats are expected to be standard on all Garrard equipment soon, according to Mr. Wilson—and thanks to his efforts.)

The second dirt-attracter is aerodynamic action—the same phenomenon that makes airplanes fly and carburetors work. There appears to be a vortex of air over a rotating record—yes, even at 33⅓ rpm—that sucks particles down against the record with remarkable force. (Try blowing cigarette smoke through a straw held vertically over the middle of a rotating record. Watch how the smoke swirls over the disc and gathers at the edge.) Conclusion: never leave a record rotating on your turntable any longer than necessary.

Once fume condensates have mixed with solid matter and been allowed to harden, no kind of dry wiping or brushing will remove the grime without destroying the grooves. Specifically, special dry-cleaning cloths or tissues hold grit that, when pressed against the record surface, produces scratches that can definitely be heard on high-quality equipment. Tracking brushes are good up to a point but, once they become clogged, they deposit more dirt than they remove. They also tend to mix up the sludge in the grooves, making that cementlike deposit that is so hard to remove. Damp pads are *very* bad—even when clean.

So is there anything you *can* use? Yes. For wet cleaning, Mr. Wilson has found a 25% solution (approximately) of ethyl (grain) alcohol or isopropyl alcohol in distilled water, applied with a soft brush, to be excellent. For most not-terribly-dirty records, just distilled water is enough.

The problem is getting the *grooves* dry after the bath. (The surface dries quickly.) As long as the grooves are wet, they will hold any dust that falls into them, or is tracked into them by the stylus as the record is played. Wiping the record is a pretty poor idea, because the cloth will leave lint and dust on the record, and anyway can't get far enough into the grooves.

Mr. Wilson's solution, embodied in a little machine ("The Record Doctor") he hopes to have manufactured, is a fluffy camel-hair brush that spins at 3,000 rpm above the record and parallel to it, just touching. The whirling brush produces a suction effect along its axis and a blowing current radially.

For cleaning records as they play, Mr. Wilson has designed a tracking device that looks much like a tone arm. At its end, resting on the disc, is a brush with bristles shaped to fit into the grooves, like playing styli. Behind the brush, on the arm, is a "suction mop"—a wad of cotton wrapped in lintless rayon fabric, stuffed like a plug into a plastic cylinder. The rayon-wrapped lower end of the plug rests lightly on the record, picking up the grime lifted out of the grooves by the brush. At the top of the "mop" is a soft rubber hose, which leads to a small, quiet suction pump. The combined effect of "mopping" action and suction is to make the dirt stick to the cotton wad so that it can't distribute itself back onto the record and into the grooves.

In a short time, according to Mr. Wilson, the wad "turned almost jet black". And noise level was reduced "to a degree that sets a new standard of listening pleasure." Tracking force with a top-quality cartridge could be lowered to *0.2 gram* without mistracking!

Things not to do

To illustrate these, let's postulate a "horrible example". You have invited some friends over to hear your system and some exciting new records. During the afternoon, your wife decides to clean up the listening room and brings out the vacuum cleaner. She begins to draw dust out of rugs, cracks and cushions. Much of it stays in the bag, but a lot of minute stuff is blown out the other end of the cleaner, back into the air. There it hangs—for a while. Then she dusts everything in sight. Do you think the dustrag picks up *all* the dust? Finally, she fluffs up the sofa cushions, sending another cloud of fine dust into the air.

Just before the guests arrive, you wipe the last of the dust (hah!) off the turntable and surrounding cabinetry, blowing a little here and there to be sure. Finally, you and your company sit down to listen, puffing on cigarettes, cigars and pipes, while a roast sizzles in the oven.

Short of emptying a bagful of grime scraped off the underside of your car into an electric fan, you couldn't do worse!

So: *don't* clean your rooms just before playing records; *don't* leave the turntable running any longer than necessary; *don't* blow on a record; *don't* wet it; *don't* use aerosol sprays (insect repellents or deodorizers) where you play records; and —don't smoke! END

Measuring Turntable Rumble

First of two articles on turntable performance checks. How to measure rumble, and how to interpret your measurements

By EDGAR VILLCHUR*

TESTING TURNTABLES IS NOT SIMPLY A MATTER OF BUYING special equipment—for example, as far as I know, no commercial rumble test sets are available.

This article describes the more important testing procedures used at the end of AR's turntable production line—amended here for the use of measuring equipment that is readily available or that can be constructed for a home or shop workbench.

The absolute amount of noise introduced electrically into a reproducing system by turntable vibration depends on such things as the sensitivity of the pickup and the setting of the volume and bass controls. Rumble is therefore measured as a signal-to-noise ratio—the ratio of rumble level to the level of a standard reference tone cut into the record.

The NAB specified this standard level in 1953[1] as 1.4 cm/sec peak lateral recorded velocity at 100 cycles. Rumble testing procedure uses a special record containing both the reference tone and "quiet" (unmodulated) grooves. Amplifier output with the reference tone playing is compared to output when the quiet grooves are playing. The rumble is the quiet-groove output, expressed as the number of db below the reference tone output.

To get a readable rumble voltage from a good turntable, the amplifier volume control must be turned up well beyond its normal range. At this volume setting, the reference tone will overload or actually damage everything in its path. Therefore the reference tone must be played through a calibrated attenuator.

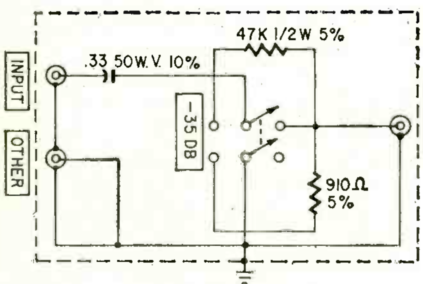


Fig. 1—Filter-attenuator used to measure rumble. Attenuator section cuts test tone by 35 db; filter section rolls off bass below 10 cycles. Build it in a metal box.

The simple device shown in Fig. 1 and in the photographs, used with a test record (specified later) and an ac meter with good response below 30 cycles, constitutes a complete rumble measuring set. Rumble measurements made with it are meaningful only for a complete arm–turntable combination, because rumble may be affected by arm characteristics and by the way the arm is mounted relative to the turntable. Cartridge response may also affect rumble readings, so that when comparing different turntables, it is necessary to use the same cartridge for each.

These are the steps in the test procedure:

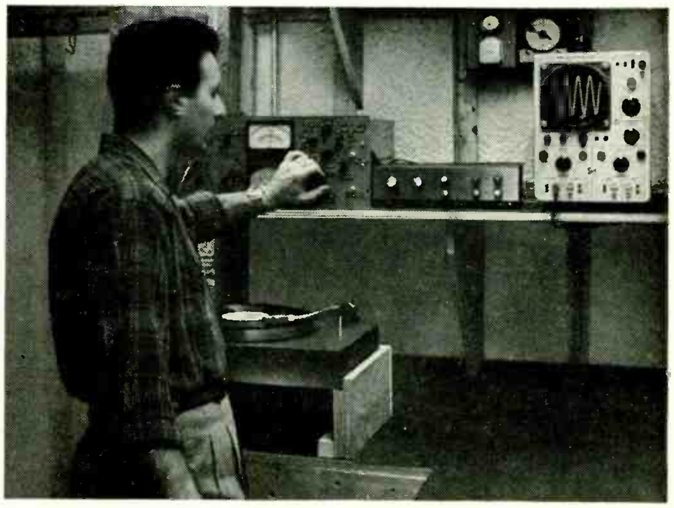
1. Connect the filter-attenuator of Fig. 1 between the turntable under test and the amplifier phono input, with the switch in the nonattenuated position. The amplifier must have standard RIAA phono equalization and the standard 47,000-ohm phono input resistance. For stereo systems, connect the turntable cable of the channel being tested to the INPUT jack of the attenuator; the other phono tip should be plugged into OTHER to ground it. The attenuator output goes to the preamplifier input of one channel (Fig. 2). Turn the balance control as far as it will go to favor that channel.

If plugging in the attenuator increases hum, substitute a very short shielded cable—perhaps 6 inches—between the attenuator and the amplifier.

[*Note*: this attenuator is designed to be used with magnetic cartridges or the special ceramics that work into a 47,000-ohm load. For a ceramic cartridge working into a 1-megohm load, multiply all resistance values and divide all capacitance values of the attenuator by 20. Some ceramics have attenuated response in the extreme bass; with such a cartridge the measurement represents turntable rumble *with that cartridge only*.]

2. Connect an ac voltmeter with a decibel scale across the highest-impedance speaker tap of the power amplifier. For strict adherence to NAB procedure, the meter movement must have the ballistic characteristics of a standard VU meter, and like the rest of the system must have response within 1 db down to 10 cycles. However, compromises with these requirements will have little effect on the *relative* readings of different turntables.

3. Play the quiet-groove section of the test record. Adjust the volume control so that meter readings from the



Turntable testing chamber at end of AR's production line. Operator is checking flutter.

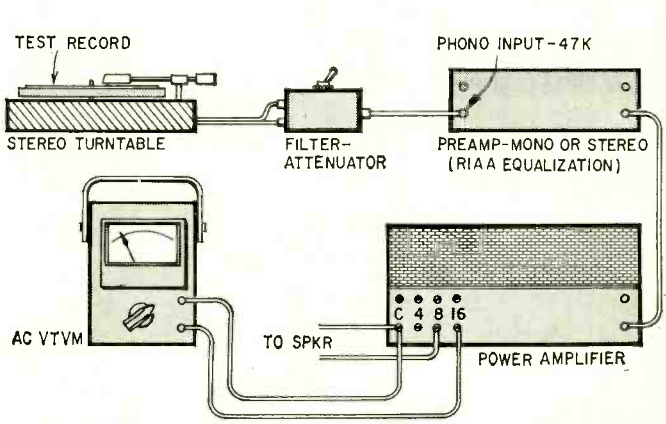
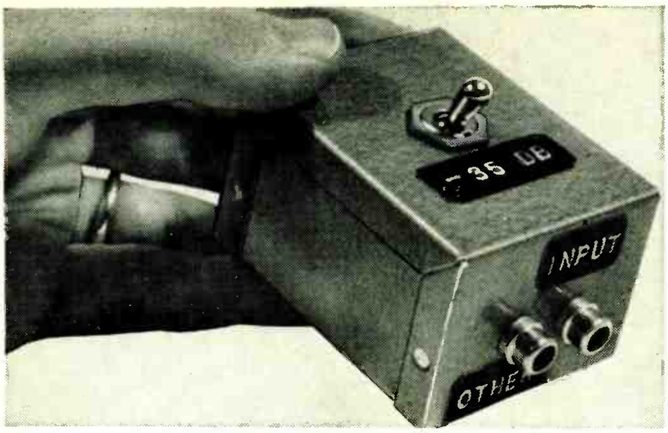


Fig. 2—Hookup for testing rumble in a stereo system. To check other channel, reverse phono plugs at input of attenuator box. Use shielded cable for the connections.

*Acoustic Research, Inc., Cambridge, Mass.

[1] Recording and Reproducing Standards. *National Association of Broadcasters, 1771 N Street, N.W., Washington, D.C. June 1953.*



Combination lf filter and 35-db attenuator for rumble measurements.

quiet grooves are about 1 volt or less. Tone controls must be at FLAT.

4. Check for acoustic feedback from speaker to cartridge. It may create a roar or howl, or in less extreme cases it may simply amplify the rumble. If disconnecting the speaker reduces the quiet-groove meter reading, feedback is interfering with the rumble measurement. Some modern turntables have sufficiently compliant spring mounting to avoid the problem completely. If you are not testing one of these, you may have to shock-mount the turntable on foam rubber or put the speaker in another room. You could leave the speaker disconnected, but it is far better to be able to monitor the sound as a check that you are measuring what you set out to measure. Hum, for example, can provide a false reading.

5. Put the attenuator switch in the −35-db position and play the test-record reference tone. Record the meter reading in db; if possible, readjust the volume control for a 0-db reading.

6. Play the quiet-groove band and throw the switch to the unattenuated position. The rumble then goes straight through the attenuator except for the filter's rolloff below 10 cycles (specified by the NAB). *Do not change the amplifier volume or bass controls,* but turn the treble control all the way down to cut surface noise.

Record the meter reading relative to the first reading, that is, − 3 db, + 5 db, etc. This reading will be quite unsteady, partly because of the test record. Since there is nothing in the quiet grooves that can improve the rumble rating, I use the lowest average reading that is maintained over one full revolution of the platter. Rumble readings are never too precise, but they should be reliable within a db or so.

7. The final step is to interpret the meter readings to get a rumble figure for the turntable.

Monophonic system, lateral reference tone 1.4 cm/sec peak @ 100 cycles: Measurements must be made with a monophonic cartridge, or with a stereo cartridge strapped for lateral output as in Fig. 3-b. The difference in meter readings between the test tone and quiet grooves, less 35 db, is the lateral rumble. For example, if the quiet-groove rumble reading is the same as for the test tone, the turntable's lateral rumble is − 35 db, the 1953 NAB standard for mono turntables for broadcast work. If the rumble reads 6 db higher than the test tone, the lateral rating is (− 35 + 6), or − 29 db. If the rumble reads 5 db less than the test tone, the lateral rating is − 40 db, the amended (1964) NAB standard.

Monophonic system, lateral reference 7cm/sec peak @ 1,000 cycles: This reference when played through RIAA equalization is almost but not quite equivalent to 1.4 cm/sec peak at 100 cycles. Use as above, but add 1 db [2] to the rating. Thus, − 37 db becomes − 36 db.

Stereo system: Test each turntable channel separately, following the same steps as above. To switch channels, simply reverse the left and right turntable cables to the attenuator, leaving everything else unchanged.

The same lateral reference tone may be used, although the rumble reading will represent combined vertical and lateral rumble. A 1.4-cm/sec tone recorded laterally produces the same output in either channel of a stereo pickup as a 1-cm/sec tone recorded at 45°. The new NAB Standard[3] specifies a reference tone for stereo of 1 cm/sec peak @ 100 cycles in the plane of modulation.

New NAB standard

The recently amended NAB Standard does not refer to the total rumble of a stereo system, but specifies that the rumble in each channel is to be at least 35 db below the new 1-cm reference. The reduced velocity of the stereo reference tone represents a tightening of rumble standards for stereo by 3 db. (As mentioned above, the rumble standard for lateral recording has also been raised—it is now 40 db below the old 1.4-cm reference.)

Each channel contributes half the signal and half the rumble. If the rumble in each channel is − 35 db, the total rumble is also − 35 db. When the two channels differ, the total rumble rating is better than the worse of the two by some amount up to 3 db, according to the following chart:

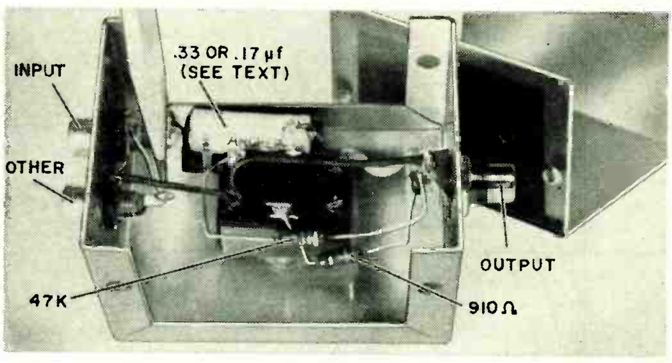
Difference between channels	Subtract from worst channel
1 db	0.5 db
2	0.9
3	1.2
5	1.8
10	3.0

For example, if the left-channel rumble is − 34 db and the right-channel is − 36 db, the total rumble is (− 34 − 0.9), or about − 35 db.

Measuring lateral & vertical rumble separately

Turntables that perform and measure well in monophonic systems may prove unusably noisy in stereo, where vertical rumble is reproduced as well. Measuring lateral and vertical rumble separately is often useful for diagnosis. All AR turntables must pass standards for lateral and vertical rumble separately.

When stereo cartridge terminals are connected in series and out of phase, as in Fig. 3-a, the pickup will provide vertical output only. When the cartridge is strapped for in-phase operation of left and right channels (Fig. 3-b), the output will represent only the lateral component of needle



Inside filter–attenuator. Note that "hot" terminal of OTHER *jack is grounded.*

[2] *The actual difference is 0.87 db.*

[3] Disc Recording and Reproducing. *National Association of Broadcasters. March 1964.*

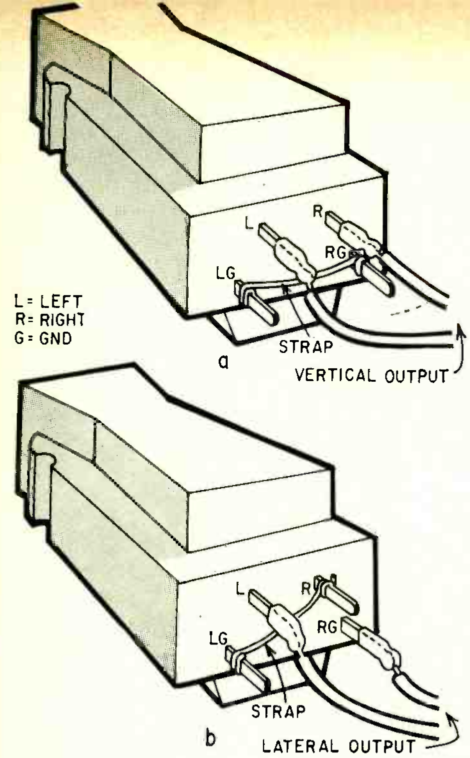


Fig. 3—How to interconnect cartridge terminals for measuring vertical (a) and lateral (b) rumble. Connection in (a) is contrary to common sense because of internal electrical phase reversal in all magnetic cartridges.

motion. In measuring lateral or vertical rumble establish the reference output from a lateral reference tone with the cartridge strapped for lateral operation. The increased sensitivity of the series connection of the cartridge must be applied to reference tone and quiet groove alike.

Vertical and lateral rumble may be combined to give total system rumble by the same method, and with the same chart that is used to add left and right channels. Rumble measured against a 1.4-cm/sec reference may be converted to the 1-cm/sec reference by adding 3 db; thus − 38 db becomes − 35 db.

Test records

Most test records are unsuitable for testing rumble in a stereo system, because the "quiet" grooves themselves have more vertical rumble recorded into them than the rumble of a first-class stereo reproducing turntable. This is probably the result of being cut on lathes designed and built for prestereo recording, in which only lateral rumble counted.

The table lists the lateral and vertical rumble readings of the same AR turntable measured with different test records. It can be seen that with test records D, E, F and G the controlling element in the measurement is not the turntable but the record grooves. The two quietest test records sold commercially that I have found are "Quiet Please!" ($1, Components Corp., Denville, N. J.), and BTR-150 ($10, CBS Laboratories, High Ridge Road, Stamford, Conn.). The reference tone on these records is 7 cm/sec at 1,000 cycles lateral.

Lateral and vertical rumble readings of the same AR turntable with seven different test records, using filter with 20-cycle rolloff and new NAB reference of 1 cm/sec @ 100 cycles. (Measured with Stanton 481AA cartridge.) All except the first record are commercially available.

Test record	Measured lateral rumble	Measured vertical rumble
AR Special	−40 db	−36 db
Components	−41	−35
CBS BTR-150	−39	−34
Brand "D"	−37	−29
Brand "E"	−36	−29
Brand "F"	−36	−28
Brand "G"	−32	−27

The 1953 NAB Standard defined a rumble-free record as one having at least 8 db less rumble than that of the system being measured. Aside from those test records in the table that clearly have up to 8 db *more* rumble than the turntable being measured, this poses something of a logical dilemma. One cannot know, when playing the quietest test record on the turntable with least rumble, whether or not the rumble content of the record is influencing the rumble readings.

If we assumed that the AR turntable had no rumble, we could deduce that we were merely measuring the rumble content of the records; if we assumed that the AR test record had no rumble, we could deduce that the measurements accurately reflected the rumble in the turntable. We think, from studying the character of the rumble, that the truth is somewhere in between, with the turntable's rumble about equal to that in the grooves of the best test records.

The question is quite academic, because when rumble is this low, a few db up or down doesn't make much difference. We can, however, put into perspective claims for total rumble of − 50 db and better. The NAB standard for professional stereo turntables appears to be crowding the limit of the present state of the art of reproducing *and recording* (if we judge the latter by test records), particularly in vertical rumble. For example, the best rating for total rumble ever given to a reproducing stereo turntable in the published test reports of *HiFi/Stereo Review* has been − 38 db using the old NAB reference, which would be − 35 db with the new 1-cm/sec reference. I do not believe there are any test records that can measure rumble very much less than this with NAB procedure.

The extreme figures for rumble that are sometimes published can be related only to a private rating system: a noise level described as − 50 db would not be very quiet if the reference were an earthquake. The technician who is used to seeing − 50-db and − 60-db rumble ratings and who sets up the measuring system described here is in for a rude shock.

Weighting rumble figures

The NAB method of measuring rumble does not take into consideration the frequency distribution of the rumble energy. It is therefore possible for two turntables to have the same rumble in terms of raw signal-to-noise ratio, and yet for one to sound quieter than the other. The Fletcher-Munson curves of hearing perception indicate that the lower the frequency of the rumble, the less audible it will be.

The production test equipment at AR provides both NAB rumble readings and frequency-weighted readings which compensate for the increased hearing sensitivity to higher rumble frequencies. Such weighted figures are not published because there is no standard with which to compare them, but they do provide a necessary check.

The simplest method of incorporating frequency weighting into rumble measurements is to listen to the rumble while you measure it. Experience with different turntables will teach you to spot the more audible concentration of energy in the higher bass.

Most commercial amplifiers and meters have reduced response below 20 cycles. In some cases this will improve the rumble reading over the strictly-NAB rating by several db. If the rumble is low to begin with, it is a justified improvement, because the subsonic rumble that is left out of the measurement is both inaudible and too small in amplitude to overload the amplifier. When the measuring equipment does not have such bass rolloff, I suggest modifying the NAB procedure by substituting 0.17-μf capacitance for the .33 μf in the filter, raising the 3-db [4] rolloff point to 20 cycles. I believe that test results with the higher rolloff are a more valid indication of turntable performance. END

[4] *A stricter interpretation of NAB requirements would allow response to be down only 1 db at 10 cycles, rather than the 3 db introduced by the filter.*

Choosing the Right Tape Machine

By **HERMAN BURSTEIN**

SALESMAN: May I help you?

CUSTOMER: I'm interested in a tape machine.

S: What sort of tape machine are you looking for?

C: Well, I don't know exactly. Just a decent tape recorder, I guess. Nothing special.

S: Excuse me, but that's pretty vague. It's like saying you want a car—which could mean anything from a sport coupé to a lavish limousine.

C: I don't really know what I want, yet.

S: Then let me ask you a few questions. Do you plan to use the machine with a hi-fi system?

C: Yes. Why?

S: If you're going to play the machine only through your hi-fi, all you need is a "basic" machine, one without a power amplifier and speaker. If you're not, you need a "self-contained" unit, one with its own power amplifier and speaker. Of course, you can also play that kind through your hi-fi.

C: Then why not get a self-contained machine in either case?

S: Because for the same money a basic machine will give you better quality.

C: I see.

S: By any chance are you interested only in playing prerecorded tapes, and not in recording? Because if you are, you can save a good deal by getting just a tape player—a machine that doesn't record.

C: That's a possibility.

S: You can save even more by getting a tape player without electronics. That's a bare transport mechanism with a playback head. The signal from the head goes direct to the "tape head" jack of your amplifier.

C: I'm not sure my system has a jack like that.

S: Well, if it doesn't, you'll need a tape player with electronics to amplify the weak signal from the head and also to supply bass boost for equalizing. Even if your amplifier does have a "tape head" input, you may want a tape player with electronics, because a good "tape deck" does a better job of amplifying and equalizing than your audio system.

C: Can we get back to tape recorders in general?

S: Sure. Now I have to ask whether you want really high-fidelity performance. Or is "pretty good" enough?

C: What do you mean by *really* high fidelity?

S: Very flat frequency response, low noise, low distortion and good transport motion—meaning low wow and flutter and accurate speed.

C: Naturally I'd like the best, but what about the cost?

S: Pretty high. You've got to pay for better design, better components and better quality control.

C: Give me an example of the specs of a typical high-fidelity machine.

S: At 7½ inches per second, which is what most people use for nonprofessional recordings, frequency response would be flat within 2 db from about 40 cycles to at least 15,000. Signal-to-noise ratio would be about 55 db, based on a 400-cycle tone recorded at a level that produces 3% harmonic distortion on the tape. Wow and flutter would be less than 0.2%, and speed would be accurate within 0.5% or better.

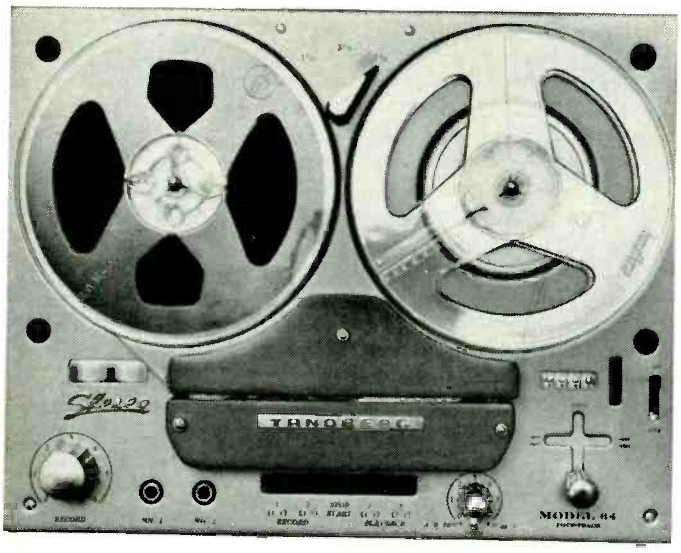
C: That's funny. Preamps and power amplifiers claim much better specs—flat response at least from 20 to 20,000, signal-to-noise ratios more like 70 db, and distortion way under 3%.

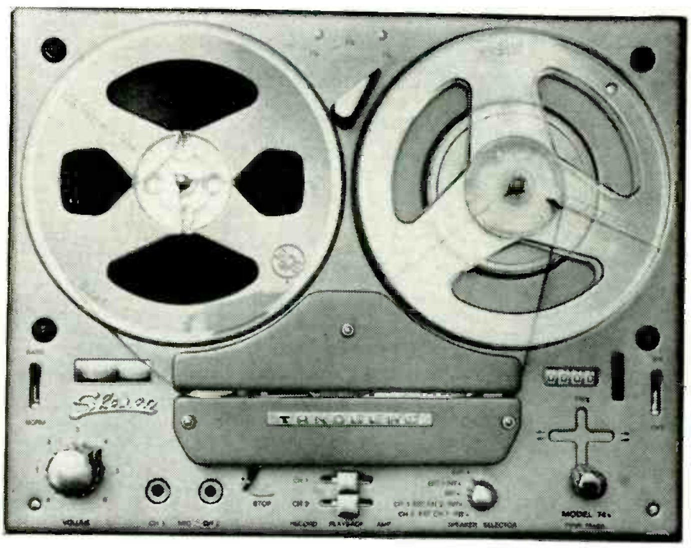
S: Don't be too surprised. A tape recorder has a much tougher assignment than other equipment.

C: Hm. Well, what about the specs for a tape machine that isn't hi-fi but still pretty good?

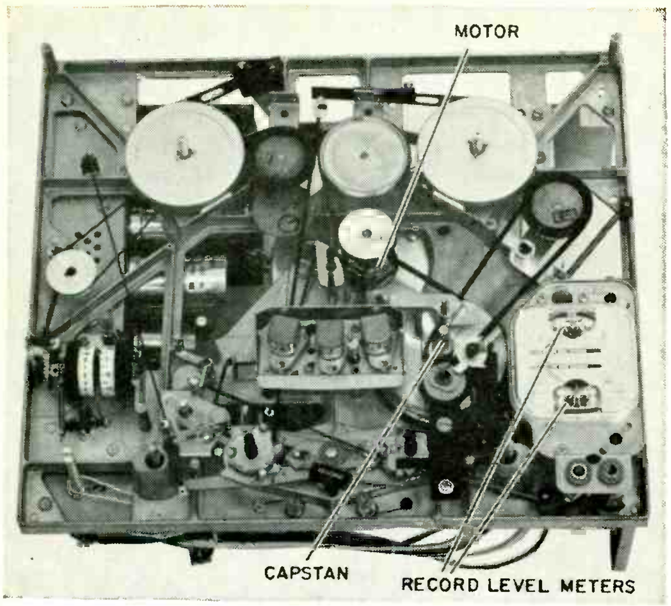
S: At 7½ ips, frequency response might be flat within 3 or 4 db between 50 and 15,000 cycles Signal-to-noise ratio would be about 45 to 50 db. Wow and flutter might run as high as 0.3% to 0.5%. Speed might be off by as much as 3%.

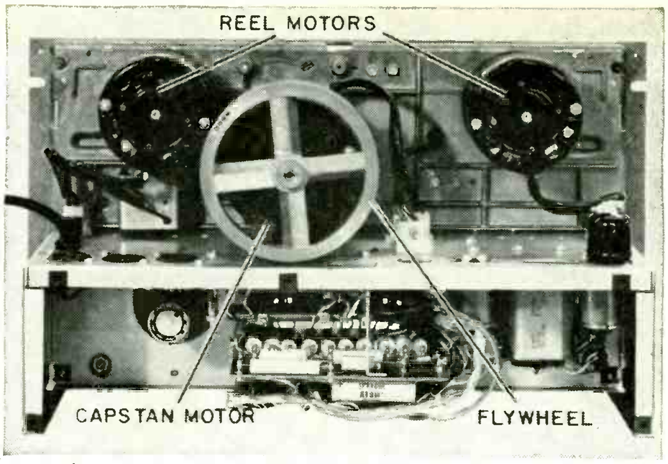
C: How much did you say would





These photos show clearly some of the differences between a tape deck (needs separate amplifier and speakers) and a tape recorder (contains everything). The Tandberg 64 deck (left), for example, has no speaker switching and one or two fewer controls than the 74 recorder (right). All knobs and buttons not essential to tape movement and recording have been omitted. Note, on both versions, the twin "eye"-type volume indicators just above the word "stereo" at left.





A single-motor transport (left) is lighter, smaller and less costly than a three-motor transport. Note the complex system of drive belts in the single-motor machine (Ampex F-44). Three independent motors in the Magnecord 1022 (right) simplify mechanism but make it heavier and bulkier. Both these machines have meters rather than electronic tubes to indicate recording level.

be the difference in cost between a high-fidelity machine and a good machine?

S: I didn't say. One might cost about twice as much as the other.

C: How much is that in dollars?

S: Oh, prices vary. A high fidelity recorder might cost between $400 and $600.

C: And a good machine between $200 and $300?

S: Roughly.

C: For the difference in money, do I get anything else besides better performance?

S: Lots. You get better, longer-lasting tape heads, sturdier mechanical construction, higher-quality parts. Capacitors would have higher voltage ratings and resistors higher wattage ratings, so there'd be fewer breakdowns. More low-noise resistors. A $600 machine has a better motor to drive the capstan—probably a hysteresis motor for accurate, stable speed.

You'll get a number of internal controls for the factory or service technician to adjust. That way you can shoot for optimum performance. The cheaper machines usually don't have such controls. A high-fidelity tape recorder is apt to have three tape heads instead of two; two or three motors instead of one; a VU meter instead of an "eye" tube as a record-level indicator. There will be tighter quality control. Is that the sort of thing you mean?

C: You said that a high-fidelity machine offers more features. What do you mean?

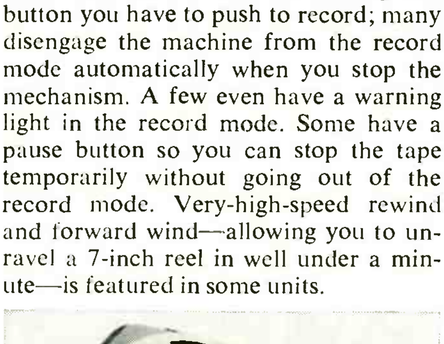
S: I mean anything that makes the machine work better or makes it easier to use. For example, a well designed machine doesn't need pressure pads to hold the tape close against the heads for good treble. Instead, it's got a system of tape guides, and it relies on tape tension for good contact. You get less wow and flutter and less tape squeal. A high-quality machine has such things as automatic shutoff in case the tape breaks or runs out, and a tape lifter that pulls the tape away from the heads during rapid wind and rewind, to cut down head wear.

C: What other features are there?

S: Oh, lots. But just which ones depends on the particular machine. I can give you a quick rundown of desirable features in fair to excellent machines.

C: Go ahead.

S: A tape counter helps you locate a particular passage quickly. To safeguard against erasing a tape by putting the machine in the record mode accidentally, most machines have a special button you have to push to record; many disengage the machine from the record mode automatically when you stop the mechanism. A few even have a warning light in the record mode. Some have a pause button so you can stop the tape temporarily without going out of the record mode. Very-high-speed rewind and forward wind—allowing you to unravel a 7-inch reel in well under a minute—is featured in some units.



Norelco 401 is typical of medium-priced high-quality home tape recorders. Push-button control, 4-track stereo record and play, sound-on-sound recording, tape index counter (rear, between reels). Machine has four speeds: 7½, 3¾, 1⅞ and 15/16 ips.

A few machines offer automatic reverse operation, so you don't have to remove and reverse the reels when you reach the end of the tape. NAB playback equalization at 7.5 ips is good, so you get flat response on prerecorded tapes. Low-impedance output permits a long cable run from the tape machine to an audio system.

Some of the top caliber recorders have inputs for low-impedance microphones, which allow a long cable run from the mike to the tape recorder. If you plan to do a lot of tape editing, you'll find that some machines make it more convenient by letting you get at the tape in front of the heads. Some better machines allow you to mix a microphone signal and the signal, say, from your FM tuner.

C: You said the better machines offer greater versatility?

S: Again, I hate to draw a sharp line between top-quality and other tape recorders, but here are some of the things to look for. If the machine is stereo, it may allow you to use all four tracks for mono recording. Some stereo machines let you record mono on only two tracks, because of crosstalk problems.

A number of stereo machines feature sound-on-sound so that you can make successive recordings on the same track, each synchronized with the previous ones. You can get variations of sound-on-sound—they may not let you synchronize—may let you put just two synchronized recordings on separate tracks. Other special recording effects are available, like echo effect and reverberation. Most machines have two operating speeds, usually 7½ and 3¾ ips, but several have three speeds or even four, including the really slow 1⅞ and $^{15}/_{16}$ ips. For high fidelity, 7½ ips is still generally necessary, but the other speeds

What's Going on with Loudspeakers?

No new principles in nearly 40 years, but a flock of exciting developments in materials and designs

By VICTOR BROCINER*

IN AN INDUSTRY THAT HAILS EVERY ENGINEERING REFINEment as a "breakthrough" and where just adding a rotatable control is enough to be "revolutionary", some clarification seems needed about what is *really* new in speakers. To be able to identify what is new, one should know what is old. So let's find out.

The basic principles of speaker design were mathematically analyzed as early as 1925 for direct-radiator speakers[1] and 1928 for horn-loaded units[2]. The famous Rice-Kellogg paper[1] began with the statement that direct radiation was adopted to eliminate horn resonance, leaving the problem of diaphragm resonance. This was attacked by trying:

1. A gold-leaf thermophone
2. Electrostatic speakers with large diaphragms
3. A throttled air-flow speaker
4. A friction-actuated, rotating-drum speaker
5. A talking arc
6. Multiple magnetic earphones used as speakers
7. Multiple horns
8. An induction speaker using a thin aluminum sheet between two pancake type coils
9. Various designs of small-diaphragm moving-coil instruments

The development of the direct-radiator speaker was not the result of an arbitrary decision but of a careful analysis of various ways of doing the job. Included in the list are *all* the speaker types in use today. Some became practical when improved materials were developed, as in the case of the electrostatic. Others were re-invented, in effect, at a later period, and appeared commercially.

Rice and Kellogg found that the open direct-radiator speakers did not reproduce bass very well because of circulation of air between the front and back of the diaphragm. A closed box behind the speakers was found to produce resonances even when lined with felt. "A happy solution . . . was obtained by employing a flat baffleboard." As speakers were further developed, the closed box came back into use. In some other cases, the problem of "circulation" was ignored.

For true piston action, the authors concluded that either the diaphragm must be very rigid for its weight and quite small, or the driving force must be applied uniformly over the entire diaphragm surface. The designs described were:

1. Rigid diaphragm of W cross-section (Fig. 1). One of these designs used a rubber surround
2. Very light conical diaphragm with cemented-on spiral voice coil, to obtain distributed driving force
3. Diaphragm of annular form (Fig. 2)
4. 45° paper cone with thin rubber surround
5. Aluminum-foil diaphragm

The paper also refers, in a footnote, to a speaker employing an aluminum strip in a magnetic field, made by Siemens and Halske in 1924. This is perhaps the "Riffel" speaker described by McLachlan[3], who also describes the "Blathaller"—the original "flat" design in which a distributed magnet system drove a zig-zag voice coil attached to an aluminum diaphragm. (The *acoustic output* is stated as 200 watts.)

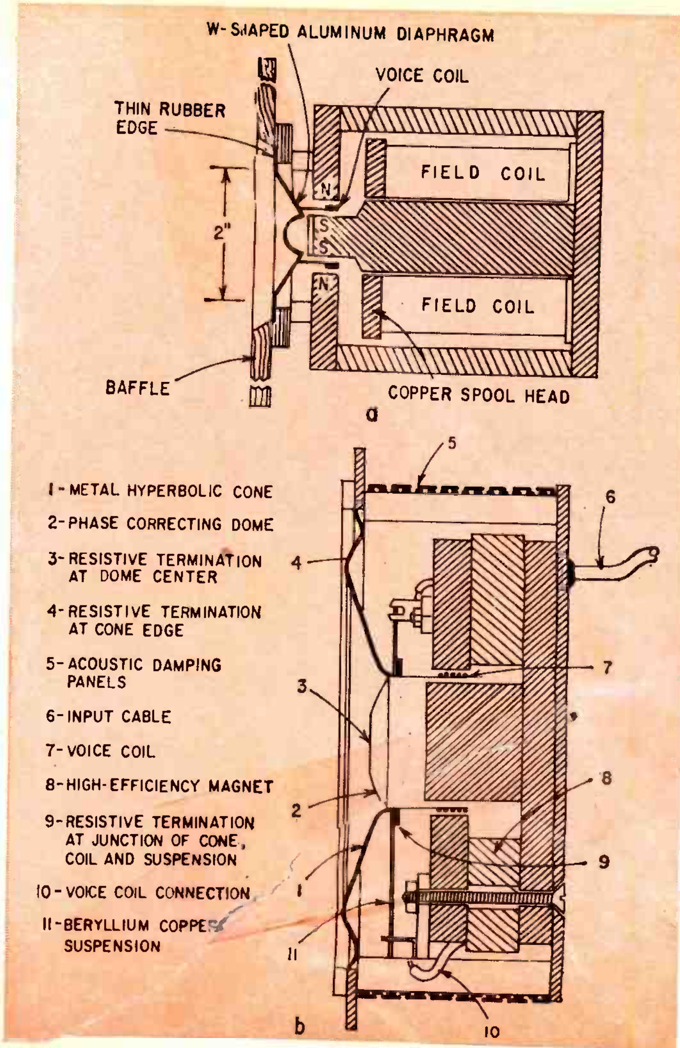


Fig. 1-a—Early rigid-diaphragm baffle type speaker. b—Modern version by Jordan-Watts. (Voice coils are shown too far toward right. They should be centered in gaps.)

What new principles of speaker design have been evolved since these pioneering efforts four decades ago? The answer is simple: none. Does this mean that speakers have not improved in all this time? Not at all. The improvements have come about primarily through refined techniques and materials. The very best speakers of the past stack up very well against today's designs, but there is a tremendous contrast in bulk and cost. Not so long ago, really enormous, complicated and expensive horn speakers were considered necessary for reproduction down to 40 cycles. Today we can do better in a 2-cubic-foot cabinet. The old elaborate, precision-built high-frequency speakers have been followed by relatively simple, moderately priced tweeters that actually respond over an octave more of frequency range.

Now, before the outraged cries begin, let me make it clear that this does not imply that bass horns are obsolete, or that there are no advantages in horn-loaded high-frequency speakers of sophisticated design. But it has been through other means that real high-fidelity sound has become available at moderate cost.

In the bass, the limiting factors have remained unchanged: the rapid drop in output below system resonance,

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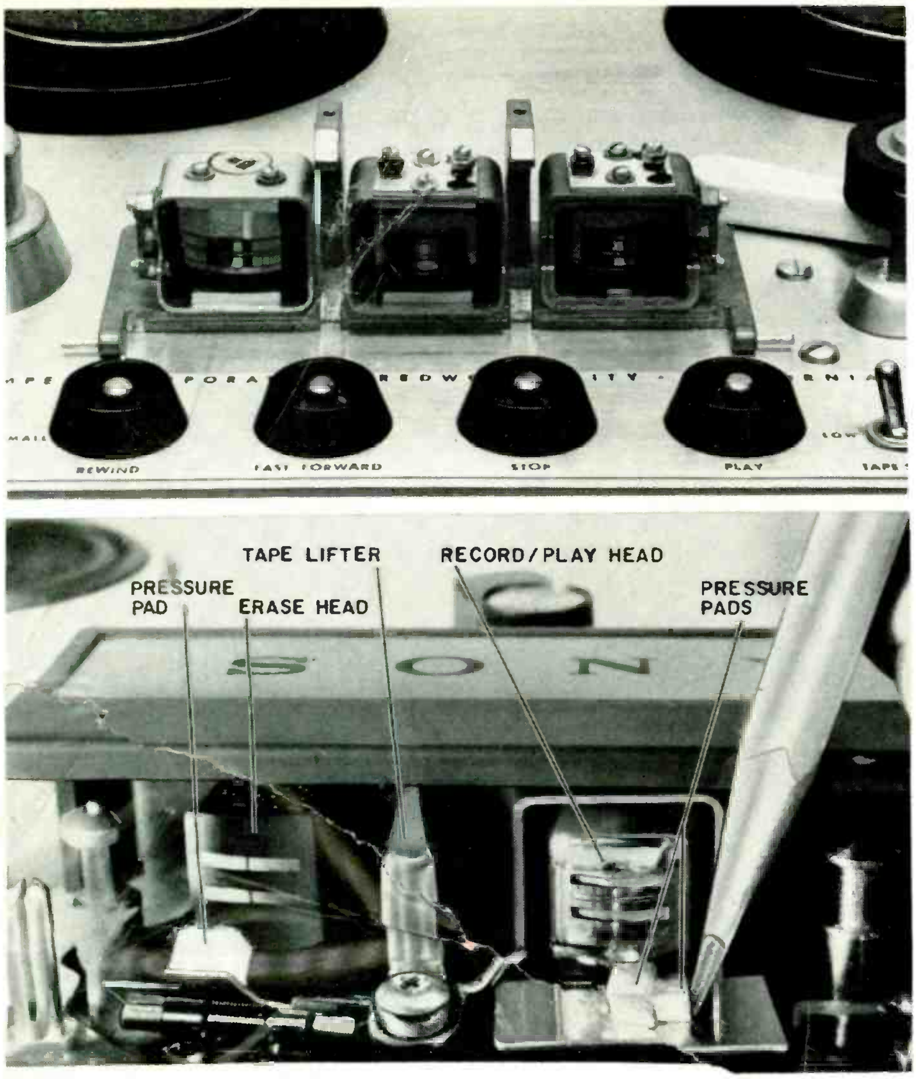
**Assistant to the President, H. H. Scott, Inc.*

[1] *C.W. Rice and E. W. Kellogg, "Notes on the Development of a New Type of Hornless Loud Speaker."* Transactions AIEE, *1925, Vol. 44, p. 461.*

[2] *C. R. Hanna, "Loudspeakers of High Efficiency and Load Capacity." Paper presented at the Winter Convention of the AIEE, New York, Feb. 1928.*

[3] *N. W. McLachlan,* Loud Speakers. *Dover Publications, Inc., 1960, p. 233. (Original edition published in 1934.)*



Professional machines generally arrange tape path and tape tension so that moving tape forces itself against head surfaces without additional pressure. Other recorders have pressure pads for one or more heads, which hold tape firmly against head surfaces. Design is less costly, but wear on heads is greater. Upper machine (Ampex 350) has three heads—erase, record, playback, from left to right. Separate play head permits listening to material recorded on tape, a moment after it has been recorded. Lower-priced machine below (Sony 200) has erase head and combined record/play head, and pressure pads. Metal flaps carrying pads spring up against head surfaces when machine is set to record or play. "Finger" between heads is tape lifter, which keeps tape from grinding against heads during fast wind or rewind.

can give you fair to good performance, and you get by with less tape. Why, at 1⅞ ips with double-play tape and recording quarter-track, you can get 17 hours of material on a single 7-inch reel! To show you how much things have advanced at the slower speeds, one machine claims response to 15,000 cycles at 1⅞ ips, while another claims response to 10,000 cycles at only $^{15}/_{16}$ ips. At the same time, noise, distortion, and wow and flutter are quite low, although not as low as at the higher speeds.

I should mention, by the way, that some self-contained tape recorders can be used as portable public address systems.

C: You said before that a high-quality machine will likely have more than one motor. Why?

S: The motor has a double job: to turn the tape reels and to turn the capstan that regulates tape speed. Designers feel that they get least wow and flutter and most accurate speed by using a separate capstan motor, leaving the job of turning the reels to two other motors, or just one other motor. When a single motor is used, you get a fairly complex system of belts and wheels. A three-motor transport is fundamentally simpler. On the other hand, a single-motor machine can also produce high-fidelity results. Several good units on the market have only one motor. They are cheaper, lighter, and smaller.

C: You also said that the better machines tend to have VU meters rather than "eye" tubes as record-level indicators. What's the advantage of one over the other?

S: The chief advantage of the VU meter is that it allows you to make quantitative adjustments in recording level. Depending on the program material you are recording, you can adjust gain up or down a certain number of decibels, as you decide. Also, a VU meter is a pretty stable device and doesn't change its characteristics much with time. In some top-flight machines, the VU meter is put to maximum use by having it read bias current, playback level, and sometimes erase current.

On the other hand, the VU meter has a severe disadvantage. It reads *average* level, not *peak* level, whereas much of the distortion we hear on tape is due to sudden, brief, strong peaks. The "eye" tube is electronic rather than mechanical, so it has little trouble following peaks and gives a substantially accurate idea of the peak levels being recorded. I think it is easier for the average person to use a magic-eye in setting recording level properly. At least one manufacturer of a very fine home tape recorder that meets high-fidelity standards has elected to stay with the "eye" tube, although the VU meter lends a professional glamor that is hard to resist.

To be fair, I should mention that tape machines with a VU meter usually calibrate the meter to compensate for its mechanical lag. That is, they provide a safety margin of about 6 to 8 db. But the safety margin you need varies with the program material and can sometimes be as high as 15 or 20 db. So you have to use a good deal of judgment when you use a VU meter.

C: Now what about a tape recorder with three heads instead of two?

S: Most home machines have two heads. One is for erasing the tape. The other is for both recording and playback. But a head that must serve two purposes is a compromise in design. You get better performance with separate heads, each specifically designed for its purpose. Another advantage of separate heads is that a machine can record and play simultaneously, so that you can monitor the signal you just recorded on the tape and check its quality. Also, it is easier to check frequency response, bias current, record-level calibration, and such on a machine that can record and play simultaneously.

C: You've certainly given me a lot to think about. Anything else I should know?

S: There probably are a few more things. But you've got a good start on what to consider in buying the tape machine to fit your needs.

C: OK, I want to think it over for a few days. Thanks very much for all your help.

S: Thank you, sir. I hope to see you back soon. END and the large excursion required of a direct-radiating surface. The "breakthrough" to modern designs actually occurred in *amplifiers*. When high-power amplifiers became available at moderate cost, it was no longer necessary to stress efficiency in speakers. The removal of this restriction made it possible to obtain a low resonant frequency by increasing the mass of the moving system. Fig. 3 shows how this flattens the response curve and extends the low-frequency range.

But this is not enough. The excursion required for a given acoustic output increases inversely as the square of the frequency. This means that a cone of a given size has to be capable of moving four times as far when the bass range is extended by an octave, and the motion must remain linear. Development of suspension systems has resulted in speakers capable of as much as ½ inch of peak excursion. If you think of such a suspension as a bellows capable of great extension, it is easy to see that it must be highly compliant as well. This, in turn, further lowers the resonant frequency.

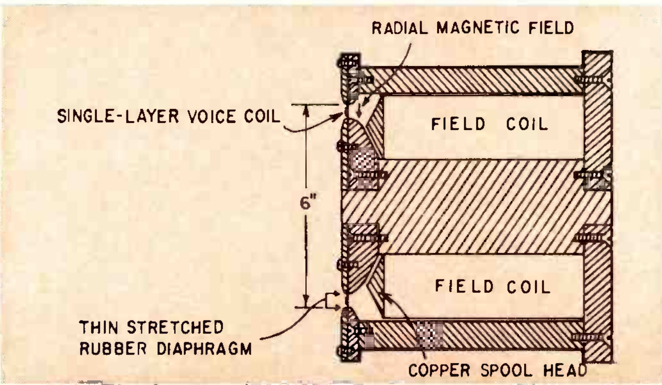


Fig. 2—Annular (ring) speaker of the 1920's.

The driving force must be maintained constant as the voice coil moves away from the center. This can be done by making the magnetic gap much longer than the voice coil, but at considerable expense. The more popular method is to make the voice coil longer than the gap. In this case, since part of the voice coil is always inactive, being outside the magnetic field, efficiency is reduced.

This high-compliance, large-excursion, low-resonance woofer can be put into a small cabinet.[4] Because it is itself fairly small, its high compliance is not decreased too much by the stiffness of the "air spring" behind it. Furthermore, the air spring is fairly linear and helps to reduce distortion still more. In some designs, cabinets are filled with loosely packed material, such as glass wool, to increase the effective compliance of the air itself, so that the cabinet acts like a larger enclosure.

Thus, this special bass speaker can function most effectively in a small enclosure. If you want more efficiency, greater power-handling capability and still lower distortion, you can get it with several woofers (or a larger speaker) in a larger cabinet. It's true that "a good big speaker is better than a good little speaker." How much better, and to what extent it justifies increased size and cost, is a matter for the user to decide.

Diaphragm designs

Early workers found that a rigid, lightweight diaphragm was very difficult to make. Lack of rigidity results in "breakup"—different parts of the diaphragm move at different velocities. These multiple modes of motion vary with frequency, and cause the frequency response of the speaker to have many sharp peaks and valleys. The audible effect is harshness, or lack of smoothness and transparency.

To solve this problem, researchers have improved diaphragm designs and materials to minimize breakup and

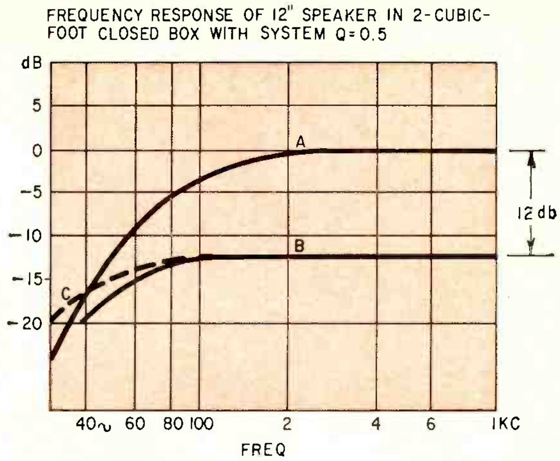


Fig. 3—Curve A shows the frequency response of a typical 12-inch speaker in a sealed 2-cubic-foot box with a system Q of 0.5. Curve B shows the same system with the speaker's mass increased by a factor of 4 (Q adjusted to remain at 0.5). Curve C is the system with the higher-mass speaker and the speakers compliance increased as well by a factor of 4. Note how the first change decreases overall output, but less repidly than before in the bass. Increasing compliance extends bass further.

worked at driving the diaphragm uniformly so that stiffness becomes relatively unimportant.

Experimenting with diaphragm designs has brought about great improvements in the performance of "paper" cones. The curved cone, the elliptical speaker, and innumerable combinations of ribs, beads, corrugations, reinforcements and damping means are a tribute to the ingenuity of cone designers and the innate perversity of inanimate objects. Woofers present no particular problem provided they are to be used only up to about 1,000 cycles, because heavy felted-

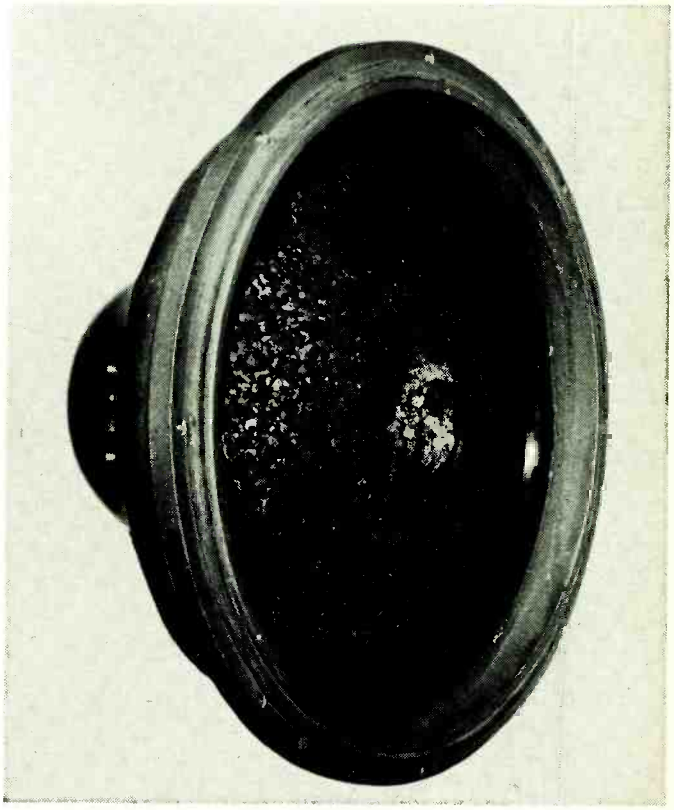


Fig. 4—IMF styrene solid-cone woofer.

[4] *V. Brociner, "Considerations of Speaker Size vs. Cabinet in Low Frequency Reproduction." Paper presented at 13th Annual Convention of AES, New York, Oct. 1961.*

paper cones can give a good approximation of piston action.

In tweeters, the small diameter needed to obtain good dispersion tends to minimize breakup. Some designs use phenolic or aluminum domes similar to those used in horn drivers. These are inherently very stiff and quite effective, but they, too, tend to break up more than you might expect. Softer materials are claimed to provide smoother performance. Attempting to use small diaphragms down to mid-range frequencies around 2,000 cycles creates the same sort of problem of excursion as in a woofer. The diaphragm just cannot move far enough. Hence there is a tendency to go to three-way systems, using a separate mid-range speaker.

It is in the mid-range that the problem of smoothness is really acute. Diaphragms must be reasonably large to permit power to be delivered at the lower limit of the mid-range, and consequently they have a greater tendency to break up than tweeters or woofers. To make matters worse, it is precisely in this frequency range that the ear is most sensitive to lack of smoothness. Also, this is where most of the music is.

Probably the quest for smooth response spurred designers on to find better materials for diaphragms and better means for driving them. Thin aluminum cones have been tried repeatedly, discarded and revived. Expanded polystyrene and polyurethane, made up of closed cells, caused a flurry of excitement and much experimenting. Here, at last, seemed to be a far superior material, with a high strength-to-mass ratio. So light is it that thick cones or even solid cones become feasible. These showed promise of overcoming problems of diaphragm breakup. The actual results were often quite disappointing; the response curves were not necessarily smoother than those of well designed paper cones.

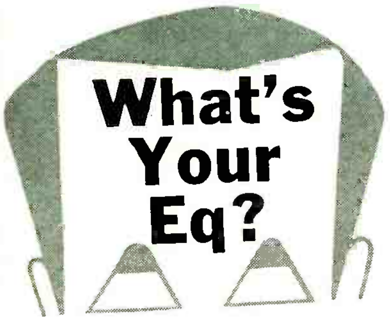
Attempts were made to improve the rigidity and surface hardness by manufacturing foamed plastic cones in such a way that a harder skin was formed,[5] and by cementing a thin aluminum sheet to the surface of the foam cone.[6] Results improved, and some designs have survived commercially. The solid-cone speaker is being manufactured in England (Fig. 4), as is the aluminum–foam "sandwich" cone.

Distributed drive

Since it proved to be so difficult to make a rigid diaphragm free from spurious resonances, designers have tried to find ways to drive the diaphragm so that it cannot break up.

We'll examine some of those ways—electrostatic systems being the principal one—and some completely coneless, diaphragmless ways of converting electrical energy into acoustic energy, in a second article, to appear shortly. END

[5] *P. B. Williams and James F. Novak, "Polystyrene Foam Loudspeaker Cones."* Audio, *May 1960.*
[6] *D. A. Barlow, "Rigidity of Loudspeaker Diaphragms."* Wireless World, *Dec. 1958.*



Conducted by
E. D. CLARK

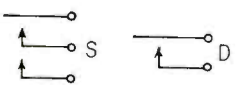
Three puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

Answers to this month's puzzle are on page 98.

Dialing

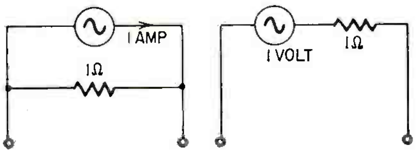
You are given a telephone dial with two switches (see diagram). S is closed whenever the dial is away from its rest position, and D is opened for each dial pulse. The stepper has two coils, one for reset and another that advances it one position each time it is energized. (Both coils may not be energized at once.)



Design a circuit to position a stepping switch to the number dialed, regardless of the stepper's initial position. You may use auxiliary relays as necessary, but no extra buttons or switches. The circuit should draw no power when the dial is at rest. (This was an actual design problem—switching audio in a broadcast station.)—*William M. Waite*

Which Is Which?

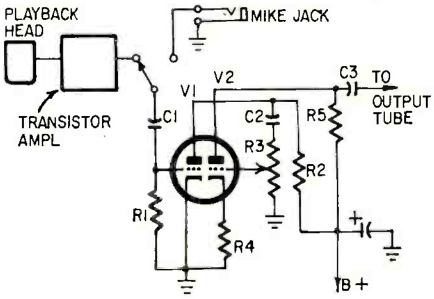
Norton's theorem states that these two circuits are equivalent as far as any external load is concerned. That is, if a resistor is connected in turn to each pair of terminals, the voltage drop across the resistor in each case is equal as is the current flow.



Assume you have two black boxes, one containing the 1-amp current source with 1-ohm shunt resistor, and the other containing the 1-volt source with 1-ohm series resistor. If you are allowed to make any measurement you wish, can you determine which box is which?—*Anthony Joseph Miller*

Distorted Recording

The owner's complaint on this tape recorder was, though it played prerecorded tapes with good fidelity, playback from music recorded with a microphone was distorted and tinny.



Previous trips to shops had netted, in addition to a lot of headaches for the owner, three new tubes, two resistors, record-playback head and a filter capacitor. A new microphone made no difference. A hint (perhaps)—using a patch cord connected into the mike connector, I recorded music from an FM tuner. The playback was *almost* normal —at least much better than when the microphone was used.

The trouble was one of the components in the circuit. When you pick out the right one, there will also be a legitimate, plausible reason. What's the trouble?—*Wayne Lemons*

50 Years Ago

In Gernsback Publications
In March, 1915
Electrical Experimenter

Electricity in Modern Warfare, by H. Winfield Secor

Talking from New York to San Francisco

Spectacular Effects with Spark Coils

Radio Time Signals and the Public

Connections for Radio-Telegraphic Sets

MIKE TECHNIQUE FOR AMATEUR RECORDISTS

Ever felt an itch to graduate out of the mike-in-the-middle-of-the-dinner-table class? Here's how to capture bigger sounds better

By IVAN BERGER

The prime requisites for making a good recording are good ears—yours and your tape recorder's. Your recorder's ears are its microphones. Buy the best you can—excellent recordings can be made with $50–$100 mikes, good ones with mikes costing $25 to $50—if you want all the sound quality your recorder can deliver. Your own ears don't feed a recorder; they feed a computer instead—your own brain, constantly weighing and judging the sound quality against your standards.

Your ears and your standards, as much as the microphones, will make the recording; you can develop them. Listen to live performances of the instruments and the performers you'll be taping. Then listen *critically* to commercial recordings, asking yourself how they succeeded and how they failed in capturing the sound you heard in live performance.

What distinguishes a good recording from a so-so one is *balance,* between individual instruments or groups, and between the musicians and the "room sound"—reverberation and background noise—of the hall in which the recording is made. Assuming that the performing group itself is a balanced one, this first requirement should not be too hard to achieve. The usual technique is to mount microphones fairly high, so that the performers in the front row won't block off the performers in the back, and symmetrically, so that all performers are at approximately equal distances from the microphone.

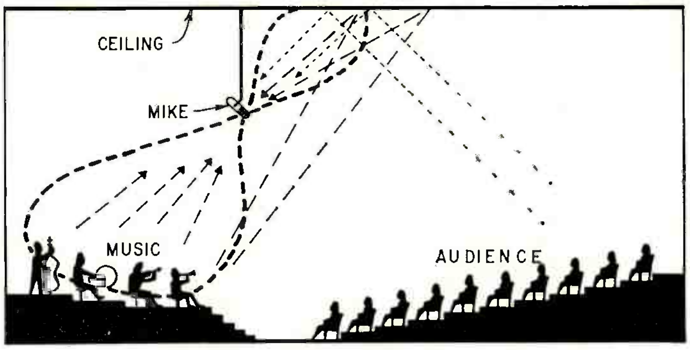


Fig. 1—One fruitful source for good recordings is church or school choir concerts. A bidirectional mike is useful here: mounted high and tilted as shown, it picks up music directly along wth reverberation from ceiling. Audience noise is largely rejected.

Microphone pickup patterns make a difference here. Bidirectional mikes have a figure-8 pattern with long, narrow lobes (Fig. 1) and need to be placed farther back if they are to cover as wide an area as unidirectional (cardioid) types. Omnidirectional (or "nondirectional") types also cover a wide area, of course.

One source of difficulty in balancing instruments is the brass section. Brass instruments beam their sound in more of a straight line than other instruments. If your trumpets point too directly at the microphone, they may sound overly bright; if they point too far away, they may lose their sparkle altogether. Become familiar with how these and other instruments project their sound.

If the group is not balanced, you will have to shift microphones—and sometimes musicians—until the microphone picks up a balanced sound.

Reverberation and perspective

Once you have balanced the musicians against each other, you must choose a perspective balance, near or far. Perspective depends upon the ratio of direct to reflected sound. The closer the microphone is to the performer, the clearer and more distinct the recording will be—but more distant recordings allow groups to blend more, and give more sense of the spaciousness (if any) of the hall or room the recording is made in.

You can work a bit farther back in stereo than you can in mono, since your ear's ability to pick out sounds is enhanced by stereo, making stereo recordings with lots of reverberation more distinct than the same recordings heard monophonically.

Sometimes a closer pickup will be desired, sometimes a more reverberant one. All else being equal, you might want more reverberation to lend a lonely quality to a sad, slow ballad than would be wanted for an up-tempo number. Extremely reverberant recording setups can be used only with slow pieces, in which each note has time to die away before the next is played.

High-frequency energy seems to be more easily lost with distance or when recording off the microphone's major axis

Two B & O bidirectional ribbon mikes were used for soloists in this church choir recording (stereo). Overall choir and organ pickup was left to two Syncron cardioid condenser mikes, suspended about 12 feet above the area in this photo. Two mikes might have been enough, but four gave an opportunity to experiment.

than low, and the mechanical noises of an instrument—clattering from a keyboard, or the bow scrape of a violin—disappear with distance, too.

My most recent recording was of a choir and organ in a fairly reverberant church. I used three microphones. After some experiment, I decided that the best position for the main mikes (both omnidirectional) was about 12 feet above the floor, with each mike about 8 feet from the center line of the apse. The third mike—a cardioid, to block sound from the conductor's feet, behind it—was in the center on a low stand in front of the soloists; this mike was bridged across both channels.

The high position of the main mikes had several advantages in this setup. First, high above the audience, they picked up comparatively little people-noise (but if the audience had coughed any more than they did, I'd have had to use cardioids). Second, the high position helped equalize the distance between the front and back rows of the choir (Fig. 2). Third, it picked up the organ better, since the organ loft was well above the heads of the choir, and last, it gave

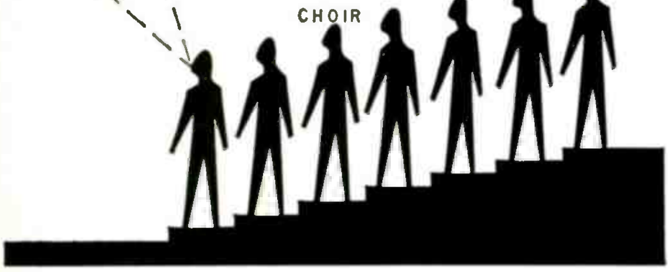
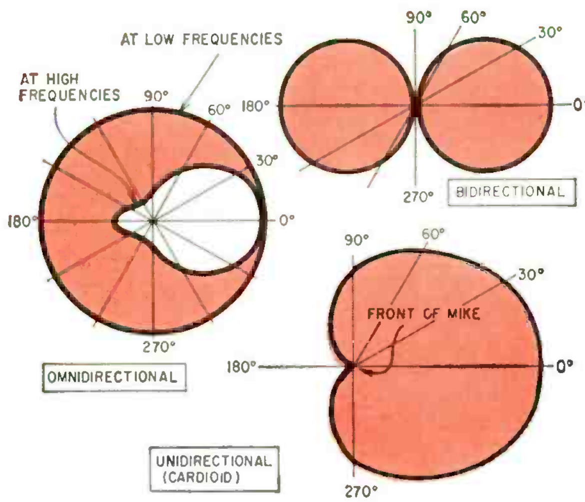


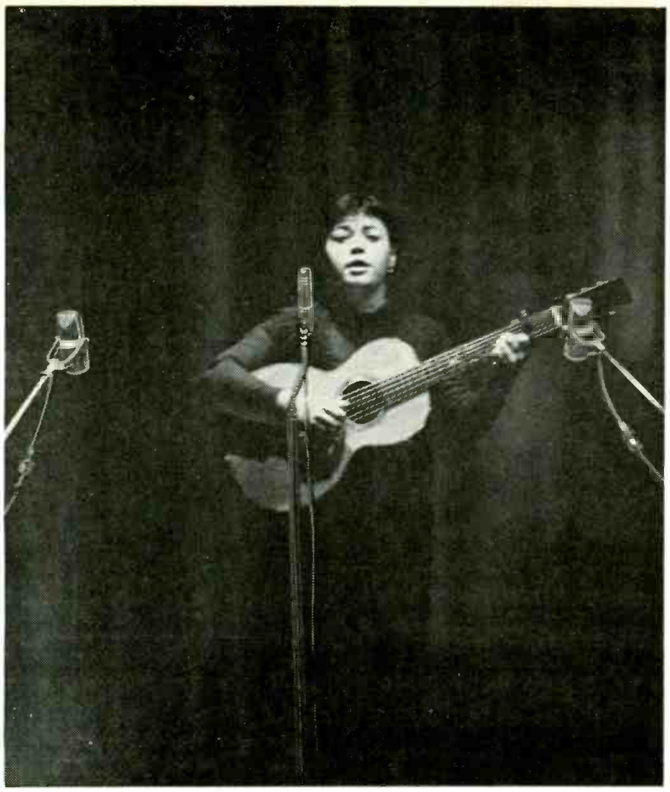
Fig. 2—A high mike position helps reduce loudness differences between performers in front and rear in larg choral or orchestra groups.



Three basic microphone types are mentioned in this article, named for their pickup characteristics rather than for the way they transform sound into electrical signals. The **omnidirectional** microphone is one that picks up sound about equally well from all directions (Latin omnis: all). At high frequencies, it tends to become slightly directional. Its polar pattern—a graph of electrical output plotted against angle of incidence of the sound—is circular. Because of the increasing directionality at high frequencies, the pattern is squeezed into a kind of lemon shape—the wide part indicating the fairly high response at the front of the mike. (The microphone is always assumed to be at the center of the polar graph—where the 0–180° and 90–270° axes cross.)

The **bidirectional** mike (Latin bi-, two) responds equally well to sound coming at it from either direction along a center axis. At right angles to that axis, the response is theoretically zero (as shown by the graph line coming in toward the center as it approaches the 90° and 270° azimuth lines.) Most bidirectional mikes are ribbon types, although some condenser mikes with multiple elements can be switched to a bidirectional pickup pattern.

The **unidirectional** (Latin uni-, one) is also called a **cardioid** microphone (from Greek **kardia**, heart) because of the vaguely heart-shaped pattern of its polar response curve. (The Germans, with just as much logic, call it kidney-shaped.) It responds most strongly to signals coming at it directly from the front, and less to signals coming from the side, until at the back there is theoretically no response at all. Good cardioids are expensive, but probably the most useful single microphone design. The vast majority are dynamic, but most condenser mikes offer a switchable cardioid position. (Simple condenser mikes are usually omnidirectional.)



Two Sony cardioid condenser mikes were the mainstays of this stereo recording of Ana Perez. Her strong voice made this placement suitable; for softer-voiced person, mikes would have been set higher and closer. Center mike, a PML condenser, was mixed to both channels in some takes, to reduce separation.

enough distance from the choir to achieve the blending I wanted.

The gain on the center mike, close to the soloists, was kept low enough not to overemphasize them when they sang with the choir, but high enough to give lifelike presence when they did their solos.

Twelve-foot stands are not commercially available. You can make your own out of light-stands and a piece of ⅝-27 threaded pipe, or—as I usually do when such tall stands aren't available—hang your mikes from a rope or line strung across the hall. (Nylon fishing line is good—strong, thin and almost invisible.)

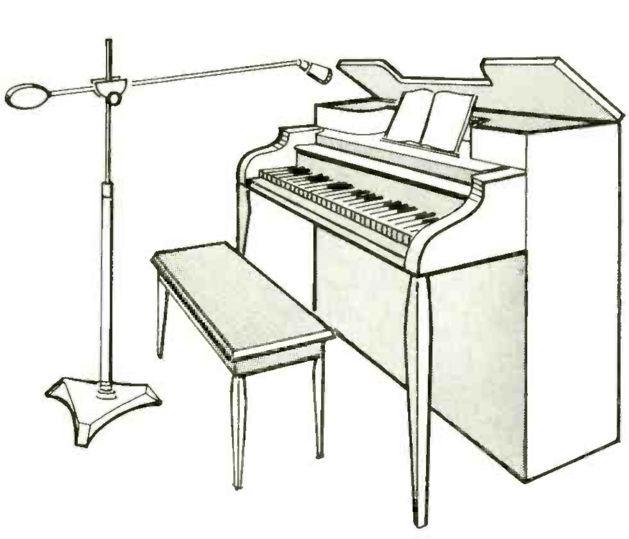


Fig. 3—Inexpensive boom extensions for floor-type mike stands are fine for reaching in, out or over.

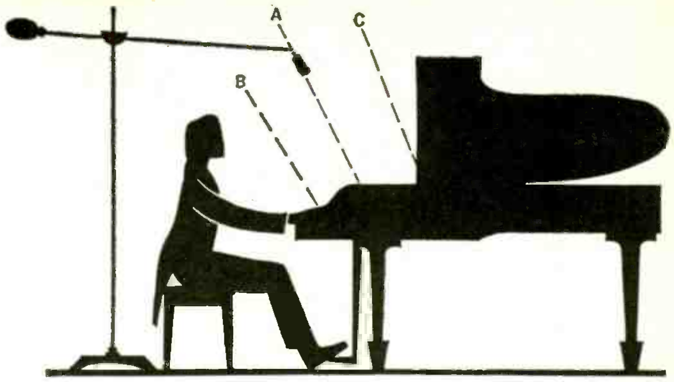


Fig. 4—A single bidirectional (or sometimes a cardioid) microphone can do justice to a singer and his own accompaniment (not necessarily on piano) if mike position between the two is chosen carefully. Position A in this sketch might yield just the right balance between voice and piano; position B would emphasize the voice (or compensate for a weak voice); position C would play down the voice compared to the piano.

Recording a singer

For an in-concert recording of Ana Perez, a rising young folk-singer, I used quite a different approach. Two cardioid microphones (Sony C37-A) were used in a toed-in, spaced-out configuration. The microphones were about 5 feet apart, and about midway between the singer's mouth and the sound hole of her guitar, for proper balance. Since the Sonys can be adjusted for cardioid or omnidirectional operation, I could have used them either way—but the concert hall was a small, hard-surfaced one, which would have reflected every cough and twitch of the audience right into the mikes had they not been fairly dead to the rear. So I chose cardioid. A third microphone—a PML condenser cardioid—was mounted closer and higher for extra presence on the voice, if needed, but wasn't used in the final recording.

All three mikes for the Solo-and-guitar recording and the center mike in the choral recording were mounted on Atlas "Baby Booms"—most worth-while accessories which help you get your mikes into otherwise inaccessible spots. Thanks to the booms, I was able to stand the mikes for Miss Perez on the firm floor, rather than the flimsy stage of the hall where we recorded. Yet I was able to push them far enough over the stage to get within a reasonable distance of her.

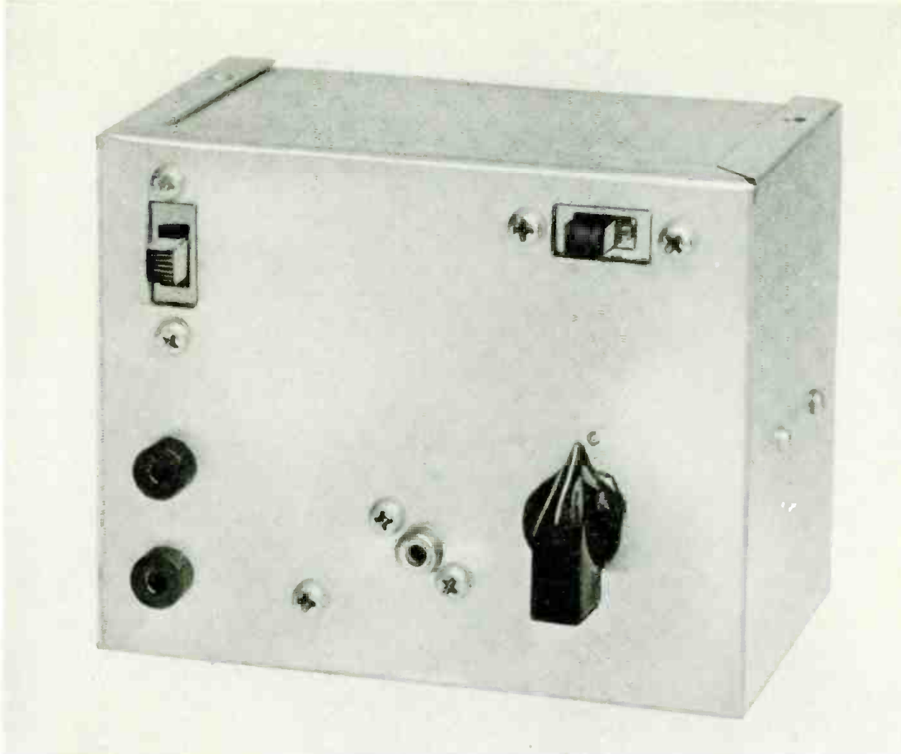
Another common use for a baby boom is over a piano (Fig. 3). It can also be used as an extension to raise a mike farther into the air than the upright stand normally reaches.

Bear in mind that you can balance recordings in many ways, not just by moving your microphone closer to or farther from your musicians. Take a singing guitarist, for example. Raise the mike, and the voice will dominate; lower it, and the guitar takes over. Which sounds best depends on the effect you're trying for, and the relative strengths of voice and instrument.

A simple approach to balancing two instruments or voices: With a bidirectional mike between them, you can vary their relative loudness by moving the mike closer to one or the other. Fig. 4 is a variation of this, for a singer accompanying himself on grand piano: the rear of a bidirectional mike picks up piano sound reflected from the open top, and the front picks up the singer.

The specific problems of microphone placement are too numerous to be covered completely, even in a book. No setup can serve as more than a general guide; even the setup for a solo piano will vary with the mike used, the room, the music, the pianist and the piano. To nobody's surprise, practice alone makes perfect. But these general tips should get you off to a good start. END

By G. POSKLENSKY



Tone Generator and Inductance Checker

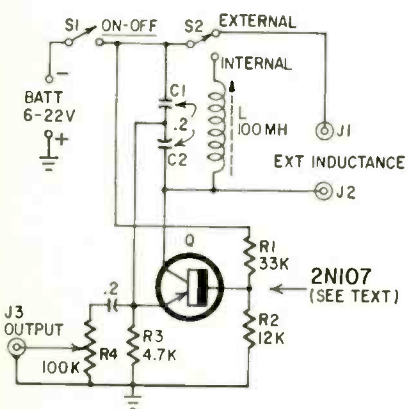
One-transistor, "two-terminal" oscillator generates audio tones and checks inductances from 5 to 600 mh

Did you ever need an audio signal in a hurry and wish that you didn't have to use the big generator with the long cord? Then build this little tone generator. Not only can you provide an audio signal with the flip of a switch, you can also use this gadget for checking television fly-backs, yokes, linearity and width coils, and to determine the inductance of coils between 5 and 600 millihenries.

Just in case you should need tones other than the one provided by the internal tuned circuit, you can connect to jacks J1 and J2 any inductance between 5 and 600 mh, flip the switch to EXTERNAL and get a different audio frequency, from 500 to 15,000 cycles.

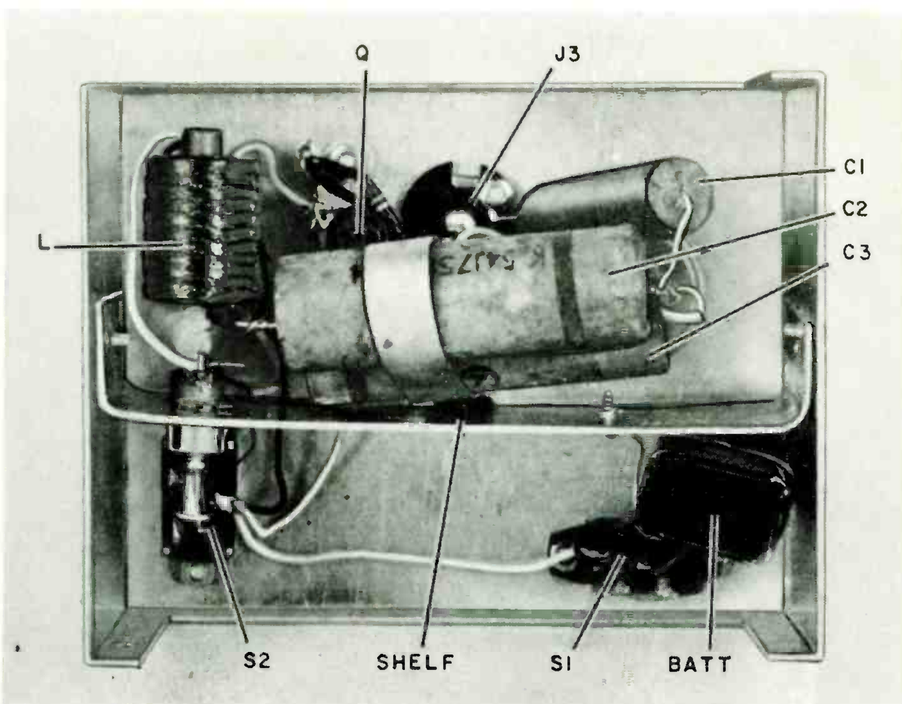
The circuit is simple. L, C1 and C2 and an inexpensive audio transistor make up a Colpitts oscillator. L and the capacitance of C1 and C2 in series determine the frequency. All parts, including the coil, are available at local parts supply stores.

A 2,000-cycle tone is developed when an adjustable 100-mh linearity coil is connected to the two 0.2-μf capacitors C1 and C2. The exact frequency is determined by the value of the adjustable inductance, and can be changed by altering the position of the coil slug. The



Circuit is simple and most values non-critical.

C1, C2, C3—0.2 μf, paper, (see text)
L—100-mh adjustable coil (Miller width control 6324; Thordarson-Meissner WC-30 or equivalent
J1, J2—banana jacks
J3—phono jack
Q—2N107 (G-E) or equivalent
R1—33,000 ohms
R2—12,000 ohms
R3—4,700 ohms
R4—pot, 100,000 ohms
S1—spst slide or toggle switch
S2—spdt slide or toggle switch
BATT—9-volt transistor radio battery (any voltage from 6 to 22 may be used)



Central shelf helps support large parts. You might very well be able to whip up one of these without actually going out and buying anything!

S-e Aug P 14

BENCH TESTED

Said the man who tried it: "The unit works well and as expected. The one-transistor circuit is simple and not very much is likely to go wrong with it. I tried several substitute transistors and all worked well. By reversing battery polarity I was able to use n-p-n transistors. When S2 is switched to external, any desired inductance can be added and almost any tone in the mid- and upper audio range can be obtained."

greater the inductance, the lower the audio frequency.

Coils with inductances between 5 and 600 mh can be checked by connecting them to the EXTERNAL jacks and moving switch S2 to EXTERNAL. Listen for the tone, or watch it on a scope. Open or shorted coils won't oscillate. Even shorted flyback secondary coils can be detected. Don't forget to disconnect one end of the damping resistor across vertical yoke windings. That resistance is low enough to kill oscillations.

To determine exact frequency, connect the generator's output to a scope's vertical input, and a known audio signal from an audio generator to the horizontal input. Vary the calibrated generator until you see a circle or an ellipse. The two frequencies are then equal.

Coil inductance can be determined by connecting the unknown inductance, between 5 and 600 mh, to the EXTERNAL jacks. Listen to the tone or measure its frequency. A tone in the vicinity of 15 kc indicates a low inductance, around 5 mh. A 500-cycle tone means a high inductance. The exact inductance can be determined by substituting the known audio frequency into this formula:

$$L = \frac{10^7}{4\pi^2 f^2}$$

where L is inductance in henries, and f is frequency in cycles per second.

Construction is easy. I made a little shelf to hold the battery and the larger components. I used 0.2-μf 600-volt capacitors because they were readily available. If you want to shrink the size of the unit, try some 50-volt capacitors. (Note that the formula above holds only for an effective series capacitance of 0.1 μf.)

Any inexpensive p-n-p audio transistor can be used. The G-E 2N107 is fine. An n-p-n transistor can be used if you reverse battery polarity. A 9-volt battery was chosen because it is cheap. Any supply up to 22 volts can be used for greater output. Mount transistor and resistors on a four-terminal strip. The box is a 5 x 4 x 3 inch Minibox, or equivalent.

The generator's output frequency is relatively free of distortion and varies little with changing loads. END

Sweep-Align AM I.F.'s

Use a scope and sweep gen to set AM i.f.'s for wide or narrow bandwidth, or anything between

By ELMER C. CARLSON

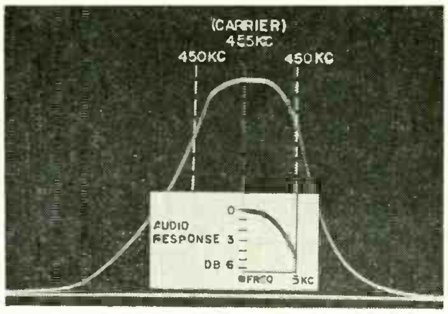


Fig. 1—I.f. bandwidth has direct effect on af response. Peak at a sideband will accentuate that sideband, and that frequency in audio response.

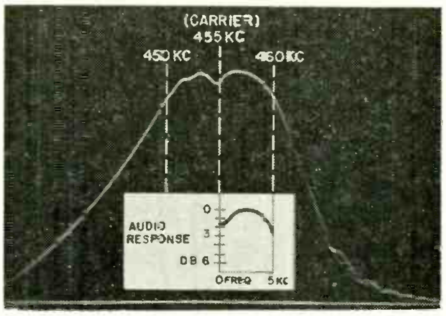


Fig. 2—A dip in i.f. response will cause a corresponding dip in audio response.

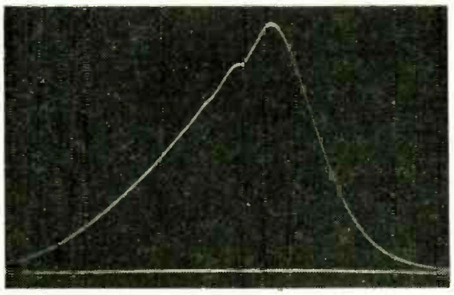


Fig. 3—A damped meter movement across avc line can give lopsided peak like this. Actual peak at nominal center frequency (455 kc) is often passed before meter reads maximum.

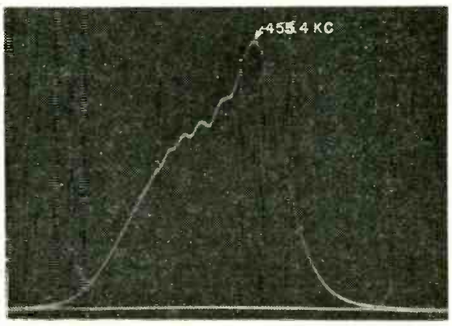


Fig. 4—When you align for maximum audio output, you're likely to peak i.f. on a tone-modulated sideband instead of on carrier.

SWEEP ALIGNMENT AT 455 KC CAN BE just as useful for troubleshooting as it is for improving audio quality. Sufficient bandwidth in the response curve of the i.f. amplifier removes one common source of frequency distortion.

The response curve of the i.f. amplifier is most important since it is the sidebands of the transmitted signal that carry the power for the audio.

In many cases, correct 455-kc i.f. alignment introduces its own frequency/amplitude distortion. The rounded top of the response curve (Fig. 1) acts much like a de-emphasis network would, since it effectively decreases the high frequencies of the audio modulation. When the station carrier is tuned to center at the top of the curve, the top is where the low-frequency (bass) sidebands are. The slope contains the sidebands of the audio modulating frequencies up to about 5 kc. A dip in the center of the response curve (Fig. 2) can noticeably reduce the bass response of even the small-speaker, inexpensive table models.

The response curve in Fig. 3 is typical of that obtained by using the common peak-alignment method with a fixed-frequency generator and a voltmeter on the avc line. [Some technicians feel that avc should always be disabled, lest it obscure changes of signal strength as alignment is varied. Shorting avc to ground is one way, or it can be disconnected from the detector or avc diode. Then the diode still provides a dc voltage proportional to carrier strength, for monitoring alignment. If avc is left connected, signal must be kept so low that not more than a few millivolts of dc appears across the avc line.—*Editor*]

The response curve is less smooth when the set is aligned for maximum audio output (usually at 400 cycles). The sharp peak in the i.f. response in Fig. 4 is about 455.4 kc (455 kc i.f. plus 400-cycle modulation). That is, the i.f. has been peaked on the upper sideband, rather than on the carrier.

The audio reproduction of receivers aligned by the methods that produced the response curves of Figs. 3 and 4 was noticeably poorer than that from the same receivers sweep-aligned for an i.f. response like that in Fig. 1.

A waveform like that in Fig. 5 is

often caused by feedback in overpeaked i.f. amplifiers. The large ripples are apparently the zero beat between the sweep generator frequency and the frequency of oscillation of the i.f. amplifier. Oscillation can usually be stopped by broadening the response curve.

Open bypass capacitors cause oscillation in some i.f. amplifiers. Here the bandwidth is more nearly normal (Fig. 6). That's a clue to the cause of oscillation.

Fitting out a generator

Sweep generators that cover 455 kc are not common, and only one is inexpensive. The Knight sweep generator is the only kit instrument designed and calibrated for frequencies as low as 300 kc. Tuning at these low frequencies is a little touchy since the instrument is primarily for FM and TV i.f. and rf amplifiers.

Vernier tuning can be a great help in setting up the generator for 30- to 50-kc sweep at 455 kc. While many vernier drives can be added to the generator tuning control, you can make a simple one. Installing it is as easy as removing and replacing the original tuning knob. You don't have to make any mounting holes in the panel. For a permanent installation, cement the device in place, or hold it with a self-tapping or machine screw concealed under the main tuning knob.

This friction drive (Fig. 7) gives an additional 5:1 tuning ratio which makes it easier to pick out 455 kc. The added knob (Fig. 8) does not interfere with the normal tuning since the drive does not rest against the large knob except when it is being used.

Construction and assembly details of the drive are given in Fig. 9. Dimensions can be varied to suit the rubber tubing used for the friction drive. The ¼-inch rod can be a piece of control shaft.

Sweep alignment is not meant to replace the signal generator method—only to supplement it. Since normal marker-injection methods are usually useless with a 10-kc bandwidth i.f. amplifier, align first with a fixed-frequency generator at 455 kc. Use a vtvm to read the avc voltage to peak the i.f. at the generator frequency. Use an unmodulated signal for the final peaking.

Let the sweep generator warm up for a half hour or more to reduce drift. This is a common procedure even with high-priced laboratory equipment.

The sweep generator is centered on 455 kc by reducing the sweep width to as near zero as possible, leaving some 60-cycle modulation to help identify the signal. Tune carefully until you hear the 60-cycle modulated signal.

With a scope connected across the detector load, adjust the sweep frequency, width and phasing controls until the response curve is displayed near the center of the scope screen. Then touch up the tuning adjustments of the i.f. transformers until you get a suitable response. END

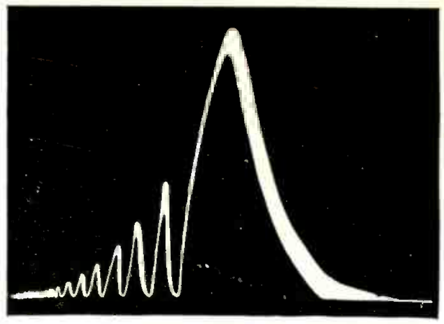


Fig. 5 — In some chassis, overpeaking leads to i.f. oscillation. Feedback occurs through stray wiring capacitances.

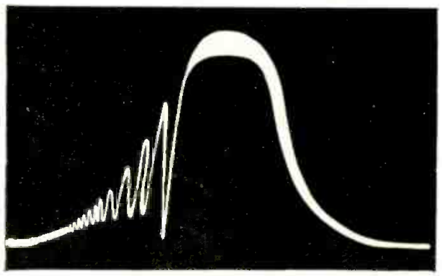


Fig. 6—Oscillation, but with a less-sharp peak, indicates an open bypass capacitor.

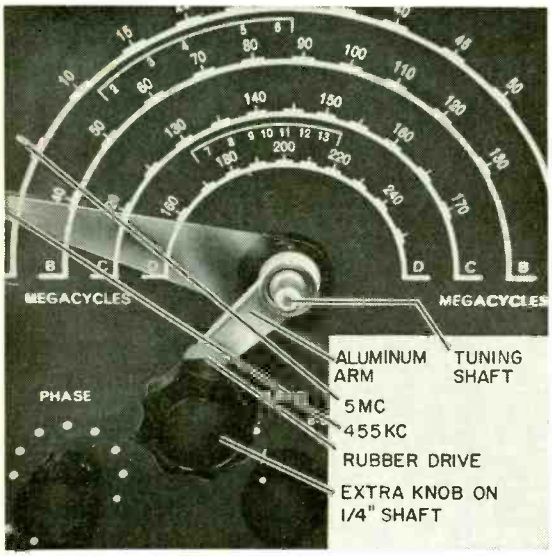


Fig. 7 (left) — With main tuning knob removed, slip vernier drive into place. Rubber pad under end of drive wheel bracket protects panel finish.

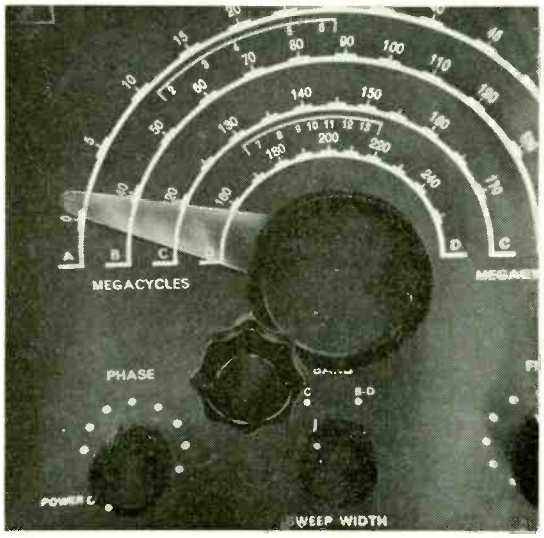


Fig. 8 (right) — Use either knob to tune. Auxiliary drive doesn't interfere with regular use; rests on main knob only when pressed there in use.

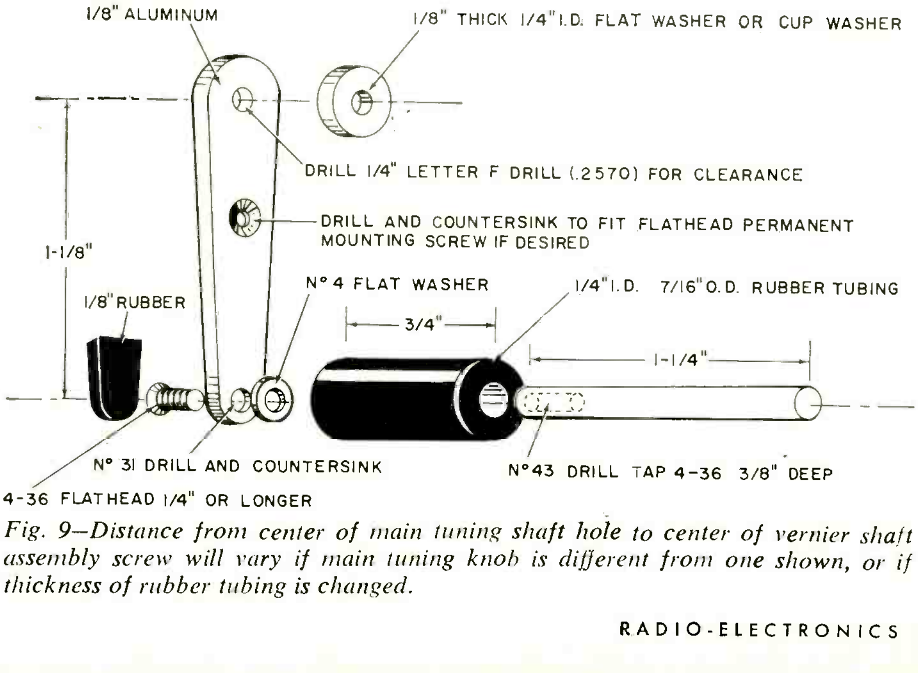


Fig. 9—Distance from center of main tuning shaft hole to center of vernier shaft assembly screw will vary if main tuning knob is different from one shown, or if thickness of rubber tubing is changed.

Automatic Degaussing

By HOMER L. DAVIDSON and ERIC LESLIE

SOME 1965 COLOR RECEIVERS FEATURE automatic degaussing. (But mostly in the higher-priced sets, so don't throw away that degaussing coil yet.)

In the G-E's, RCA's and Admiral's, the tube is demagnetized each time the set is turned on. Current, either from the primary or secondary of the power transformer, is passed through the degaussing coils. RCA and G-E have the demagnetizing circuit in series with one leg of the transformer secondary as in Fig. 1. The degaussing coils and a varistor are in series across a thermistor. The thermistor has about 120 ohms resistance when cold. The varistor's resistance is fairly high with no voltage applied.

When the set is first turned on, the thermistor resistance is high and about 60 volts ac appears across the coils and varistor. The varistor's resistance drops and about 2 amps flows in the circuit. Current through the thermistor heats it, lowering its resistance and reducing the

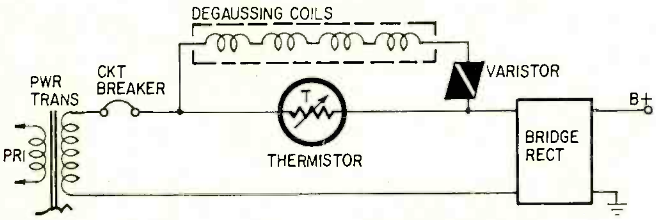


Fig. 1—The circuit used in RCA and G-E sets is possibly the simplest, consisting only of a varistor, a thermistor and the degaussing coils.

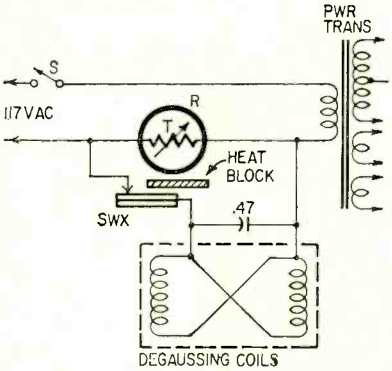


Fig. 2—The Admiral AMF (Automatic Magnetic-Free Circuit) uses a thermal relay to cut out the degaussing coils.

voltage across the degaussing coils and the varistor. The varistor's resistance increases as the thermistor's decreases. Within about 20 seconds, the magnetic field drops from a maximum at 60 volts, 2 amps to a negligible 1 volt at 0.5 ma.

The Admiral circuit (Fig. 2) is almost identical. There are two coils, each consisting of about 200 turns of No. 24 wire on a form approximately 12 x 5 inches. They are tucked around the front edge of the picture tube, on each side. Besides a thermistor, there is a bimetal switch (SWX) and a ceramic heat block. When the set is turned on, more than half the primary voltage is across the degaussing coils. The thermistor heats and its

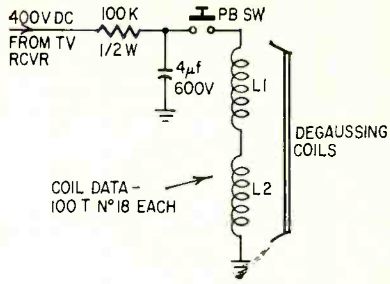


Fig. 3—The Packard Bell system uses a damped wave train from an LC circuit (the degaussing coils and 4-μf capacitor).

resistance drops to 0.4 ohm, which almost shorts the coils. A ceramic thermo-insulator between the thermistor and the switch is heated slowly and, when it becomes warm enough, the switch opens. The back emf is dissipated in the resonant circuit formed by the coils and the 0.47-μf capacitor. If the set is turned off, it is necessary to wait until the switch cools and closes before the set can again be degaussed (about 5 to 8 minutes).

The Packard Bell circuit (Fig. 3) is somewhat different. Besides the two degaussing coils, a 4-μf 600-volt capacitor is connected to the dc supply through a 100,000-ohm resistor. A pushbutton switch discharges the capacitor through the coils. The "ringing" produces a damped alternating wave train about 15 milliseconds long at roughly 570 cycles.

In this circuit, degaussing is, of course, instant, and the set owner can see if his tube is magnetized by pressing the button and watching the results.

A kit has also been announced. With it, a technician can add automatic degaussing to most color sets, It is made by Colman Electronics, Amarillo, Tex.

A big advantage of instant degaussing is that the TV set can be installed or moved without producing color impurities. It will cut out many nuisance calls for the TV service technician. END

Photo 1—One of the degaussing coils installed near the rim of the tube in an RCA set.

Photo 2—Closeup of main features (thermistor and resistor) of the RCA degaussing circuit.

See MAY p 4

Pretty much the last word in simplicity, this instrument is really accurate and features separate calibration for 4-, 6- and 8-cylinder engines

Tachometer-Dwellmeter for Your Car

By J. J. CONRADI*

IN OUR SEARCH FOR IMPROVED INSTRUMENTATION for fuel research at Shell Oil, we have developed a portable tachometer considerably more reliable than the commercially available ones we have used. We have built several and are very pleased with their performance.

The circuit of the tachometer and dwell indicator is shown in the schematic diagram. The circuit needs only three external connections: one to ground, one to the 12-volt supply and one to the distributor side of the ignition coil primary.

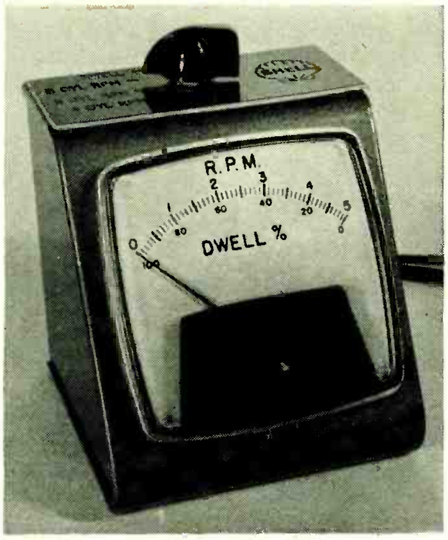
How it works

With the distributor breaker points closed, the current through primary 1 magnetizes the core to saturation in one direction. The current through primary 1 is limited by R1. When the breaker points open, the current through primary 2 produces a magnetizing force opposite to that in primary 1 and about twice as large. Therefore, the core is magnetized to saturation in the opposite direction. The current in primary 2 is limited by the sum of R2 and the resistance of choke L. The combination of L and capacitor C filters out the high-frequency voltages that appear across the breaker points.

Each time the core magnetization is reversed from saturation in one direction to saturation in the other, a pulse is induced in the secondary winding. Pulses of one polarity are rectified by diode D1, and the meter indicates the average value of the rectified current, which is proportional to engine speed.

Resistors R12, R13 and R14 are adjusted to calibrate the tachometer for 4-, 6- and 8-cylinder cars. Zener diode D2 makes the tachometer indication virtually independent of battery voltage.

The dwell-indicating circuit is conventional. With the breaker points open, current flow through D3 produces a stable voltage at the Zener value. This current is limited by R7 and the resistance



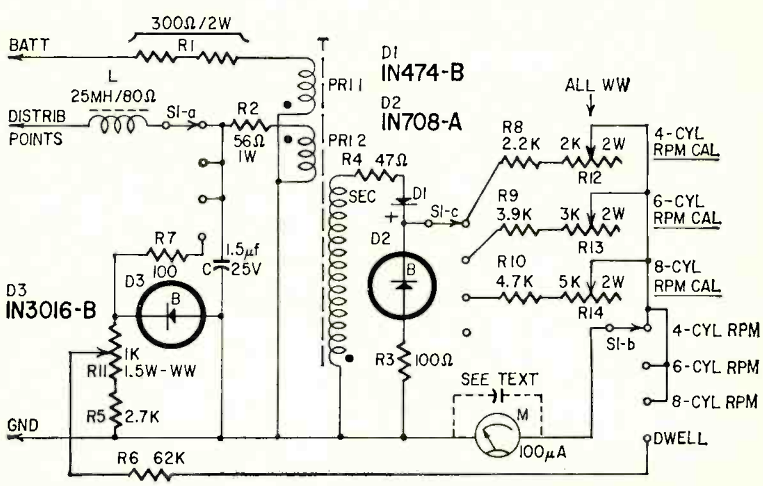
Tach-dwellmeter is housed in box only 4 inches across.

of choke L. The Zener voltage is divided by resistors R11 and R5. R11 is adjusted so that the current through R6 and the meter causes full-scale meter deflection. Operation of the distributor breaker points results in an average current through the meter, proportional to the fraction of the time that the points are open. The fraction of the time that the points *dwell* (are closed) is indicated directly by a scale that reads from right to left in percent of full scale.

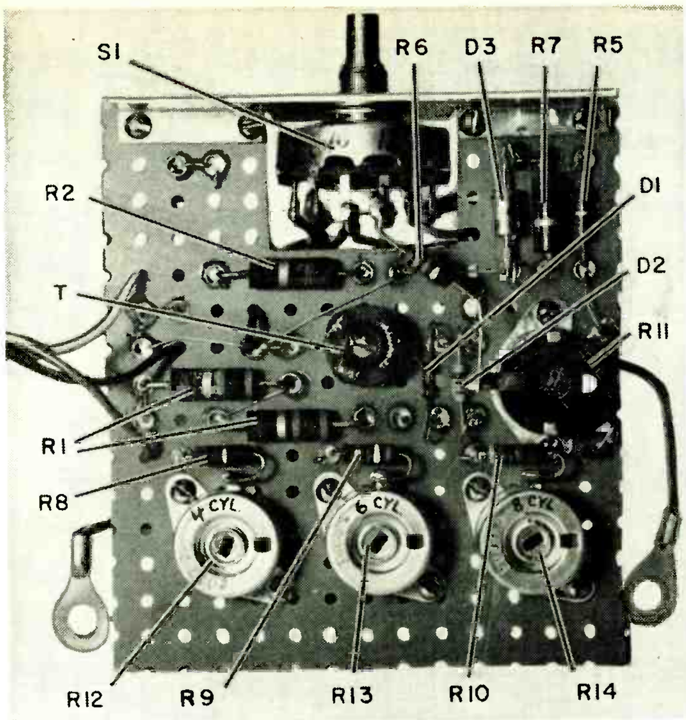
The face of the meter was modified by cementing to it a new paper face containing the desired numbers and lettering. A cutout in the new face lets the old graduations show through, so that the accuracy of the original meter is not changed by slight misalignment of the new face. The new face reads rpm from 0 to 5 in thousands, from left to right. The smallest graduations correspond to 100 rpm. The DWELL % scale reads from right to left from 0 to 100. The smallest scale graduation is 2%, which corresponds to about 2° of

C—1.5 μf, 25 volts, ceramic (Sprague 5C-14)
D1—1N474-B
D2—5.6-volt Zener diode (1N708-A)
D3—6.8-volt Zener diode (1N3016-B)
L—25-mh rf choke (80 ohms) (J. W. Miller 6308 or equivalent)
M—100-μa meter (G-E DO-91 or equivalent)
R1—300 ohms, 2 watts (two 150-ohm, 1-watt resistors in series)
R2—56 ohms, 1 watt
R3—100 ohms
R4—47 ohms
R5—2,700 ohms
R6—62,000 ohms
R7—100,000 ohms
R8—2,200 ohms
R9—3,900 ohms
R10—4,700 ohms
R11—pot, 1,000 ohms, 1.5 watts, wirewound (Continental-Wirt WC818A or equivalent)
R12—pot, 2,000 ohms, 2 watts, wirewound (Mallory FL-2K or equivalent)
R13—pot, 3,000 ohms, 2 watts, wirewound (Mallory FL-3K or equivalent)
R14—pot, 5,000 ohms, 2 watts, wirewound (Mallory FL-5K or equivalent)
All resistors ½ watt, 10% except as noted
S1—3-pole, 4-position rotary switch (Mallory 3234J or equivalent)
T—pulse transformer (see text and schematic)
Perforated board, miscellaneous hardware

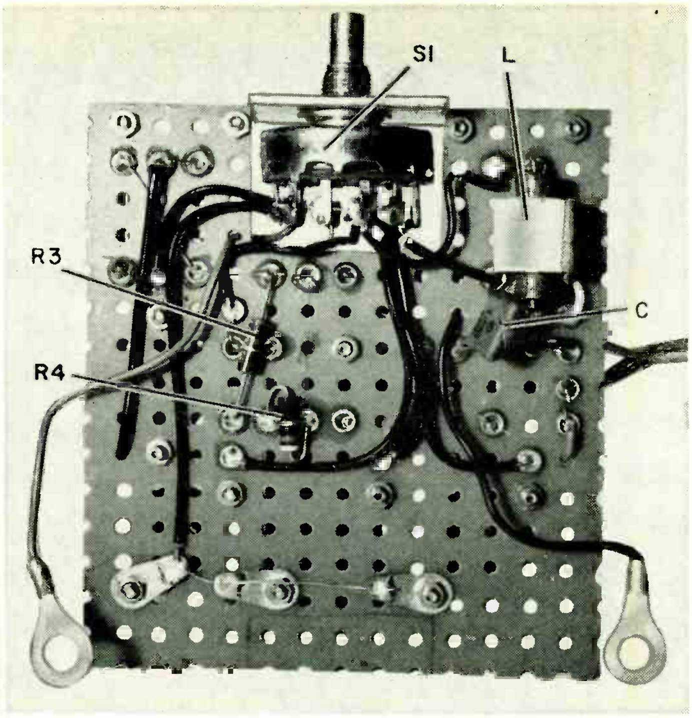
Circuit of the combined tachometer and dwell meter. Pulse transformer T is wound as described in the text. Phasing is important: the same pulse polarity should appear at each terminal marked with a dot.



*Shell Oil Co. Research Laboratory, Wood River, Ill.



Top of perforated circuit board clearly shows most of the wiring. All calibration adjustments are easy to get at.



Underside of board carries the rest of the wiring.

crank angle for an 8-cylinder engine.

Indicating the dwell of the breaker points in percent of the total cycle (dwell plus break) instead of in degrees of crank angle simplifies the instrument without spoiling its usefulness. You need only convert the recommended dwell angles for cars to percent of dwell.

A 10-μf capacitor across the meter terminals will help to prevent too serious pointer bounce in poorly damped meters.

The tachometer circuit can be used in positive- or negative-ground 12-volt systems, but *the dwell circuit is for negative ground only.*

Two ways to calibrate

We calibrated our tachometers on a Sun distributor tester, on which the speed of the distributor shaft was measured accurately by using a Hewlett-Packard counter to count the pulses generated in a magnetic pickup by a toothed-wheel shaft. The calibration adjustment was made so that positive and negative deviations of indicated rpm from true rpm were about equal. This required setting the meter slightly off zero on some instruments. The maximum error of our tachometers, which are fitted with selected G-E meters, is about 30 rpm as observed at increments of 500 rpm from 0 to 5,000 rpm. The very linear G-E Assembly Products Series II Stylist meter, which has a photographically produced scale, makes possible a maximum error of about 10 rpm.

You can also calibrate the tachometer with only an oscilloscope. Connect the vertical input terminals across the distributor breaker points and the horizontal amplifier to a 60-cycle power-line source. Adjust the engine speed until you see a stationary pattern. Adjust rheostats R12, R13 and R14 to indicate the correct rpm. For example, if the oscilloscope pattern shows one cycle of make-and-break of the distributor breaker points per cycle of horizontal deflection (1/60 second), the engine is running at 7,200/N rpm, where N = number of cylinders (assuming a 4-cycle engine). This is 900, 1,200 and 1,800 rpm for 8-, 6- and 4-cylinder engines, respectively.

Other calibration points occur for stationary patterns having 2, 3, 4, etc., make-and-break cycles per cycle of horizontal deflection and correspond to 2, 3, 4, etc., times the rpm indicated above. Since the power-line frequency is usually very close to 60 cycles, the accuracy of this method depends mainly on how well you can hold the engine speed constant.

One tachometer application is recording the shift patterns of test cars with automatic transmissions. The throttle is opened wide and the car allowed to accelerate and to shift transmission gear ratios while the engine rpm is observed on the tachometer and recorded. To follow faithfully the large and rapid decreases in rpm with each downshift, the meter must respond rapidly.

The high-speed limitation on the performance of the tachometer, a result of the finite time required to reverse core magnetization, may be specified in terms of the maximum and minimum dwell of the breaker points for which satisfactory performance is maintained for the most severe condition—an 8-cylinder engine running at 5,000 rpm. This minimum dwell is about 25% or 11° of crank angle, and the maximum is about 90% or 40° of crank angle. These limits are well outside those specified for conventional engines. So the tachometer should do well with any engine whose dwell angle is approximately correct.

Transformer T is wound on a tape-wound toroidal core, type no. 50153-2A, made by Magnetics, Inc., Butler, Pa. The core costs approximately $2 on a one-piece basis, plus shipping for 2 ounces. [Please refer in your order to this article and issue of RADIO-ELECTRONICS.—*Editor*]

Each primary is 50 turns of No. 38 enameled wire. The secondary is 200 turns of the same. Scramble-winding is perfectly all right.

For winding, a small bobbin was made from a 1-inch piece of 3/16-inch nylon rod. The winding area was formed by turning down the center section to ⅛-inch diameter over a length of 9/16 inch. The bobbin is random-wound full with No. 38 enameled wire and is then used to random-wind the primary and secondary sections by passing it through the core. Very likely you have something in your junk-box that would serve just as well. Service cement holds the windings. Two halves of a ¼-inch rubber grommet and a screw secure the finished transformer to the circuit board. END

The Case for NTSC in Europe

By GEORGE H. BROWN*

An article called "Color Television Throughout the World" appeared in our January issue. The author, E. Aisberg of the French magazine Télévision, *and other electronic periodicals, is from France, the home of the SECAM system, and his views are presumably affected by his familiarity with that system. Another set of views is expressed by Dr. Brown in this article.*

ON THE 24TH OF THIS MONTH (March), Study Group XI of the International Radio Consultative Committee (CCIR) will convene in Vienna, Austria, for a two-week session aimed at reaching agreement on what standards to recommend for a color television service in Europe and the USSR. The conclusions will not be binding on the home countries of the participants, but will have important psychological and technological force because of the supranational character of the group and its recognized competence.

Whether CCIR is able to achieve the consensus so earnestly hoped for at this meeting is a moot point. There are strongly held and conflicting viewpoints on almost every issue, especially about which proposed color television system is technologically superior—NTSC, SECAM, or PAL.

Nevertheless, a decision cannot long be postponed. Impressed by the explosive growth of color television in the United States and Japan, the European public is exerting greater pressure on its own television industry to introduce some system and to do it soon. In Britain, the government would like to identify itself with a dramatic new service to the nation, but hesitates to go it alone. In Russia, there is strong desire to have a color service in operation in time to celebrate the 50th anniversary of the Bolshevik Revolution of 1917.

Thus, the question nagging at the collective conscience of the European television industry is not *whether*—nor even *when*—but *what* color television service to introduce that will satisfy all interested parties, or at least the majority.

In a straightforward bid to influence the CCIR in favor of the proven NTSC system used in the United States and Japan, RCA late last year put together a special mobile exhibit consisting of two standard color TV cameras, a video-tape recorder and playback unit, several color and black-and-white receivers and associated transmitting and studio gear.

Accompanied by a skilled band of engineers and others, this exhibit was transported first to London, England, where it arrived in October of last year, coincident with a meeting of the European Broadcasters Union (EBU) at the BBC Laboratories. Purpose of the EBU meeting was, among other things, to view a comparative test of the NTSC, SECAM and PAL systems as conducted by the BBC. We invited the EBU members out to our mobile unit for a more comprehensive demonstration of NTSC's capability. Our invitation was quickly and graciously accepted.

We had developed our transmitting equipment to operate on the proposed European color transmission standards (625-line scan, 50 fields, 4.43-mc subcarrier). Our team began its demonstration by transmitting color programs "live," and by tape, film and slide. In addition, the programs were shown on both color and black-and-white receivers simultaneously.

Finally, in what the French might call a *coup de grace*, these same engineers transmitted to a color receiver "live," recorded the program on video tape, and later played it back for comparison. In doing so, they used one set of tape heads to record the program and another to play it back, thus underscoring the interchangeability of parts and uniformity of product that characterize RCA's equipment as used with the NTSC system in the United States.

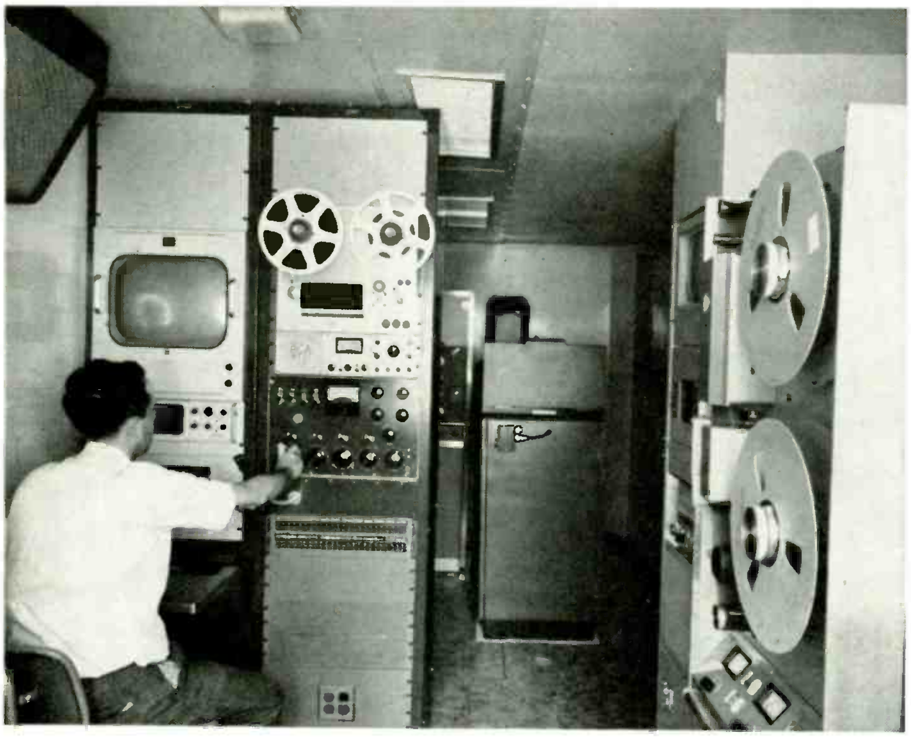
The results were outstanding and caused a French broadcast official to announce that his hat was off to RCA for having overcome the deficiencies in video tape recording and playback which are supposed to be inherent in the NTSC system. Actually, such deficiencies have long since been engineered out of our equipment. Video tape recording and transmission have become so reliable in the United States that last year, for example, NBC prerecorded 61% of its color programs on video tape.

In the BBC test, in my opinion, the very real weaknesses of the SECAM and PAL systems were evident. Of these, incompatibility between black-and-white and color reception was the most pronounced. In the PAL demonstration, there was a persistent "line crawl" which moved diagonally from the lower left to the upper right corner of the black-and-white sets receiving the color transmission. The SECAM picture was little better. To me, neither system was able to produce black-and-white images that would be found acceptable by viewing audiences either in Europe or anywhere else.

The group next embarked for Helsinki, Finland, where we put on in December a demonstration similar to the one we had provided for the EBU, and with similar results.

This was followed by a like tour to Stockholm, Sweden, where the mobile exhibit was set up for a combined show-

* Vice President, Research and Engineering, Radio Corporation of America



Inside the RCA color-TV demonstration van. The mobile unit is touring several major European cities, and will end in Vienna on March 23, in time for the CCIR conference.

ing to government officials and television set manufacturers from Norway, Denmark and Sweden. Again, the results were clear-cut and the NTSC system performed its complex routines without untoward incident.

At this point, and as a consequence of RCA's initial demonstration in London, the exhibit and its troupe of traveling engineers were invited to Moscow. Initially, seven of us met with Russian officials and presented a series of lectures at the Ministry of Communications in Moscow. Altogether, these meetings and lectures occupied a total of five days and produced, among other things, evidence of a strong interest in color and a desire to explore the details of all competing systems.

The next stage was a visit of the mobile unit to Moscow in January for a further series of demonstrations along the lines of those we had presented in England, Finland and Sweden.

During December, a series of tests started to compare the NTSC and SECAM systems in the area of long-distance microwave transmission. At various times in December and January, these tests originated in Paris, East Berlin, Prague, Warsaw and Moscow. In every instance, the NTSC signal came through in completely acceptable broadcast quality. The SECAM signal, on the other hand, frequently showed its susceptibility to noise and produced color of inferior quality.

Thus, on Europe's own ground—in London, Helsinki, Stockholm and Moscow—and in accord with Europe's own proposed color transmission standards of 625 lines, 50 fields, RCA was able to demonstrate, beyond reasonable doubt, that the NTSC color television system is well suited to the needs of the European community, as it has been to the United States for the past 11 years, and to Japan for the past four.

The conviction seems inescapable that choice of either SECAM or PAL over NTSC would be a mistake fraught with the most serious technical and economic hazards for Europe. Such a course of action would result in a system technologically and operationally inferior to what is presently available.

At the root of the trouble in both experimental European systems is the simple fact that they have been designed to obviate defects that have turned out to be only short-term problems in implementing the NTSC system by making unacceptable sacrifices of long-term flexibility, versatility, performance and cost effectiveness.

For example, when all the components of the SECAM system are in perfect adjustment from transmitter to receiver, at least 50% of the vertical color resolution possible with NTSC is lost. So are the valuable properties of constant luminance and compatibility with black-and-white transmission. Moreover, engineers at our receiver manufacturing plants in Indianapolis, Ind., estimate that, because of their greater complexity, SECAM receivers would cost from 15% to 25% more per unit to produce than comparable NTSC receivers. These engineers have been designing and manufacturing color television receivers for 11 years. They ought to know.

In the case of PAL, in addition to the effects on black-and-white receivers, additional components required in the receivers make them far more expensive than either NTSC or SECAM units.

Why were such compromises made in the two experimental systems? According to their proponents, this was done to make video-tape recording simpler and to reduce sensitivity to phase distortion during microwave transmission.

Even granting that the sacrifices do accomplish these purposes, I still question a procedure that compromises the whole system for all time in order to achieve a subsystem advantage for a short time, and benefits the broadcaster at the expense of the individual set owner.

Our demonstrations in Europe also proved that signals generated according to NTSC color standards have no shortcomings in video-tape recording. And as far as long-distance microwave circuits are concerned, let us not forget that color service now extends the length and breadth of the United States, covering over 99% of all American homes. This is accomplished, of course, via a network of microwave relays, some of which reach over 3,000 miles.

Still another point to be stressed is the adaptability to change and growth that is an integral part of the NTSC system. This is not the case for SECAM and PAL.

Since its adoption by the FCC on December 17, 1953, NTSC color television has undergone hundreds of component and apparatus improvements without modification of the basic system.

This kind of flexibility simply does not exist in the experimental SECAM and PAL concepts. In my opinion, they are pretty firmly tied to the *status quo*. Adoption of either of these systems by Europe, in my judgment, constitutes foreclosure on any substantial improvement in its color television service in the future.

I would like to sum up the case for adoption of the NTSC color television system in Europe by quoting from the report of the EIA Ad Hoc Group on Color TV which is to be submitted for consideration to the CCIR study group this month:

> NTSC provides the largest number of benefits with regard to receiver cost, compatibility and complexity, and provides the minimum of limitations on receiver performance.

END

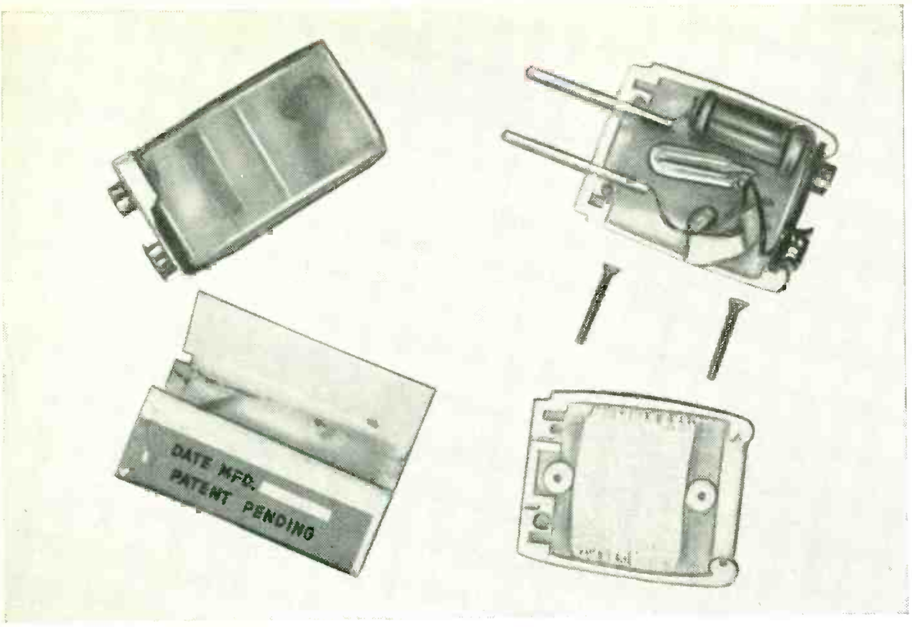


Fig. 1—Left, "skinned" chargeable battery; right, inside a typical charger.

when wet cells dry out

By CARL REMEL

RECHARGEABLE 8-VOLT BATTERIES ARE available as replacements for the 9-volt dry-cell battery used in so many transistor radios. As with many rechargeable cells, these have a little more than 2 volts per cell when fully charged. Unfortunately, cells sometimes dry out.

To get at the cells, remove the outside plastic case with a sharp knife. (It may not be possible to preserve it intact.) The four cells are easily seen in the segmented polyethylene case (Fig. 1). Careful examination will show which cell or cells are dry. It is possible to rejuvenate these cells to some extent. Make a small hole in the edge of the cell case with a sharp knife. A hot needle (or thin nail) will also make a suitable opening. Distilled water may now be added with a needle type applicator (Fig. 2). It is best to wait at least several hours or over night before attempting to recharge the battery. This allows adequate time for the crystals to dissolve and the liquid to penetrate the plate separators.

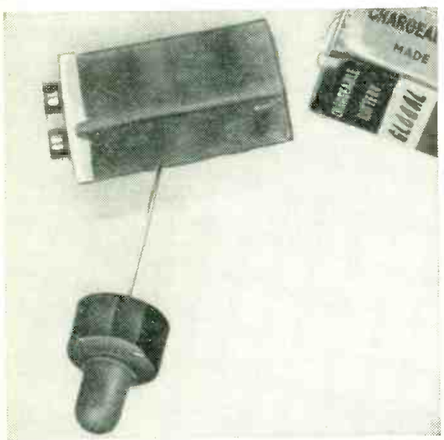


Fig. 2—Inject new life with needle applicator or hypodermic.

A short charge of 15 minutes will show if a cell is shorted. The battery

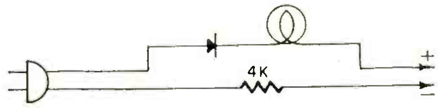


Fig. 3—Simple charger circuit.

should show nearly 8 volts when measured with a vtvm. A reading of 8 volts will also be obtained across the battery while under charge if no cells are shorted or open.

The circuit of a typical charger (Fig. 3) is simple. The lamp indicates battery continuity. If it doesn't light, there is an open circuit somewhere.

Even a completely shorted battery will not increase the lamp brilliance a noticeable amount. Most of the 8-volt additional drop is across the resistor.

If the original external battery case is ruined, it may be possible to use a different case. Some of the imported 9-volt cells have metal cases. The crimped edge on the terminal end of the battery is easily opened. The dry battery is then slipped out of the case.

After the polyethylene case is resealed and the top terminals insulated, the storage battery can be inserted in the metal case from the old 9-volt battery.

Save the connector from the old 9-volt dry battery too. For convenience when recharging, it can be attached to the outside of the radio case. It is wired in parallel with the original connector inside the case. The extra battery connector allows the 8-volt storage battery to be recharged without opening the case. Always recharge with the radio turned off. END

NEXT MONTH IN RADIO-ELECTRONICS

New Life for Old Auto Radios

Motor-car radios—especially the 6-volt type—are becoming a drug on the market. They can be made into excellent small a-c radios with little trouble or expense. You will find them better in sensitivity—and often in quality—to the small table radios sold commercially.

Industrial Electronics for the TV Man

How do I get into industrial work? And what will I find when I get in? Could I handle industrial equipment? Have you ever asked yourself these questions? Jack Darr answers them in a story directed at electronic service technicians who feel that life might be better with fewer customer problems and more money for jobs.

Antennas for Color TV

A color TV depends on its antenna far more than does black-and-white. Next month, an article that tells you why, and how to make the antenna bring in good color.

Easy-to-Build Transistor Ignition

Here is a transistor ignition setup that uses only one transistor, with a Zener diode across it. Combines the performance of the best systems with extreme simplicity of construction. This job was tested by both an electronics and an automotive man.

Hypersensitive Relay Operated by Light

This easily constructed 2-transistor device is so sensitive that a 7.5 watt night light will hold it on from a distance of 25 feet. Or you can use black light. Detects burglars, signals when customers come through a door, and can be hooked up to count moving objects—or for a host of other uses.

You'll find these and many other articles, features and regular departments in next month's RADIO-ELECTRONICS.

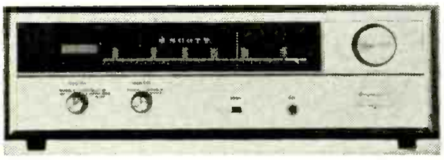
APRIL ISSUE

(on sale March 18)

AUDIO EQUIPMENT REPORT

Scott 312 FM Stereo Tuner

AS PRACTICALLY EVERYONE KNOWS, H. H. Scott has been responsible for some of the best FM tuners made, and has long advocated the wide-band detector design that other companies got around to adopting only with the arrival of multiplex broadcasting. Many other credits belong primarily, if not exclusively, to Scott, including the time-switching multiplex circuitry now almost standard in top-quality stereo tuners.



Any Scott tuner, then, arrives with built-in interest, and the new 312 is interesting on several counts. The second of Scott's entries in the solid-state derby, the 312 is actually a hybrid design that uses both transistors and nuvistors—four nuvistors in its front end. It also signals the dropping (apparently once and for all) of the company's planetary tuning dial in favor of the standard slide-rule dial. And it comes with several new and worth-while features, including a front-panel tape output and a STEREO THRESHOLD control that should be particularly helpful in recording off-the-air.

To take first things first, the transistor-nuvistor design of the 312 is an obvious acknowledgement of the problems that still beset current all-transistor front ends in dealing with signal overload and cross-modulation. In addition to overcoming these troubles, the 312's four nuvistors help to make it an undeniably "hot" tuner that will pull in distant FM stations with ease. Whether Scott might have got equally excellent results by sticking with all-transistor design is a question, but the nuvistors obviously perform well.

A lot of thinking has gone into the design of the 312's stereo circuitry, and the facility most worth discussing is the STEREO THRESHOLD control. This works with the AUTOMATIC STEREO setting of the tuner, and allows the listener to decide for himself just how much interference and background noise he will tolerate in a stereo transmission. Once you decide the point at which you would rather listen to untroubled mono instead of noisy stereo, the AUTOMATIC STEREO setting on the 312's front panel automatically keeps the tuner in mono operation until a stereo signal of acceptable quality comes along. And once the choice of mono or stereo reception is made, momentary variations of signal strength will not cause the tuner to jump back and forth between mono and stereo. This makes taping off-the-air a considerably less chancy business than with many other stereo tuners. It may take some time to determine the best setting of the THRESHOLD control for receiving any given station in your particular location, but once it is determined, the tuner's own decision-making is a pleasure to live with.

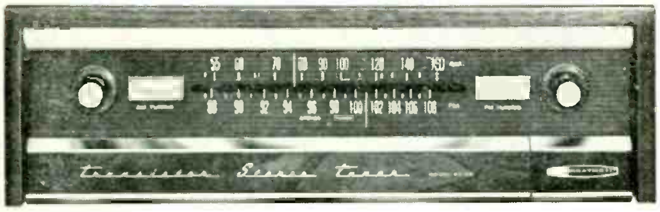
The 312, unlike older Scott designs, offers a slide-rule tuning dial. The dial is accurately calibrated and easy to read, with a convenient logging scale underneath the megacycle markings. The tuner's signal-strength meter gets a bit jumpy at times, but is generally easy to use for accurate tuning. Additional conveniences include noise and SCA filters. The front-panel tape output makes

continued on page 66

13 Heathkit® Values... See the other

$195.00 All-Transistor AM/FM/FM Stereo Receiver, AR-13A

Just add 2 speakers for a complete stereo system! 46 transistor, 17 diode circuit for cool, instant operation, plus the quick, uncompromising beauty of "transistor sound." Compact, yet houses two 20-watt power amplifiers (33 watts each, IHF music power), two preamplifiers, and wide-band AM/FM/FM Stereo. Attractive new "low-silhouette" walnut cabinet styling. 34 lbs.



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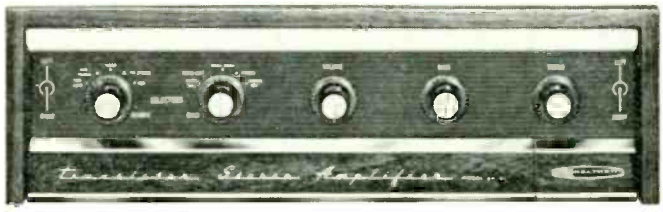
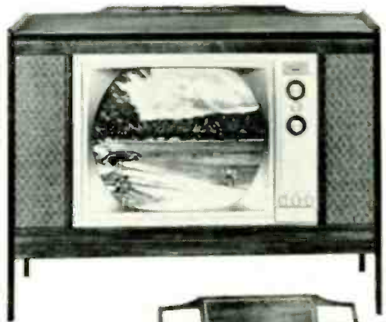


$149.95 Matching Deluxe All-Transistor 70-Watt Stereo Amplifier, AA-21C

Enjoy the quick, unmodified response of each instrument with its characteristic sound realistically reproduced. No compromising! Enjoy 100 watts IHF music power at ± 1 db from 13 to 25,000 cps. Enjoy cool, instant operation from its 26 transistor, 10 diode circuitry. Unusual value. 29 lbs.

Deluxe 21" All-Channel Hi-Fi Color TV, GR-53A . . . $399.00

Compares to sets costing up to $200 more! Only color TV you can build yourself, only color TV you can adjust & maintain yourself with exclusive "built-in service center," only color TV you can install 3 ways . . . wall, custom cabinet, or either of Heath factory-built cabinets. Tunes all channels, 2 thru 83, to bring you 21" of true-to-life color and black & white pictures, plus *hi-fi* sound. Features 24,000 volt regulated picture power; deluxe Standard-Kollsman VHF tuner with push-to-tune fine tuning & new transistor UHF tuner; 26 tube, 8-diode circuit. All critical assemblies prebuilt & aligned . . . goes from parts to picture in just 25 hours. GR-53A, chassis, tubes, VHF & UHF tuners, mount. kit, speaker. 127 lbs. . . $399.00 GRA-53-7, deluxe walnut cabinet, 85 lbs. . . $115.00 GRA-53-6, economy walnut-finished cabinet, 52 lbs. $49.00



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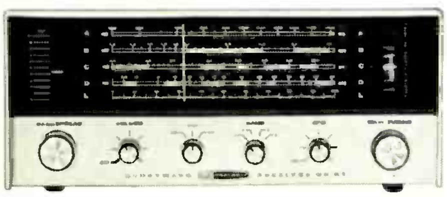
GD-983
$849.00



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New! Heathkit 4-Band Shortwave Listener's Radio, GR-64 . . . $39.95

Covers 550 kc to 30 mc in 4 bands to bring you international, ham, weather, marine, Voice of America, and AM broadcasts. Features built-in 5" speaker; lighted bandspread tuning dial, relative signal strength indicator, and 7" slide-rule dial; 4-tube superhet circuit plus 2 rectifiers; simple circuit board construction; "low-boy" cabinet. 13 lbs.

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A versatile performer anywhere in electronics! Boasts single AC/Ohms/DC probe; 7 AC, 7 DC, & 7 Ohms ranges; easy-to-read 4½" 200 UA meter; 1% precision resistors for high accuracy; and an extended low frequency response of ±1 db from 25 cps to 1 mc. Functions include AC volts (RMS), AC volts (peak-to-peak), DC volts, resistance & db measurements. Simple circuit board assembly. 5 lbs.
Assembled IMW-11........$39.95

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Measures AC volts (RMS), DC volts, resistance & db. Separate 1.5 & 5 volt AC scales for high accuracy; "gimbal" mounting bracket for easy bench, shelf or wall mounting; meter tilts to any angle for best viewing; smoother vernier action zero & ohms adjust controls; large, easy-to-read 6" 200 UA meter; and single AC/Ohms/DC test probe. 7 lbs.
Assembled IMW-13........$49.95

IG-112
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New! Heathkit FM Stereo Generator, IG-112 . . . $99.00
Produces all signals required for trouble-shooting & alignment of multiplex adapters, FM tuners & receivers. Generates mono FM or composite stereo FM signals. Switch selection of 400 cps, 1000 cps, 5000 cps, 19 kc, 38 kc, plus 65 kc or 67 kc SCA test signals for complete alignment capability. Simple to assemble & use. 10 lbs.

GDP-134
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New! Heathkit/NELI Transistor Ignition Kit, GDP-134 . . . Only $34.95
Save $35! Features 4-transistor, zener-diode protected circuitry; built-in conversion plug for switching to conventional ignition. Operates on 6 or 12 v. DC pos. or neg. ground system—installs easily on all cars, foreign & domestic. Completely sealed against moisture, corrosion, etc. Simple to assemble & install . . . all parts included. 7 lbs.

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connecting a tape recorder unusually easy.

I checked out the 312 in Alford, Mass.—some 135 air miles from New York City—a deep-fringe area by anybody's standards. As a fringe-area tuner, the 312 did magnificently. Not only is it as sensitive as any tuner I've come across, but its limiting curve is such that full limiting seems to take place with signals just a hair above the minimum strength needed for marginal quieting. In stereo it did remarkably well. The background noise on some stereo transmissions from New York City was no worse than other tuners' background on mono broadcasts. It seems almost pointless to pay more than the 312's price of $259.50 for a tuner with nominally higher sensitivity. The money would be far better spent on a good, high-gain outdoor antenna.

In places where stations were crowded closely on the dial, the Scott's excellent selectivity kept them neatly apart with hardly a trace of audible interference.

To sum up, the Scott 312 has remarkable sensitivity, good stereo seperation and excellent overall audio quality. It can be recommended particularly to fringe-area dwellers who don't want to spend a year's income or thereabouts on other tuners of comparable capabilities.—*John Milder*

SPECIFICATIONS

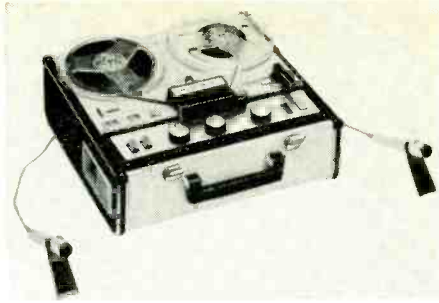
(All specifications are the manufacturer's)

Usable sensitivity (IHF): 2.2 μv
Signal-to-noise ratio: 65 db
Distortion: under 0.8%
Drift: less than .02%
Frequency response (stereo): 30 to 15,000 cycles, ±1 db (FCC limits; Scott tuners will exceed them)
Capture ratio: 4 db
Selectivity: 30 db
Crossmodulation rejection: 80 db
AM supression: 55 db
Calibration accuracy: 0.5%
Stereo separation: 35 db
Dimensions: 15½ x 5½ x 13¼ in.
Price: $259.95
H. H. Scott, Inc. 111 Powdermill Rd., Maynard, Mass.

Sony TC-200 Stereo Tape Recorder

THE TAPE RECORDER THAT APPEARS IN part on our cover this month is a most attractive package of sturdy, versatile and easy-to-run machinery. A completely self-contained four-track stereo recorder and player, the Sony TC-200 has two speakers built into detachable lid halves, two low-impedance microphones and a remarkably simple array of jacks and controls that make it unusually flexible.

It plays or records either four-track stereo or four-track mono tapes. It records sound on sound, allowing a whole range of entertaining and useful



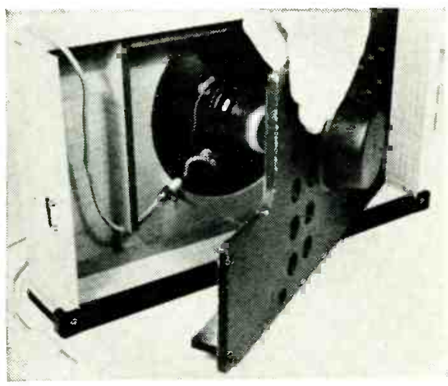
tricks, and lends itself very nicely to "tape teaching"—recording a "model" on one track (say, for example, a speech as recited by a coach, or a foreign-language vocabulary), leaving the other track free for trial by the student. He can record and rerecord to his heart's content without erasing the model.

The TC-200 also works without tape as a stereo (or mono) public-address system. All you need do is depress the record buttons on one or both channels without moving the tape transport knob, and sound from the microphone(s) is amplified and fed to the speaker(s).

Other features: a treble boost-cut tone control (for playback only); a "pause" button to hold the tape for a moment without changing the mode of the recorder, for editing or cueing; one output for each channel that can either feed the speakers (or any speakers) direct, or, with the flick of a switch, become a medium-impedance voltage output for feeding a hi-fi system. The output of one channel can be cross-connected to the input of the other through an adapter cord (supplied) for sound-on-sound recording.

The electronics of the 200 is a marvel of economical design, apparently without serious sacrifice in quality. Each channel has but three stages—a high-gain silicon n-p-n transistor, a high-gain low-noise pentode, and a beam-pentode output stage. There is more than enough gain, with the microphones supplied, for any recording job the average user may want to undertake.

Wire shows path of sound through duct in Sony TC-200 speaker.



A third (triode-connected) beam-pentode is the bias and erase oscillator for both channels. (There are separate bias-current adjustments for each channel—a useful feature that few recorders in this price class have.)

The action of all controls is firm and positive. The tape comes to a stop almost instantly when the transport knob is returned to STOP from any other position. It was possible to spill a little tape when releasing the FAST FORWARD lever (though not when it is locked in, for longer fast-forward runs). The feed reel did not stop quickly enough. This is worst at 3¾ ips.

Sound from the detachable 6-inch speakers is good. They are mounted in the half-lids with their backs enclosed by a baffle of semi-rigid foam plastic, punched with some thirty ⅝-inch holes. The holes are covered from the inside with a porous, acoustically absorbent material, to provide pressure relief and resistive damping. One side of this irregularly shaped box is formed into a duct, evidently to give some bass reinforcement. Just how much this contributes to the sound is not easy to assess, but the overall tonal balance is pleasing.

One feature of this machine that I appreciated particularly is that it can be switched into the record mode (by depressing either or both of the record buttons at the left front) without starting the tape. This permits convenient recording level adjustments before recording starts.

The TC-200 runs quiet and cool. The front of the head housing can be slipped off for precise cueing or editing, if that should be necessary. Microphone and high-level auxiliary inputs are mixable (though they don't have separate controls). The recorder looks sturdily built and is easy to carry. For under $240, it looks like a fine buy for the amateur taper who expects to be doing some serious recording from time to time.—*Peter E. Sutheim*

SPECIFICATIONS

(All specifications are the manufacturer's)

Tape speeds: 3¾ or 7½ ips
Frequency response: 50 to 14,000 cycles ±3 db at 7½ ips; 50 to 10,000 cycles ±3 db at 3¾ ips.
Signal-to-noise ratio: 46 db (each channel)
Flutter & wow: less than 0.19% at 7½ ips; less than 0.25% at 3¾ ips
Erase head: in-line, quarter-track
Record/playback head: in-line, quarter-track
Bias frequency: appprox. 55 kc
Level indication: two meters
Level control: single record-playback volume, one for each channel
Tone control: treble boost or rolloff on both channels simultaneously
Editing facilities: instant-stop lever, automatic tape lifter, fast-forward and rewind, manual cueing and digital tape counter
Reel size: up to 7-inch
Outputs: one 8-ohm speaker or high-impedance line per channel (selectable by switch)
Inputs: low-impedance microphone or high-impedance auxiliary
Power output: 1.5 watts max. per channel
Weight: approx 27 lb
Dimensions: 15 x 8-15/16 x 15⅞ in

END

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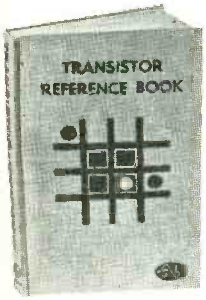
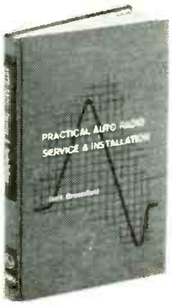


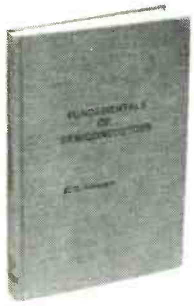
26. TRANSISTOR REFERENCE BOOK by David Kilpatrick, William Dittrich, David Emmel

Lists all transistors, cross references them and supplies information on their operating characteristics. Clothbound — *Retail Price* $6.00



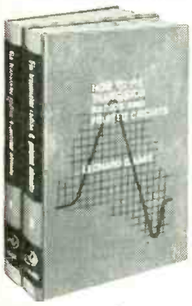
87. PRACTICAL AUTO RADIO SERVICE & INSTALLATION by Jack Greenfield

How to handle bugs in these specialized sets. How to service power supplies, various tube types, hybrids. Time-saving hints on installations and removal. Clothbound —*Retail Price* $4.60



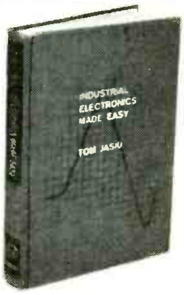
92. FUNDAMENTALS OF SEMICONDUCTORS by M. G. Scroggie

Thoroughly explores the entire field of semiconductor devices—transistors, rectifiers, photoelectric devices, thermistors, varistors, etc. Clothbound—*Retail Price* $4.60



96. HOW TO FIX TRANSISTOR RADIOS AND PRINTED CIRCUITS (2 volumes—count as one book) by Leonard C. Lane

Theory and practical knowledge in a remarkable, easy-to-understand way. Tells how transistors work, why they amplify. Explains current and voltage gain; analyzes circuits. Reference section for "instant servicing." Hundreds of diagrams. Clothbound—*Retail Price* $9.90



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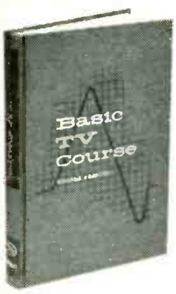
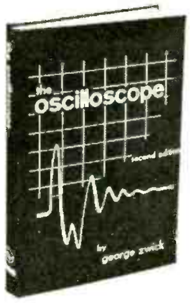
So popular that 8 printings have been sold out! Everything you want to know—Ohm's Law, capacitance, tubes, transistors, and how they work in a receiver—practical servicing techniques. Clothbound—*Retail Price* $5.75



105. BASIC TV COURSE by George Kravitz

A completely up-to-date guide to TV that covers such new developments as transistorized portables. A thorough practical discussion of circuit operation, sync methods, sweep systems, tuners, amplifiers, variations in power styles. Presents technical detail in easy-to-follow style. Clothbound—*Retail Price* $5.75



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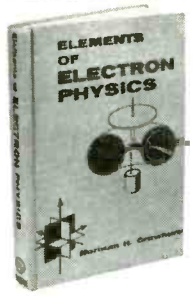

113. ELEMENTS OF ELECTRON PHYSICS by Norman H. Crowhurst

Explains the how and why of electronics in simple understandable language. Covers the beginnings of electronics, electron theory, solid-state semiconductors, tubes for electronics and electronic circuits. Clothbound—*Retail Price* $5.65

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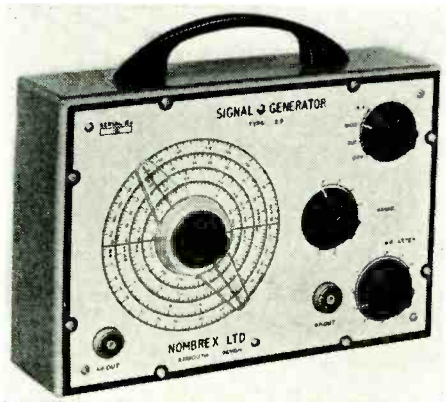
Nombrex Model 27 Signal Generator

THIS LITTLE TRANSISTORIZED SIGNAL generator is one of a line of miniature test instruments imported from England. It is reminiscent of the Oak Ridge line that made a brief appearance about 14 years ago. Only 6½ inches wide, 5½ inches high (including the handle) and 2¾ inches deep, overall, it is an ideal addition to the radio–TV service caddy.



The Nombrex model 27 provides continuous coverage from 150 kc to 350 mc in eight bands, each having a tuning ratio of around 3 to 1. The first seven ranges are covered on fundamentals and the eighth (118 to 350 mc) uses the second harmonic of the 59–175-mc band. The hair-line cursor permits the frequency control to be set to within 1%. The rf signal can be modulated by a built-in 400-cycle oscillator. The audio signal is available at a separate output jack.

Frequencies up to 30 mc were checked on a very accurate communications receiver with a 100-kc calibrator and were well within the manufacturer's specifications. Frequencies up to 213 mc were checked out by beating fundamentals and harmonics against FM and TV stations. The rf oscillator is surprisingly stable. From a cold start, it remained within a few cycles of zero beat with CHU (Dominion Observatory, Canada) for well over an hour. A heat lamp was focused on the case until it was quite warm. Drift was less than 400 cycles.

Although its small size is one of the most attractive features of this instrument, this very factor is responsible for a major annoyance. The calibrations on the frequency dial are too small for comfort. A magnifying type cursor like those on some slide rules would be a worth-while addition.

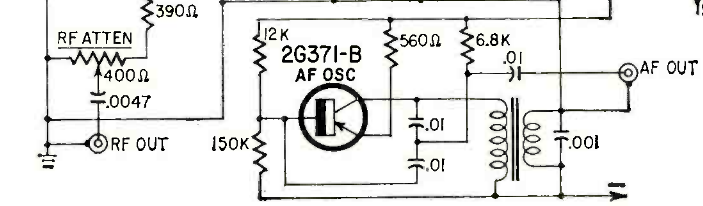
The model 27 is ideal for trouble-shooting TV, radio and audio equipment in the field. A modulated signal can be injected into rf and i.f. circuits to isolate a defective stage. Its accuracy is quite adequate for peaking adjustments in almost all circuits except those that include crystal or magnetostrictive filters. Rf leakage is almost undetectable, so the simple rf attenuator provides ample control over the signal level.

The circuit

The rf oscillator uses a Hartley circuit on bands 1 through 5. On bands 6, 7 and 8, the oscillator circuit appears to be a modified Colpitts in which feedback from collector to emitter is provided by stray and interelectrode capacitances. The audio oscillator circuit is a tough one. Is it a Hartley or Colpitts, or what? The rf oscillator's collector current flows through the secondary of the transformer and is modulated at 400 cycles when the audio oscillator is turned on.

This and other all-transistor test instruments would be greatly improved by the addition of some type of eye-catching (and preferably nonelectric) "power

Simplified schematic of the Nombrex model 27. Not all range-switching details have been shown.



SPECIFICATIONS

(All specifications are the manufacturer's)

Frequency bands: (1) 149 to 438 kc, (2) 425 to 1,250 kc, (3) 1.18 to 3.83 mc, (4) 3.4 to 10.75 mc, (5) 9.8 to 34.1 mc, (6) 29.5 to 69 mc, (7) 56 to 166 mc, (8) 118 to 350 mc.

All ranges except band 8 are on fundamentals.

Accuracy: Better than ±2% overall, but generally within 0.5 to 1.5% on individual bands and scale positions. Frequency shift with changing load or attenuator setting less than 0.2%. Shift due to falling battery voltage less than 0.4% down to 7.5 volts.

Output levels: Average rf output 50 mv into 75 ohms on all ranges. Af output approximately 1 volt rms at 400 cycles.

Output impedance: Varies with attenuator setting. 400 ohms at maximum output.

Battery: 9 volts, Burgess P6 or equivalent. Average life is several months with 3-ma drain.

Dimensions: 6½ x 5½ x 2¾ in.

Weight: 2 lb.

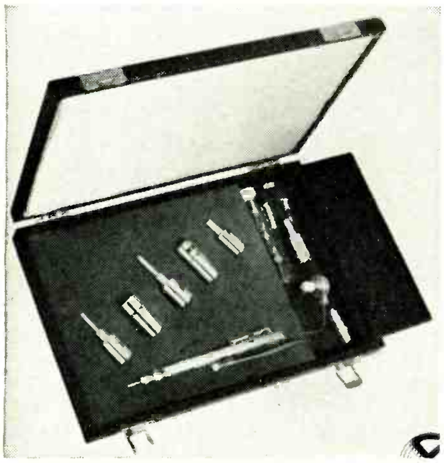
Price: $39.95

(Manufactured by Nombrex Ltd., Exmouth, Devon, England. Imported by Path Products Corp., 55 Halley St., Yonkers, N. Y.)

on" indicator. Normal battery drain is generally low, but batteries don't last long when you inadvertently leave the tester on for long periods.

The Nombrex model 27 is a dandy little instrument that you have to "live with" and use to really appreciate. Use a simple pocket magnifying glass to read the tuning dial, and the "partnership" will be a happy one.—*Robert F. Scott*

Don Bosco Universal Transducer Set PHD 100-A



MANY KINDS OF LAB MEASUREMENTS and electronic tests can be made with this versatile instrument. The *Stethotracer* is a combination of high-gain (60-db) amplifier and transducer. The amplified output may be fed to an *earpiece* for convenience and portability, or to an *oscilloscope* or *voltmeter* for exact measurement. The basic amplifier is contained in a penlike housing. Various probes as required may be attached at the end of the "pen", which measures 5⅝ inches long and ½ inch in diameter, and weighs 1½ oz. The amplifier range is from 60 cycles to 100 kc.

Four point probes are included, each to be screwed into the tracer as required. One is a crystal diode probe to detect modulated rf, as in a radio receiver. Since the tracer is battery-operated, there are no external power supplies or lines to connect.

There are three attenuator probes: a 0-db direct probe with 3,500 ohms impedance, a 20-db probe whose impedance is 35,000 ohms, and a 40-db probe with 350,000 ohms impedance. The 40-db probe would be used, for example, where signal strength is very high. The sound output in the earpiece is limited to a maximum of 2 mw in any case, so there is complete protection for the ear.

A vibration pickup is available to detect very weak motion. With it, I could hear the ticking of a clock several feet away on a table. Flow through pipes is readily detected with this transducer.

Another useful transducer is the tape head (93-mil track). With it, a recorded signal may be read off by simply running the probe along the track. There is ample gain from the amplifier for this purpose.

The photovoltaic probe included in this stethotracer set may be used to measure weak illumination. If the light source is modulated, the af becomes directly audible in the earpiece. If the illumination is constant, the output of the amplifier may be fed to a dc voltmeter for direct measurement. Output plugs for this purpose are included. The output is 400 mv in direct sunlight.

Another useful transducer in the set is the inductive probe. When this is connected to the Stethotracer, you can easily measure and trace hum fields around a transformer or a current-carrying conductor. The instrument may also be used as a magnetic tachometer for detecting the speed or motion of any ferrous object, or to aid in designing shields around electromagnetic components. Sensitivity of this probe is 250 mv per oersted. Impedance is 1,330 ohms at 60 cycles.

A miniature but high-quality dynamic microphone is still another transducer included in the set. It makes a sensitive hearing aid.

For quantitative measurements from any of the transducers, the earpiece is removed from the output and a scope or meter substituted. A double-plug output adapter is available for this.

The Stethotracer is powered by a size AAA cell whose life is about 250 hours. Noise level of the amplifier is 3 μv peak to peak with input shorted. A maximum of 1 mv peak to peak may be applied for full linear output across 600 ohms. The tracer and probes are housed in an attractive plastic box, 10¾ x 7¼ x 1½ inches. They add up to a compact, versatile signal detection and test system for the lab or workshop. Net price is $180.—*I. Queen* END

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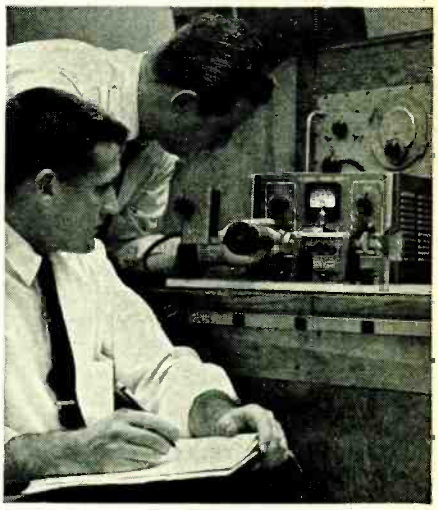

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New Departure in Communications Receivers

Continuous tuning from 500 kc to 30 mc is featured in this new British receiver

By ROBERT F. SCOTT
TECHNICAL EDITOR

A RADICALLY NEW APPROACH TO COMmunications receiver design is incorporated in a series of British receivers that cover 500 kc to 30 mc without gaps and without the usual bandswitching in the signal and local oscillator circuits. The variable-frequency local oscillator is used as the electronic bandswitch. The effects of local oscillator drift are automatically cancelled in the unique circuitry.

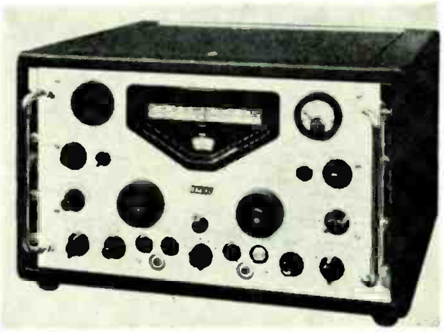
Conventional high-grade general-coverage communications receivers are of two general types. Most are usually double- or triple-conversion designs with the first i.f. around 1600 kc or higher, and one or two lower i.f.'s for gain and selectivity. Various electronic and mechanical innovations are used in the local oscillator circuit in an effort to obtain the near-crystal stability needed for SSB and single-signal reception.

A few of the more elaborate receivers use broad-band rf circuits, crystal-controlled fixed local oscillators and variable first i.f.'s to cover small segments of the tuning spectrum. For example, a separate crystal may be required for oscillator control in each 1-mc sector of the tuning range.

The British *Racal* circuit can be considered the equivalent of 30 crystal-controlled converters—each covering a 1-mc spectrum—feeding into a 2–3-mc tunable receiver for continuous coverage up to 30 mc. But, instead of using a separate cyrstal for each 1-mc segment, Racal uses *one* crystal and a harmonic generator as a common frequency control for all bands.

The Racal RA.17 receiver

The block diagram of the RA.17 is shown. There are two tuning controls.



One, the MEGACYCLES dial, is a continuous-tuning equivalent of the more conventional bandswitch. It is calibrated from 0 to 29 in 1-mc steps. The MEGACYCLES dial controls the variable-frequency local oscillator that tunes from 40.5 to 69.5 mc. The second control—KILOCYCLES—is calibrated in kilocycles and tunes the 2–3-mc receiver over its range. To tune to a given frequency, say 14.125 mc, set the MEGACYCLES dial to 14 and the KILOCYCLES dial to 125.

A receiver for dc?

The rf amplifier may be operated with an aperiodic 0- to 30-mc wide-band input or with double-tuned switched preselectors covering 0.5 to 1, 1 to 2, 2 to 4, 4 to 8, 8 to 16 and 16 to 30 mc. All signals up to 30 mc or those within a selected segment (4 to 8 mc, for example) are amplified and fed to the first mixer.

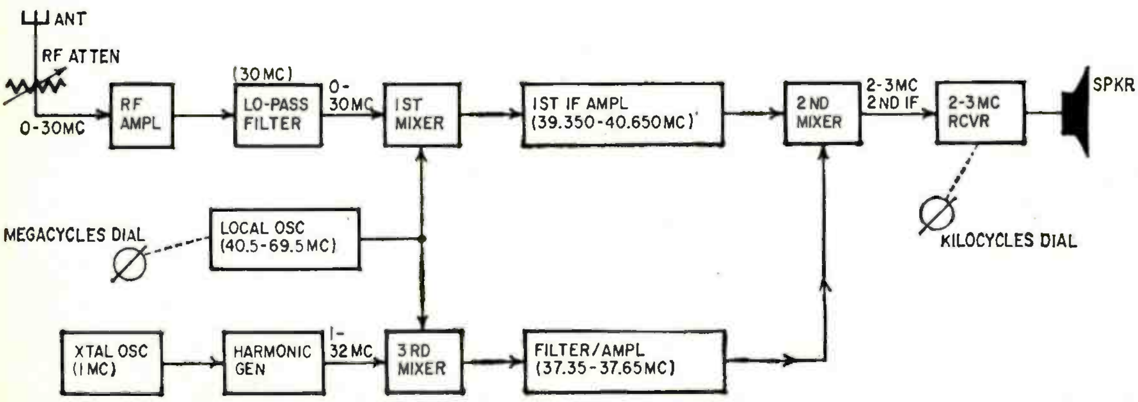
This wide panorama of signals from the rf amplifier beats with the signal from the variable-frequency local oscillator to develop a 40-mc first i.f. The i.f. amplifier bandwidth is 1.3 mc (39.35 to 40.65 mc) so it passes a 1.3-mc slice of all the rf signals beating with the local oscillator. Which incoming signals are included in this 1.3-mc slice depends on the setting of the local oscillator. These signals are amplified in the first i.f. amplifier and fed to the second mixer.

The output of the local oscillator also goes to the third mixer where it beats with a harmonic of a 1-mc crystal oscillator to give a difference frequency of 37.5 mc ±150 kc. This difference frequency is amplified in a 37.5-mc amplifier with 300-kc bandwidth.

(The 1-mc crystal oscillator and its harmonic generator produce harmonics ranging well above 35 mc, but a minute with pencil and paper will show that, for any local oscillator frequency between 40.5 and 69.5 mc, there is only one crystal oscillator harmonic that will produce a difference frequency in the range of 37.35 to 37.65 mc.

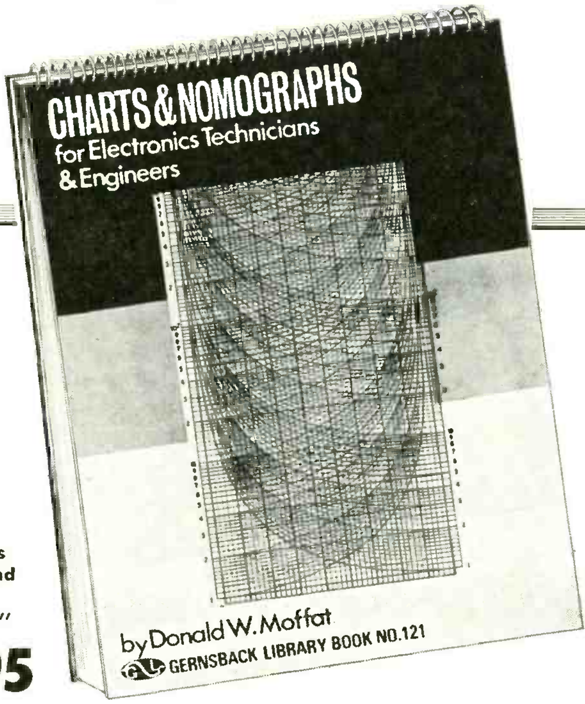
Remember that the local oscillator's dial is calibrated in 1-mc steps. Let's say that 41.5 mc is 1, 42.5 is 2 and so on until we reach 69.5 mc, which is marked 29. Suppose that the oscillator is tuned to 41.5 mc. What frequency must the harmonic generator produce to develop 37.5-mc output from the third mixer? Obviously 4 mc—the 4th harmonic of 1 mc—since the harmonic frequency that is used is the *difference* between the local oscillator frequency and 37.5 mc. When the oscillator is tuned to 69.5 mc, 32 mc or the 32nd harmonic of 1 mc produces the desired 37.5-mc beat frequency.)

The 37.5-mc (±150 kc) signal produced by beating the local oscillator and crystal harmonic is used as the oscillator frequency for the second mixer. Here, it beats with the first i.f. to produce a difference frequency ranging from 2 to 3 mc. This second i.f. signal is



Block diagram of Racal RA.17 shows essential components of new system. From second mixer on, circuitry is fairly conventional. Receiver is available in "all-Americanized" version with American tubes, connectors and hardware sizes.

just published!



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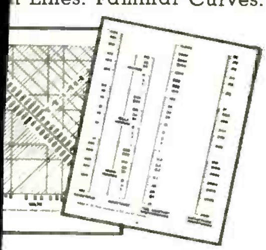

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fed into a conventional 2–3-mc superhet that serves as the variable second i.f. Its dial is calibrated in kilocycles. With it, we select the desired signal from the panorama of signals in the 2–3-mc second i.f.

Now for a few practical examples to see how this revolutionary circuit works. Assume that we want to tune in a 3-mc signal. The MEGACYCLES dial is set to 3 and the local oscillator operates on 43.5 mc. The 1.3-mc wide 40-mc first i.f. will pass all incoming signals between 2.85 and 4.15 mc. At the same time, the 43.5-mc oscillator output mixes with the 6th harmonic of the 1-mc crystal oscillator to develop the 37.5-mc difference frequency. The output of the second mixer covers a range of 1.85 to 3.15 mc.

The receiver that acts as the second i.f. is only 1 mc wide so it can recover only those signals falling between 2 and 3 mc. The frequency of the signal that we want to receive is a whole number (without decimal parts) so the KILOCYCLES dial must be set to 0, which corresponds to 3 mc.

Now let's take a 7.4-mc signal. It beats with the 47.5-mc local oscillator to develop the first i.f. at 40.1 mc. The local oscillator and 10th harmonic of the crystal oscillator beat to generate the 37.5-mc injection signal for the second mixer. The 40.1- and 37.5-mc signals beat to develop the 2.6-mc second i.f. (Other signals will develop other second i.f.'s between 2 and 3 mc. But remember that the one we want comes in at 2.6 mc.)

The receiver that acts as the second when the KILOCYCLES dial is at 0 the variable-frequency second i.f. is actually tuned to 3 mc. This time, we want to receive 7.4 mc (7,400 kc) so the KILOCYCLES dial must be turned to 400. This shifts the frequency 400 kc to 2.6 mc and the 7.4-mc signal is tuned in "on the nose".

Drift compensation

Drift in a variable-frequency local oscillator is always a serious problem in most superhet receivers. At higher frequencies, drift is often great enough to throw the desired signal outside the i.f. passband. This is not possible in the Racal circuit. Let's see why. We have just seen that a 47.5-mc local oscillator frequency is used when tuning to 7.4 mc and we end up with a 2.6-mc second i.f.

Suppose that the local oscillator drifts 15 kc from 47.5 to 47.65 mc. The first i.f. for a 7.4-mc signal is now 40.25 mc. The 47.65 oscillator signal mixes with the 10th harmonic of the crystal oscillator to produce a 37.65-mc injection frequency at the second mixer. *The resulting second i.f. (40.25 – 37.65 mc) is 2.6 mc, the same as it would be if the oscillator had not drifted.* Thus the effect of oscillator drift has been canceled.

The stability of the front end in the RA.17 is the same as that of the 1-mc crystal oscillator. We all know that a 1-mc crystal oscillator can be pretty stable. We use them all the time as secondary frequency standards and calibrators.

The 2–3-mc superhet circuit used as the variable-frequency i.f. or interpolation receiver is a conventional type using a 100-kc i.f. It includes such features as avc, tuning meter, automatic noise limiter, bfo and variable selectivity. The complete receiver has 23 tubes.

The Racal receiver, as you might expect, is expensive. The RA.17C-12 model is being manufactured here for the American market and for areas where American tubes, connectors, screws and other components are common. The price in the US is approximately $1270 FOB Silver Spring, Md. The general specifications are:

Stability: After 1½-hour warmup, drift is less than 50 cycles per hour at constant temperature and line voltage.
Input impedance: 75 ohms, unbalanced.
Tuning: Effective scale length 145 feet (12 inches equals approximately 200 kc).
Sensitivity: 1 µv for 18-db signal-to-noise ratio on CW reception with 3-kc bandwidth. 3 µv for 18-db signal-to-noise ratio on 30% modulated MCW signal.
Selectivity: 6 selectable bandwidths. 6-db bandwidths are 13, 6.5, 3, 1.2, 300 and 100 kc.
Image response: With wide-band or tuned input, external images are at least 60 db down. Spurious internally generated images below noise level in all cases.
Noise factor: Less than 7 db throughout range.
Avc time constants: (Short) 25-msec charge, 200-msec discharge. (Long) 200-msec charge, 1-sec discharge.
Dimensions and weight (in cabinet): 20¼ in. wide, 21⅞ in. deep, 12 in. high. 97 lb.
Manufacturer: Racal Electronics, Ltd. Bracknell, Berks., England, and Racal Communications, Inc., 8440 2nd Ave., Silver Spring, Md.

New Semiconductors and Tubes

CANNED TUBES

The latest thing in tube packaging seems to be the humble but venerable tin can—the same kind, with the tab-top design, used for frozen juices.

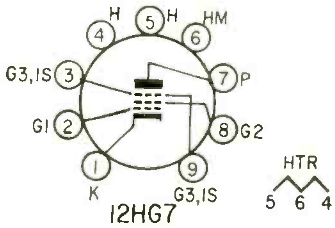
Eitel-McCullough engineers hit on the canning approach as a way to protect delicate tubes for aerospace applications from corrosion and breakage. The tube nestles in soft polyurethane foam, and the can makes an airtight seal. Tests showed no harm to tubes even when they were dropped onto a concrete surface from the height of a three-story building.

The tops of the cans are designed so that twisting the tab in the center tears out the end of a short spiral strip. Pulling on the tab tears the strip to the edge of the can top and then all the way around until the top falls away.

12HG7

A new frame-grid sharp-cutoff pentode for video-output-stage service in color TV sets has been announced by RCA. The new tube, marked 12HG7, has a large 9-pin base (novar or neonoval), and is said to be equally useful in receivers with low- and high-B-plus.

Its high dissipation (10 watts maximum) makes it possible to eliminate the dropping resistor and bypass capacitor often used where plate voltage for the video output tube must be cut down. The 12HG7's transconductance is extremely high—32,000 μmhos—and its output voltage capability is high, permitting fewer video amplifier stages. The low grid-to-plate capacitance means a high gain-bandwidth product.

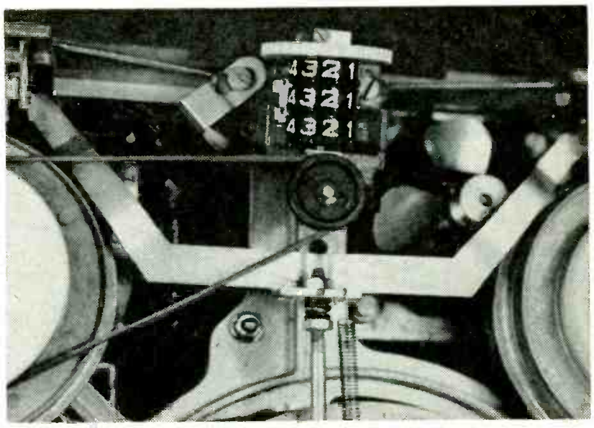


Another feature of the 12HG7 is its tapped heater, for operation at 6.3 volts 0.52 amp, or 12.6 volts 0.26 amp.

With a plate supply voltage of 300, a screen supply of 135 and a cathode resistor of 47 ohms, the 12HG7 plate draws 31 ma, the screen 4.8 ma, and the tube has a plate resistance of approximately 60,000 ohms. END

TECHNOTES

NORELCO 200, 300, 400 RECORDERS: COUNTER DRIVE BELTS

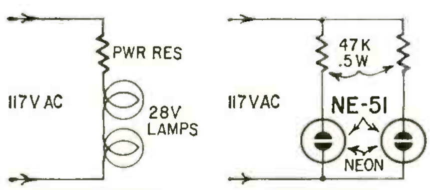


When servicing any of these tape recorders, always see that the counter drive belt is installed the way it was when the machine entered the shop. The counter will operate equally well on either take-up or supply reel. The correct position is on the supply reel.

The reason for the caution is that the customer will perhaps have prepared a log corresponding to the counter indication. By changing the counter position you will upset his log and make it difficult for him to find selections—*Steve Dow*

COOL SETS WITH PINK PILOT LIGHTS

Many recent inexpensive AM-FM—stereo-phono combinations have series-connected line-operated pilot lights. Besides having rather short lifetimes, the bulbs need a dropping resistor which produces quite a bit of extra heat and tends to shorten the life of nearby components.

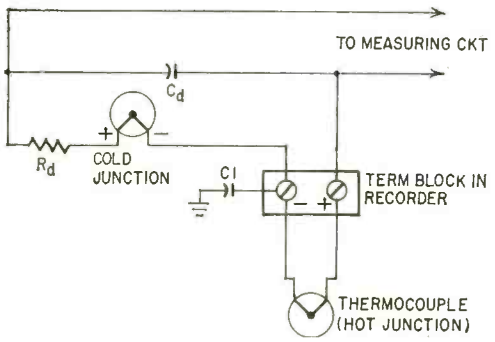


A simple solution is to replace the bulbs with low-power neon lamps, eliminating the power resistor and installing in its place a small dropping resistor for each bulb. A typical conversion is shown in the schematic.

The average set owner loves the exotic color produced by the neons. You'll find the time required for modification is far shorter than the time you spend in finding a supplier for the crazy pilot bulbs used in such a set.—*George R. Wisner*

LOSS OF BURNOUT PROTECTION IN BROWN ELECTRONIK 152 RECORDER

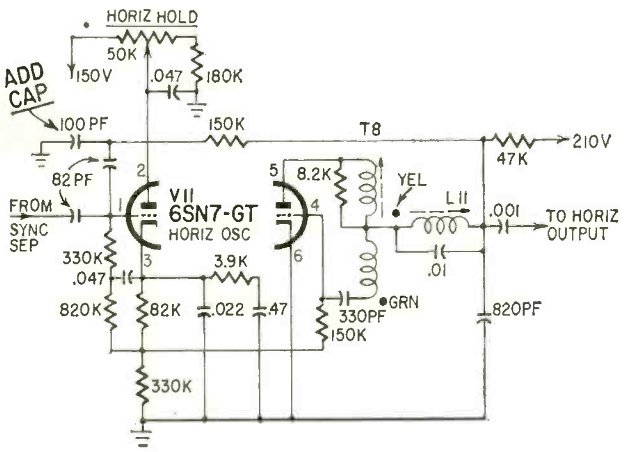
In production processing of rubber or plastic where a predetermined temperature must not be exceeded, Brown Electronik temperature recorders with a *burnout safety* are used. The safety drives the recorder pen slowly to top scale if the thermocouple, extension wires, voltage amplifier tubes or converter should burn out. The recorder control, with the pen at top of scale, shuts down the heating cycle.



When servicing the recorder for failure of the burnout circuit, check three components before removing the amplifier for more extensive testing. First, the 1-μf paper capacitor, C1, connected between the thermocouple (−) and ground. Next, the 400-μf 6-volt, nonpolarized damping capacitor, Cd, in the top left side of the recorder chasiss, in the standardization compartment. This capacitor can be checked only by substituting a new unit. On one occasion, four were tried before one of them was satisfactory. Finally, check the burnout switch on the amplifier chassis. The slide switch should be set to position No. 1.—*F. G. Lewis*

TRANSVISION TV KIT TROUBLES

When I finished my Transvision model G TV set kit, I noticed two troubles not due to wiring mistakes. The first was horizontal oscillator instability. The second was retrace lines. This is how I eliminated them.



The symptoms of the first ailment were breakup of the raster (Christmas-tree effect) as the set warmed up, and critical adjustment of L11 (see schematic). The horizontal oscillator circuit is a Synchroguide type. When all components and wiring checked OK, I began scanning the schematics of other Synchroguide TV sets. Most of them had a small fixed of trimmer capacitor from the junction of the 82-pf capacitor and the 150,000-ohm resistor in the feedback path. If there was a trimmer, it was called "horizontal lock" or

continued on page 86

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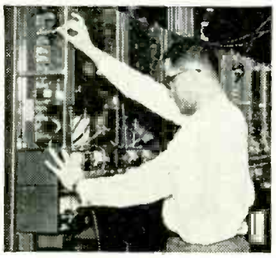

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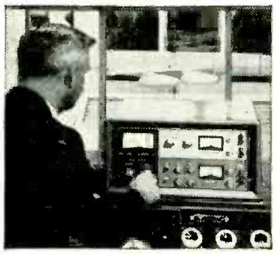

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Dept. RE-2B, 1776 E. 17th St., Cleveland 14, Ohio "horizontal locking range." There was no such capacitor in the Transvision. A 100-pf disc ceramic capacitor improved horizontal stability greatly and eliminated the Christmas-tree effect.

I got rid of the retrace lines by disconnecting the yellow lead of the vertical output transformer from pin 2 of the CRT, and connecting that pin instead to the vertical oscillator plate (6DE7 pin 6) through a 56-pf capacitor. Spikes there are synchronous with the retrace lines and, when they are fed to the grid of the CRT, they blank the tube during the retrace period.

After these faults were cleared up, the set worked perfectly.—*Paul Galluzzi*

WHAT IS HIGH FIDELITY?

continued from page 31

which is quite different from what the composer intended the audience to hear.

How does all this apply to the home? If "fidelity" or "realism" is what we are striving for, and I assume this is usually the case, let us examine how we can best accomplish this. Consider, first, loudness. It is impractical and sometimes impossible to produce loud sounds in one's home, not to mention that many people, particularly women, object to excessive noise. Therefore, let us try to reproduce a level of loudness that most listeners actually find in a concert hall—a considerable distance from the orchestra. It is the music heard in the rear of an auditorium that we must transport into the home. To make such low-level music reproduction sound realistic, the frequency contour has to be changed, and in particular the lows must be emphasized. Properly designed equipment should readily be able to accomplish this; it is usually a question of adjusting existing controls. Many hi-fi instruments have so-called loudness controls which are intended to give the same effect. However, mostly they do not compensate enough for very low-level listening.

Proper loudness with compensation does not alone give realistic reproduction. We must stimulate the diffused character of the sound source, particularly when simulating listening conditions in the rear of the concert hall. This can be done in the home in a number of ways. Assuming one were to assemble a "fi" sound system from a number of components, the layout of furniture in the room, the materials as well as the size and shape must be considered carefully before installation. As a matter of fact, from the point of view of obtaining the most desirable effect, this survey is the most difficult and the most important item. Since we are trying to reproduce the effect of distance, the speakers should be located as far as practical from the desired listening area.

One has the choice of combining the bass frequencies below 200 cycles for both the right and left sides of the stereo system into a single bass speaker. Thus only a single bass speaker needs to be properly located. This bass speaker should be at the farthest possible distance from the listening area, at a greater distance than the treble speakers, and could be concealed around some corner. Due to the nondirectional characteristics of the low frequencies, one can tolerate all kinds of obstructions between the listening area and the source of low-frequency sound.

In the example described here, the right and left speakers need produce only middle and high frequencies (200 cycles and up), which ordinarily reduces the size of the speaker enclosure or the baffle area. This makes it possible to locate these right and left speakers so that they radiate sound not toward the listening area but toward opposite corners of the room, about two-thirds up toward the ceiling. If the two corners along a given wall are too widely separated, the speakers can be brought nearer the center, at the same time aiming the sound toward the wall, two-thirds up toward the ceiling. It is very difficult to prescribe a universal method of optimally locating the speakers. This usually has to be arrived at experimentally by the ultimate users of the sound system. To make a process of trial and error more purposeful, one should constantly keep in mind the original objective: to re-create certain concert-hall conditions in the home. The kind of fidelity we are striving for is the recreation of the effect of distance, requiring three major ingredients:

1. Listening at low level with a great deal of low-frequency emphasis.
2. Maximum diffusion of sound over a large area.
3. Placing all sound sources as far from the listening area as possible, and locating bass farthest away.

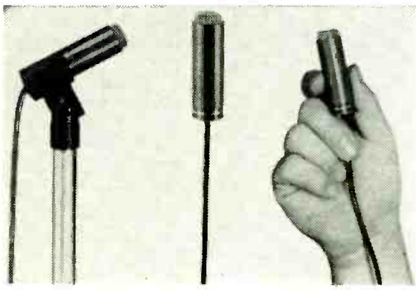
The reason why Mr. and Mrs. A's expensive equipment didn't produce "music" was that the mere assembly of expensive components perhaps satisfies engineering specifications but rarely produces fidelity. Often only a fraction of the capability (and therefore cost) of a so-called hi-fi installation, when properly utilized, is needed to produce realistic music reproduction in the home. Also, there are now available a few compact, self-contained phonographs which have been purposely engineered with the philosophy of "fidelity" in mind and can demonstrate that a relatively low-cost, compact machine can give the music-lover a great deal of satisfaction. END

NEW PRODUCTS

SUBCARRIER DETECTOR, kit or wired, for reception of SCA background-music programs on FM broadcast carriers.

Plugs in multiplex output of FM tuner, or wires into discriminator. Has electronic muting so no sound is heard in absence of subcarrier program.—**Music Associated**, 65 Glenwood Rd., Upper Montclair, N.J.

SMALL MICROPHONE, *model 571*, 2⅝ in. long, ¾-in. diameter. Moving-coil, dynamic type with frequency response from 50 to 10,000 cycles; single impedance matches any low-impedance input from 50 to 250 ohms; output level −60.5db (0db = 1 mw with 10 μbars). Has nondetachable 30-ft 2-conductor cable. Steel case, finished in nonreflecting



gray. Weighs 2 oz, less cable.—**Shure Bros., Inc.**, 222 Hartrey Ave., Evanston, Ill.

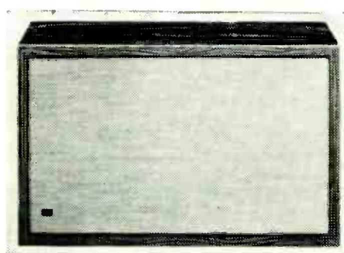
MOTIONAL FEEDBACK STEREO SYSTEM, *model AM-229M*. Second voice coil in speaker generates distortion canceling voltage which is fed back into amplifier. 30-watt stereo amplifier and two 2-way speaker systems. Inputs for magnetic or crystal phono, tuner, tape, and aux. Response 30 to 25,000 cycles. Hum and noise −60 db. Output impedance 8 ohms. Oiled walnut cabinets; amplifier 14¾ × 9¾ × 5⅝ in., speakers 19¾ × 11¾ × 6 in.—**Olson Electronics, Inc.**, 260 S. Forge St., Akron 8, Ohio

STEREO RECORDING AMPLIFIER, *model SRA-3*, updates *SRA-2L* with 2 studio type VU meters and studio-calibrated control knobs, is heavier by 4 lb, instantly interconnects with Sony *263-E*, *262-D* and *263-D* tape decks. Bias frequency: 80 kc from push-pull oscillator circuit. Response: 30–18,000 cycles with *263-D* deck. Tube complement: two 12AX7, two 6DA5, one 12AT7, one 12BH7, one 6X4, four 1N34A germanium diodes. Power: 40 watts 110–117 volts 60 cycles. 12¼ × 8½ × 4 in., 12⅝ lbs.—**Superscope, Inc.**, 8150 Vineland Ave., Sun Valley, Calif.

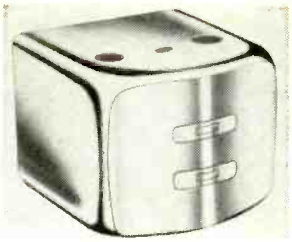
MARINE RADIO TELEPHONE, *Challenger 62*. 62 watts, FCC type-accepted; 6 marine channels plus broadcast band. Range: 2,000–6,000 kc for both transmitter and receiver. Push-to-

talk mike. Silicon diode battery polarity protector. 13½ × 10⅝ × 6¼ in., 15 lbs. Universal mounting tray, aluminum nonmagnetic construction.—**Sonar Radio Corp.**, 73 Wortman Ave., Brooklyn 7, N. Y.

THREE NEW SPEAKER SYSTEMS. *Sonata II* (*model B-211*, illus.),



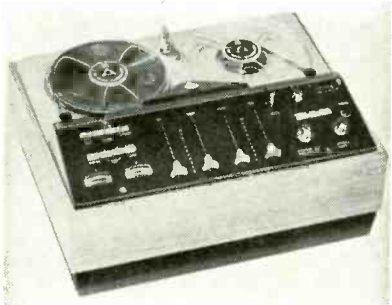
is 23⅝ × 14¼ × 11½ in.; *B-199A* bass speaker and *B-200Y* treble unit; L-C crossover 6 db per octave at 2,500 cycles; frequency range 50–16,000 cycles; impedance 8 ohms. *Concerto II* (*model B-312*) and *Concerto III* (*model B-313*), are 24½ × 17¼ × 12½ in. *Concerto II* uses B-207A coaxial speaker with response from 45 to 16,000 cycles; 6 db per octave crossover at 2,500 cycles. *III* adds B-209B midrange speaker and N-10102A crossover network; range 45 to 16,000 cycles; crossovers 6 db per octave at 800 and 2,500 cycles. For all models recommended amplifier power is 20 watts rms or more.—**R. T. Bozak Mfg. Co.**, Darien, Conn. 06821



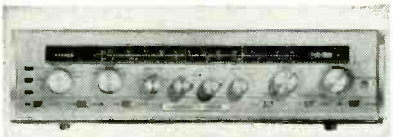
FM STEREO TUNER KIT, *model AJ-13*, has 3 controls: automatic frequency control switch, on–off FM–stereo selector, and flywheel tuning control. 7-tube circuit includes built-in FM multiplex. Sensitivity: 2½ μv for 20 db of quieting; mono response ±1 db 30–20,000 cycles; stereo response ±2 db 50–15,000 cycles; harmonic distortion 1% or less at 1 kc; channel separation 25 db or more at 1 kc. Has stereo broadcast indicator light, edge-lighted slide-rule dial, external antenna terminals, transformer-operated power supply with silicon diode rectifiers. Steel cabinet in brown and beige.—**Heath Co.**, Benton Harbor, Mich.

TURNTABLE, *PE-34*, has semi-pneumatic cueing and indexing tone-arm control for 7-, 10- and 12-in. records for starting or stopping at any point. Tone arm lifts automatically at completion of play. 4-speed nonmagnetic aluminum-weighted turntable mounted on precision bearings; belt plus idler wheel drive system; 4-pole induction motor with reserve torque floats in triple rumble-isolation system; built-in spring-loaded stylus pressure-adjustment gauge; vernier speed adjustment. 13 × 10¾ in. long and wide; 3 in. above mounting board, 3⅝ below. Satin walnut base optional.—**Elpa Marketing Industries Inc.**, New Hyde Park, N. Y.

8-TRACK STEREO TAPE HEAD, *model B2L*, for ¼-in. tape, has 100-microinch head gap for 3¾ inches per second. Head mechanically indexed to 4 discrete positions to provide 4 stereo or 8 mono channels. Solid or laminated core versions. Hyperbolic all-metal face with mu-metal shielding. Can be used as record/play head and comes in various impedances.—**Nortronics Co., Inc.**, 8101 10th Ave. N., Minneapolis, Minn. 55427

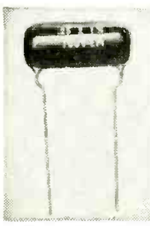


STEREO TAPE RECORDER, *Beocord 200* (portable or console), has 3-channel stereo mixing facility using professional type slide potentiometers. Completely transistorized. Response: ±2 db, 40–16,000 cycles at 7½ ips, 40–14,000 cycles at 3¾ ips, 50–6,000 cycles at 1⅞ ips. Wow and flutter: peak to peak; less than 0.2% at 7½ ips, less than 0.3% at 3¾, less than 0.5% at 1⅞. Channel separation better than 45 db. Signal-to-noise ratio: better than 50 db. Hysteresis-synchronous motor. Console (shown): 18 × 14½ × 9 in. 38 lb. Portable: 18 × 14 × 10 in., 41 lb.—**Dynaco Inc.**, 3912 Powelton Ave., Philadelphia, Pa. 19104



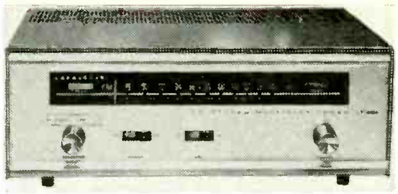
TUNER/AMPLIFIER, *S-7700 III*, with built-in circuitry and test points permitting direct connection of a scope to measure degree of multipath interference. Receives AM, FM and FM multiplex, has inputs for phono and tapedeck. Two 40-watt music-power channels with outputs for 4-, 8- and 16-ohm speaker systems for stereo; separate powered center-channel output. IM distortion 1½% at 36 watts per channel. Response at rated output: 20 cycles to 20 kc ±½ db. 16¾ × 4 × 14 in.—**Sherwood Electronic Labs, Inc.** 4300 N. California Ave., Chicago, Ill. 60618

TUBE TESTER, *model 1101*, tests all popular receiving and picture tubes; has 3½-in. d'Arsonval meter in bridge circuit. Tests for emission, shorts, leakage and gas. Pin straighteners for all tube types. Complete tube chart. 8⅝ x 11⅝ x 3¼ in., 4 lb.—**Mercury Electronics Corp.**, 111 Roosevelt Ave., Mineola, N. Y.



DIPPED TUBULAR CAPACITORS, *TYPES MD* (dipped Mylar) and *MPD* (dipped Mylar-paper), are available in 100-, 200, 400 and 600-vdc ratings. Noninductively wound and vacuum-dipped, in tolerances as low as ±1%, they are suitable for environmental and high-temperature applications.—**Arco Electronics, Inc.**, Community Dr., Great Neck, N. Y. 11022

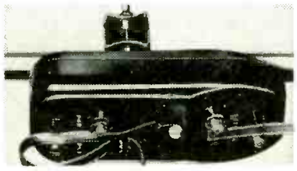
FM STEREO TUNER, *LT-250*. Stereo Search system locates stations broadcasting FM multiplex stereo by sending an audible signal through both channels; has tuning eye and switchable

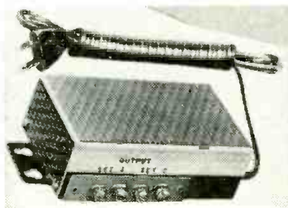


afc. Built-in multiplex circuit provides stereo separation of 38 db at 400 cycles with less than 1% distortion. Tuned rf stage. Sensitivity 2 μv for 20 db quieting. 12¾ × 5⅝ × 9½ in.—**Lafayette Radio Electronics Corp.**, 111 Jericho Turnpike, Syosset, N. Y.

STEREO AMPLIFIER KIT, *LK-72-B*, has 80-watt output, equalization positions for phono and tape deck, separate bass and treble controls for each channel, center-channel signal for extension or center-channel speaker, subsonic filter, redesigned front panel. Factory-mounted terminal boards, tube sockets.

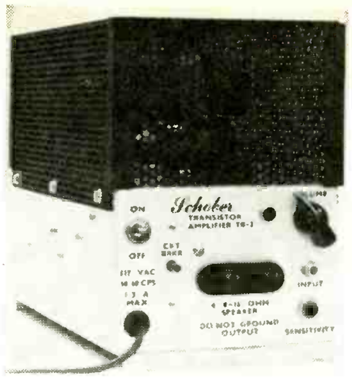
All wires precut and prestripped. Power rating: 40 watts (IHF) per channel; power band, 20–20,000 cycles ±1 db; response, 20—20,000 cycles ±1 db; harmonic distortion 0.8%.—**H. H. Scott, Inc.**, Dept. P, 111 Powdermill Rd., Maynard, Mass.





ANTENNA AMPLIFIERS, *Tele-Amp* series feature transistor and nuvistor design, printed-circuit boards. Weatherproof; mount on any crossarm or mast with two nuts. Model *VUT-3* is 3-transistor vhf/uhf/FM; *VN-2*, 2-nuvistor vhf amplifier; *VT-2*, 2-transistor vhf; *VT-1*, 1-transistor vhf/FM; *UHT-1*, 1-transistor uhf.—**JFD Electronics Corp.**, 15th Ave., at 62nd St., Brooklyn 19, N. Y.

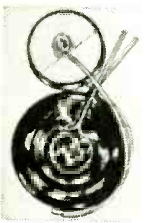
TRANSISTOR AMPLIFIER KIT, *TR-2*. Rating, 40 watts continuous sine wave at less than 0.75% harmonic distortion; response, ±0.5 db, 20—20,000 cycles; 1.4% intermodulation at 40 watts; clipping point, 45 watts minimum with 8-ohm load. Hum and noise 83 db below rated output; sensitivity, 55 mv for 40 watts output; input impedance, 100,000 ohms.



Recommended for hi-fi and stereo systems, organs, other electronic musical instruments, PA systems. 11¼ × 5⅜ × 7⁹⁄₁₆ in., 13 lb.—**Schober Organ Corp.**, 43 W. 61 St., New York, N. Y. 10023

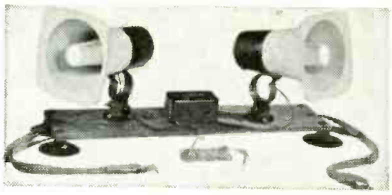
5-IN-1 TOOL combines 2 screwdrivers—1 standard and 1 Phillips—with 3 hex socket wrenches in ¼-, ⁵⁄₁₆- and ⅜-in. sizes. Pocket clip, shock-resistant handle. Metal parts of nickel-plated tool steel.—**General Electric Electronic Components Div.**, Schenectady, N. Y.

ALL-TRANSISTOR FM STEREO RECEIVER, the *SR-300*. IHF music power output 36 watts. Response ±1 db at 1 watt: 8 to 25,000 cycles; 10 to 23,000 cycles at full rated power. Harmonic distortion less than 1%. Hum and noise suppression 90 db. Damping factor 25:1. Square-wave rise time 5 μsec. Usable FM sensitivity 2.9 μv IHF. Image rejection better than 40 db. Spurious response rejection better than 60 db. Multiplex separation 30 db. 14½ × 4½ × 9¾ in., 14 lb.—**Harman-Kardon, Inc.**, 15th & Lehigh Ave., Philadelphia 32, Pa.



GLOBAR RESISTOR KIT, *model FRTV*, consisting of thermistor and varistor used in automatic degaussing circuits for color TV (RCA, Zenith, Warwick, Magnavox, G-E, Wells Gardner, Curtis Mathes and others).—**Workman Electronic Products, Inc.**, PO Box 5397, Sarasota, Fla.

MOBILE SOUND SYSTEM. *Ampli-Vox, model S-310* is all-transistor, push-pull design. Rated 32 watts EIA music power (50 watts peak). Response: 50–15,000 cycles; less than 5% distortion at full output. Outputs for two 8- to 16-ohm speakers; inputs for microphone and auxiliary sources. Signal-to-noise ratio: 80 db. Amplifier operates on 12 volts dc,



can be adapted for ac or flashlight batteries. Tape deck or phono can be added.—**Perma-Power Co.**, 5740 N. Tripp Ave., Chicago, Ill. 60646

ELECTRONIC EXPOSURE METER KIT, *Knight-kit KG-275* uses cadmium sulfide photocell powered by two 1.35-volt mercury batteries, will read light down to 0.014 footcandle. Color-coded scales indicate proper lens openings and shutter-speed combinations; push-to-test button on back of case is built-in battery tester. High range, 20 to 28,000 footcandles; ASA film-speed settings, 6 to 12,000 (1° to 12°); f-stop settings, 0.5 to 64; shutter-speed settings, 1/4,000 sec to 30 minutes; cine settings, 4 to 128 frames per second; EV settings, −12 to +22; acceptance angle, approx. 50°; color response peaked at 5,600 A. 4¼ × 2¼ × 1⅜ in.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

CHILLING SPRAY, *Frost Aid*, chills suspected faulty components to −20°F in 2 seconds with no liquid residue, reveals components with thermal intermittents. Packaged with long plastic extender tube in 8- and 16-oz sizes.—**Chemtronics, Inc.**, 1260 Ralph Ave., Brooklyn, N. Y. 11236

TURNTABLE BASE/COMBINATION. Cover of *Model DCB-1* has side panels of oiled walnut to match the base,

continued on page 94

See P 94

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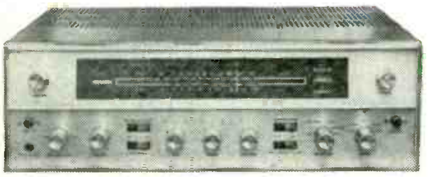

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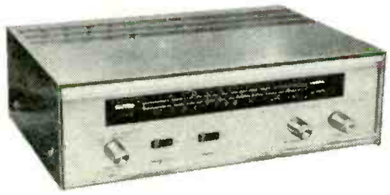

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New LT-325 AM/FM Multiplex Tuner combines simplicity, flexibility, and superb styling. 20-Tube performance provides a great variety of features, including a new audible tone "Stereo Search System." Imported, **99-0001WX.**

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RUGGED SILICON MESA TRANSISTORS USED IN ALL CRITICAL AREAS FOR EXTRA RELIABILITY

INCLUDES .003% TOLERANCE CRYSTALS FOR FREQUENCY STABILITY

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MODEL HB-500 **139.50**
Stock No. 99-3027WX Only

■ 12 Crystal-Controlled Transmit & Receive Positions ■ 23 Channel Tunable Receiver with Spotting Switch ■ 15 Transistors, 5 diodes ■ Dual Conversion Receiver with 5/10 μV Sensitivity ■ Exclusive Quality Mechanical Filter For Razor-Sharp Selectivity ■ Variable Squelch, "S" meter ■ Dependable Sealed Relay Switching ■ Compact 3"Hx11⅞"Wx6¹¹⁄₁₆"D ■ For 12VDC (optional 117VAC Solid State power Supply available) ■ Supplied With Crystals for Channel 12, easy-mount Mobile bracket, Push-to-Talk Dynamic Mike.

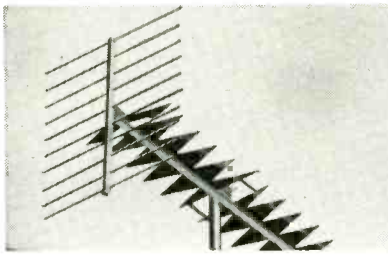
NEW! LAFAYETTE DELUXE 8-CHANNEL DUAL CONVERSION 5-WATT CB TRANSCEIVER *SUCCESSOR TO THE FAMOUS LAFAYETTE HE-20C*

Model HB-200 **109.50**
Stock No. 42-0118WX ONLY

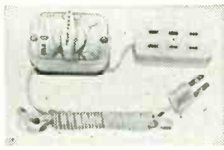
■ 9 Tubes plus 3 Silicon Diodes plus 2 Crystal Diodes for 17-Tube Performance ■ Super Sensitivity—1 Microvolt or Less ■ 8 Crystal Receive Positions plus 8 Crystal Transmit Positions plus 23-Channel Tunable Receive ■ Push-to-Talk Microphone ■ Dependable Relay Switching ■ Illuminated Meter with 3-Position Switch ■ Adjustable Squelch and Automatic Noise Limiter ■ Spotting Switch ■ Built-in 117 Volt AC Power Supply with 12 Volt DC Mobile Transistorized Power Supply ■ Plug-in facilities for Lafayette Selective Call Unit ■ With Bracket Handle, Push-to-Talk Ceramic Mike, Pair of Transmit and Receive Crystals for Channel 15 plus Crystal for Dual Conversion.

NEW PRODUCTS continued

with rigid smoke-tinted plexiglass on other surfaces. They can be lifted off or left in raised position. For all Dual automatic turntables.—**United Audio Products, 12 W. 18 St., New York, N. Y. 10011**

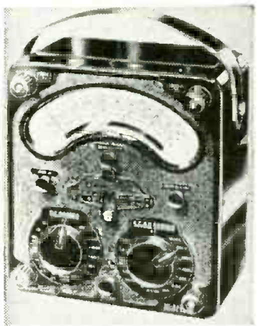


UHF ANTENNAS. The 13-element suburban *Bandsaw* (*model 4311 G*) and the 22-element fringe *Super Bandsaw* (*model 4310 G*) have adjustable bandspan that can be set for peak gain in desired section of band with calibrated scale with 6 printed channel numbers. Can be easily stacked with tapered-spacing stacking harness, model *4312 G*. Peak gain of single *Bandsaw* is 12 db, 15½ db for *Super Bandsaw*, 3 db increase when stacked.—**Channel Master Corp., Ellenville, N. Y.**



TIMED EXTENSION CORD automatically shuts off anything electrical at preselected time. Control 1, 2 or 3 devices at once, dialing any period from 1 minute to 4 hours. 6-foot cord; 10 amps—125 volts ac. Postage paid with order of 3. Cream finish, gold dial face.—**Value Village, Box 501, Buffalo, N. Y. 14205**

EPOXY SPRAY KIT, *Guardon,* for painting models, comes with separate aerosol power sprayer, powered by safe freon gas. Also included are solvents, a newly developed filler and mixing accessories.—**F. C. Kenyon Co., Inc., Box 92, Whippany, N.J. 07981**



MULTIMETER, *model 8, Mark III AvoMeter* has 30 self-contained ranges for measuring resistance and current and voltage in both ac and dc. Accuracy: 1% of full scale on dc, 2.25% on ac ranges. Foolproof mechanical cutout, temperature-compensated movement, polarity-reverse button. Resistance: 0–2.5, 2,000, 200,000 ohms; 0–20, 200 megohms. Dc volts: 0–2.5, 10, 25, 100, 250, 500, 1,000, 2,500. Dc sensitivity: 20,000 ohms per volt. Current (dc): 0–50, 250 μa; 0–1, 10, 100 ma; 0–1, 10 amp. Shunts available for 50, 100 and 200 amp. Current (ac): 0–100 ma, 0–1, 2.5, 10 amp. Ac volts: 0–2.5, 10, 25, 100, 250, 1,000, 2,500.—**Amacoil Instruments, Inc., 750 St. Ann's Ave., Bronx, N. Y. 10456** END

All specifications from manufacturers data.

booklets New Literature charts catalogs

ORGAN DEMONSTRATION RECORD, *GDA-232-5,* 7-in., 33⅓-rpm record shows off tone of Heathkit/Thomas Coronado BL-3 transistor organ.—**Heath Co.,** Benton Harbor, Mich. 49023. **50¢**

HIGH-FIDELITY COMPONENT CATALOG, 16 pages with drawings, specs of both heptagonal and bookshelf-style speakers, turntables, cartridge and arm, including 2 pages on "Facts About Playing Records" and "Basic Stereo Record Library".—**Empire Scientific Corp.,** 845 Stewart Ave., Garden City, N.Y.

HI-FI COMPONENTS BOOKLET, 12 pages, many photos, specs and curves describing line of tuners, receivers, amplifiers and speakers and accessories.—**Sherwood Electronic Labs Inc.,** 4300 N. California Ave., Chicago, Ill. 60618

CUSTOM ENGINEERING BULLETINS, *CEB 2* and *9. No. 2* explains factors to consider when designing a 3¾-ips tape system. *No. 9* contains engineering data for easy-to-construct silicon transistor recording amplifier.—**Nortronics Co., Inc.,** 8101 10th Ave. N., Minneapolis, Minn. 55427

REPLACEMENT CHART, Sonotone's *Condensed Crystal Cartridge Cross-Reference Guide, No. SAC-28* is a sheet on card stock, 3-hole punched, lists 146 crystal cartridges (stereo and mono) which can be replaced by 6 Sonotone models.—**Electronic Applications Div., Sonotone Corp.,** Elmsford, N.Y.

TRANSDUCER BULLETIN, *No. C-103,* single sheet, looseleaf-punched, with photos and specs on 2 outdoor paging and talkback speakers, *model OP-6* and *OP-8,* plus description of special mounting bracket.—**Oxford Transducer Corp.,** 2331 N. Washtenaw, Chicago, Ill.

DATA SHEETS on 5 columnar speaker systems for public-area sound, including medium-duty and heavy-duty concert-service types, medium-duty and heavy-duty general-service types and one for areas of severe reverberation. With specs and response curves.—**R. T. Bozak Mfg. Co.,** Darien, Conn. 06821

1965 FLYER, 8 pages of semiconductor bargains, integrated circuits, pancake transistors, etc., $1 sale, plus double bonus to mail-order customers.—**Poly-Paks Co.,** PO Box 942, S. Lynnfield, Mass.

VIBRATOR REPLACEMENT GUIDE, write for bulletin *Class 250.00,* 8-page, looseleaf-punched listing of vibrators used in communication and Citizens band equipment. Listed by manufacturer with cross index to competitive vibrator type numbers.—**Cornell-Dubilier Electronics, Promotion Dept.,** 50 Paris St., Newark, N.J.

MULTIPLIER PHOTOTUBES WALL CHART, *PIT-701,* 2 colors, 33 x 25 in., gives socket and shield information, constructional details, JEDEC curves, conversion factors.—**RCA Electronic Components & Devices,** Harrison, N.J.

PLUGS CATALOGS. *Catalog LR/MR-3A* describes series of weatherproof plugs; 8 pages, illustrated with specs. *Catalog CK-1* has specs and photos of subminiature circular plugs.—**Cannon Electric Co.,** 3208 Humboldt St., Los Angeles, Calif. 90031

SCR BULLETIN, *CT-27* on 2N681–2N692 series, gives 14 parameters per type, 9 performance characteristics each plus curves in 4-page bulletin.—**Tung-Sol Electric Inc.,** 1 Summer Ave., Newark 4, N.J.

ZENER DIODE BROCHURE, *T4262,* 12 pages, looseleaf-punched, illustrations. Discusses manufacturing, process control, test assurance procedures and facilities, plus device selection charts for designers and procurement specialists.—**Motorola Semiconductor Products, Inc.,** Dept. TIC, Box 955, Phoenix, Ariz. 85001

SCREWDRIVER CATALOG SHEET, *N764,* describes an interchangeable blade set designed to work with Allen hex recess setscrews and cap screws. Includes regular handle, 9 blades and 4-in. extension shaft.—**Xcelite Inc.,** Orchard Park, N.Y.

POWER, APPARATUS AND CONTROL CABLE CATALOG, *Section A,* 33 pages, looseleaf-punched, describes and illustrates silicone-rubber-insulated cables and many other types for applications such as soaking pits, boiler rooms, heaters, motion picture machines, traffic signals. Table of wire gages and National Electrical Code tables.—**Continental Wire Corp.,** 322 N. Cherry St., Wallingford, Conn.

MEMORY-CORE SPECIFICATIONS replace all but 2 sheets of Section 800 of Ferroxcube catalog.—**Ferroxcube Corp. of America,** Saugerties, N.Y.

MEASUREMENT SYSTEM CATALOG, *AO-64,* illustrates and lists technical data on the Omega system of pressure, acceleration, vibration, displacement and force measurement, with applications chart.—**Omega Instruments Div., Dressen-Barnes Electronics Corp.,** 2599 N. Fair Oaks Ave., Altadena, Calif. END

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.

UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

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RADIO-ELECTRONICS now has a new Non-Commercial rate of 30¢ per word for *individuals.* (Our commercial rate remains at 55¢ per word.)

Readers interested in buying or selling personal items or equipment can now do so at little cost.

See the classified section for details and order form.

technicians' News

WHO PAYS FOR THAT FACTORY GUARANTEE?

Reprinted below is an article that appeared in the December issue of the *TSA Service News*, official monthly of the King County Television Service Association, Washington.

"We received a letter the other day which reaches an all time high in outright frankness.

"The letter was from the 'national service manager' of a well-known factory on company letterhead and over his signature.

"The letter suggests that he *expects* us to gouge the out-of-warranty customer to support the factory 'guarantee' program.

"He freely admits that his factory-paid labor rates are not intended to cover our costs of doing their work, and states we should charge the other customers referred to us, in sufficient amount to cover the losses brought about by the below-cost rates paid by the factory for in-warranty repairs.

"In the letter he absolutely refuses to take cognizance of our increased labor costs and other costs of doing business and states his factory has no intention of reviewing their outdated rate schedules. And we gather we can take it or leave it!

"He is certainly frank about his company's attitude, but we wonder if his bosses expected him to put it in writing."

RADIO-ELECTRONICS queried the association, and received a reply from James O. Humphrey, its public information director. He wrote, in part, "Our article . . . is documented in our files by an actual letter . . . to one of our members. The letter was in reply to a letter directed to him, . . . asking if the factory had any intention of raising . . . the $3.50 flat rate paid by the factory. [Recent wage negotiations in the Seattle area had brought the hourly cost per employee to $4.07, including taxes and benefits.] Our article reports his reply.

"We have had many factory 'representatives' suggest that we [should] cheat our customers to recover our losses on factory-paid warranty work, but . . . always . . . verbally. This is the first instance where we have been able to document the factory philosophy."

MOCH WRITES LBJ ON EXTENDED WARRANTIES

Frank J. Moch, executive director of the National Alliance of Television & Electronic Service Associations, has written President Johnson about the plight of the independent service technician in the face of expanding extended-warranty programs of TV set manufacturers.

Prompted by an article in *Home Furnishings Daily*, the letter referred especially to one sentence in the article: ". . . when the transistorization of TV becomes standard, a 5-year warranty—at least on parts—could be offered with little or no cost problems." Moch wrote, "In other words, quality is allegedly so good that service is not needed (or rendered) and so the buyer is being offered absolutely nothing but protection from something that is not likely to occur.

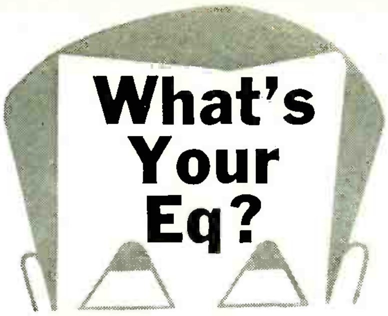
". . . Restraint of trade is the underlying plan. (1) Obviously the cost of *any* warranty, despite claims of being free, is figured in the price of the product; (2) the factory says it doesn't expect to render service; (3) making [the] extended warranty universal, puts the company in the 'insurance' business . . . everybody contributes to pay the costs on a few; (4) this creates captive service which isolates the customer from the seller and deprives [him] of a free choice of service agency; (5) it will eliminate the retailer by depriving him of servicing his own customers and keeping contact too costly; (6) it permits the factory to propagandize and brainwash the customer at the customers's own expense, and so permits the factory to perpetuate itself to the exclusion of independent servicers and sellers.

"Because this . . . will destroy . . . thousands of independent businessmen, we believe your personal attention is vitally needed. Action to stop this restraint of trade is urgent."

Copies of the letter went to the FTC, to Rep. Roosevelt, chairman of the House small-business committee, and to the Justice Dept.

Following a similar action in Chicago last fall, the New York distributor of Admiral color television has added a 1-year parts-and-labor warranty to all newly introduced color sets.

Emerson Radio Associates, Inc., independent distributor for Emerson Radio, Inc., has placed a 5-year parts and service warranty on its 11-inch transistor TV, which retails for $149.95. END



These are the answers. Puzzles on page 48.

Dialing

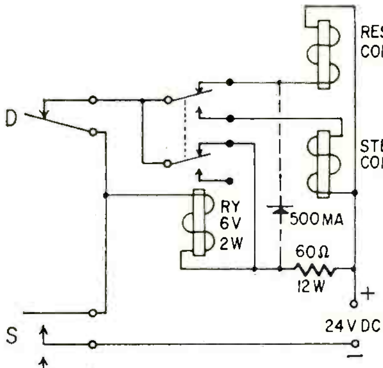


Fig. 1

If the stepper coils are 24-volt, a single 6-volt relay can be used (Fig. 1). In operation, S closes, energizing the reset coil which is held until first opening of D removes short on relay coil. Relay now pulls in and step coil is operated directly from D contact closures. Lower relay contact may be eliminated by use of a diode (dotted lines) if desired.

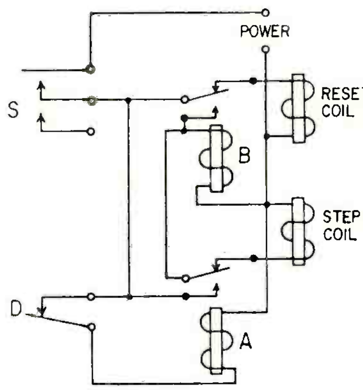


Fig. 2

In the two-relay version (Fig. 2), D closes, energizing the reset coil and relay A which in turn pulls in relay B, locking out reset. There is enough time delay in relays for reset to operate properly. Relay A follows D pulses and causes step coil to operate for each opening of D contact.

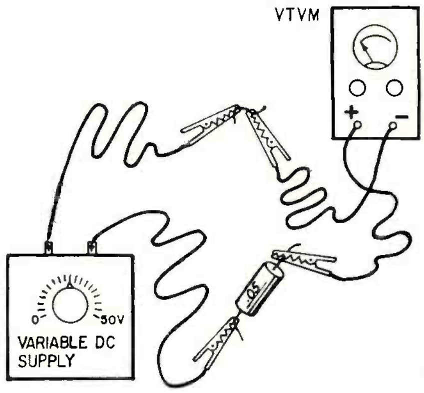
Which is which?

With no external load, the box containing the current source is pumping 1 watt of power into the shunt resistor. Therefore, this box will get hot—at least hotter than the other, whose circuit is dissipating no power.

If the boxes are made of nonmagnetic material, the one with current flow will also deflect a magnetic compass.

Distorted Recording

The trouble was slight leakage in C2. It did not have too much effect on playback because the volume control was not turned up high, so there was considerably less positive voltage on V2's grid. When the microphone was used, it was necessary to advance the volume control almost to full. This put positive voltage on the grid and caused severe distortion.



Music from the FM tuner was recorded at low level and, ironically, it was my concern about overloading the first tube that caused me to turn down the tuner volume and turn up the recorder volume. Imagine my surprise when I found that distortion set in.

Incidentally, this capacitor checked good with an ohmmeter. However, when checked as shown, there was a steady voltage reading through it. END

WHEN YOU ORDER MERCHANDISE BY MAIL . . .

- *Be sure to include your name and address. Use your zip code number if you know it.*
- *Type or print if you can—if not, write clearly.*
- *Don't send cash! Remit by check or money order.*
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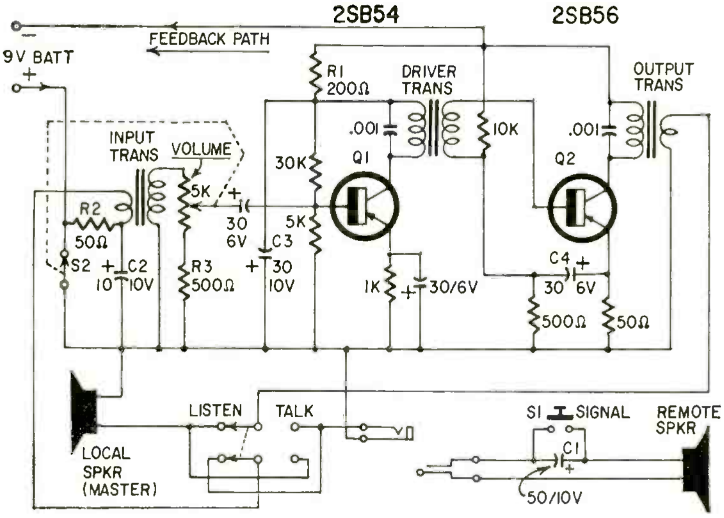
noteworthy Circuits

The master station answers by turning the unit on. This switches the battery's positive terminal direct to the amplifier common through S2. The unit then works like a normal intercom. The reactance of C1 is negligible so the remote need not hold the call key down to talk or listen. If the wires to the remote are reversed, battery current flows through C2 and the master will buzz continuously when switched off. C2 bypasses R2 for talk-listen operation and limits the feedback for the signal circuit.—*Steve P. Dow* END



UNUSUAL INTERCOM CIRCUIT

In the Tophonic battery intercom, typical of many inexpensive transistor systems, an unusual signal circuit is used so the remote station can signal the master, even when the master is turned off. Only two wires connect the master and remote.

When the unit is off, S2 is open and the positive battery terminal is connected to the input transformer through R2. When the signal key (S1) at the remote is closed, the battery circuit completes through the remote speaker, the input transformer and R2. The output transistor's collector current flows through the input transformer, making the unit act as an oscillator to produce a tone in the master speaker. The battery circuit of the output stage is decoupled from the input stage by R1 and C3.

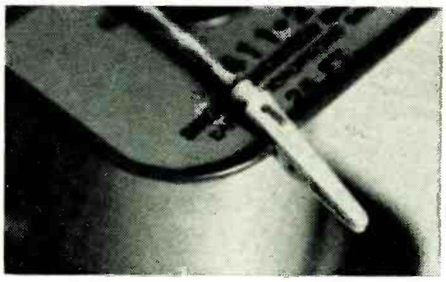
C4, between Q2's base and emitter, provides enough negative feedback to stabilize the amplifier, even when the battery is weak. The low side of the volume control is grounded through R3 to allow enough signal through to maintain feedback when the control is at minimum.

The installment of "Glossary of Color Terms" was unfortunately omitted this month, due to lack of space. It will be completed in an early issue.

try This one

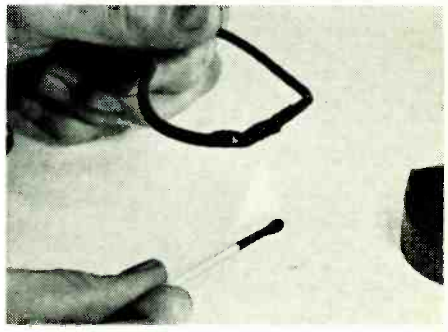
SOLDERING MINI-GATOR CLIPS

Soldering a wire lead to a Mini-Gator clip is difficult. The clip as well as the wire must be held in place during the process. You need one hand to hold the solder and the other to hold the iron. That doesn't leave any free hands for positioning and holding the clips and lead. I've tried using a vise, pliers with rubber bands around the handles, and a number of makeshift jig ideas.



The solution shown in the photograph is the best I've found. Strip the end of the wire, pass it through the small hole in the clip, and bend it against the clip. Slip the clip over a metal spool as shown in the photograph. The clip and the wire are held in place for easy soldering.—*F. H. Frantz*

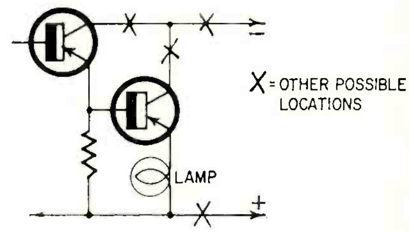
FLAME LOOSENS TIGHT TAPE



Remember the tough time you had when you tried to remove some plastic electrician's tape from a splice? The adhesive of this kind of tape is so good that it holds too tight! Next time, heat the tape in the flame of a lighter or match. This will soften the adhesive and lessen its tenacity.—*John A. Comstock*

PROTECT YOUR TRANSISTORS

A simple way to protect transistors from overload, thermal runaway, etc. is to place a flashlight bulb in series with the emitter or collector of the transistor.



The principle is based on the fact that lamps are positive-temperature-coefficient resistors and, as the current in-

continued on page 102

SCHOOL DIRECTORY

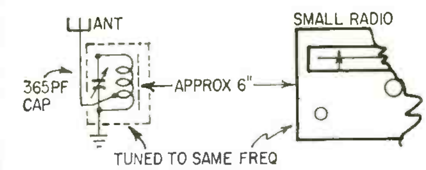
TRY THIS ONE continued

creases in the circuit, the resistance of the bulb increases. Also, the lamp limits the maximum current for a given supply voltage. Generally, the higher the voltage rating of the bulb, the lower the maximum current through the circuit.

To determine the lamp size to use, determine the absolute maximum I_c (collector current) of the transistor from the specifications. Then pick a lamp that will pass only that maximum current with the amount of voltage applied to the transistor.

You can determine that from catalogs if you know the bulb's type number, or measure it with a milliameter in series with the bulb connected to its rated voltage.—*J. A. Vanslette*

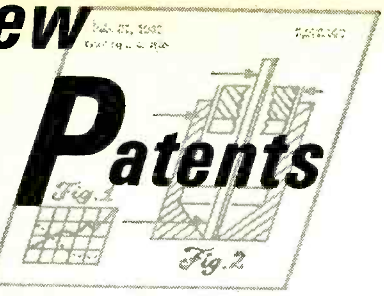
"OUTBOARD" ANTENNA BOOSTS SMALL-RADIO PERFORMANCE

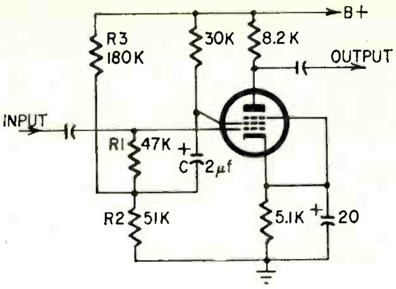


Wire a ferrite-core antenna in parallel with a 365-pf tuning capacitor. Connect one end of the combination to ground, and the other end or, preferably, the tap, if there is one, to a short antenna. Place the hookup about 6 inches from your transistor portable (or other small set). Turn on the radio, tune in a weak station. Then vary the tuning of the "outboard" antenna until the signal strength increases. You should note quite an improvement. No connections to the radio are required.

You can build the tuned circuit into a small plastic (not metal) box. It also increases the radio's selectivity, cutting down on "birdies", images and nearby interfering stations.—*Mark H. Goodman, W6AKG*

new Patents





BOMB DETECTION

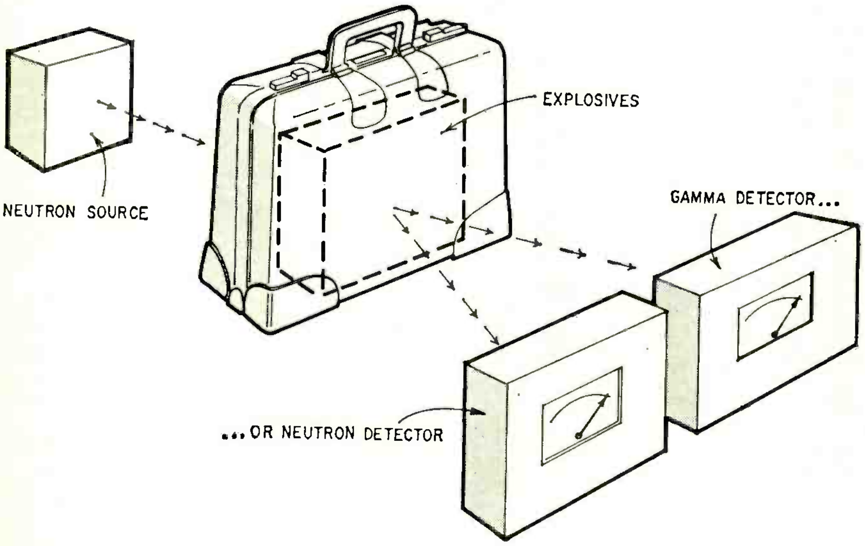
Patent No. 3,146,349

Edward D. Jordan, Kensington, Md. (Assigned to US of America as represented by US Atomic Energy Commission)

The inventor suggests that all explosives be mixed with an additive (during manufacture). Boron is recommended. To detect hidden explosives in locked luggage or small packages, they would be scanned by a low-level thermal neutron flux field. When neutrons reach the boron, some of the particles are lost, and gamma rays are generated. The detector may indicate the loss of neutrons or measure the gamma radiation.

Efforts to evade this test might include shielding with lead or some material that would capture neutrons. Such attempts would be exposed by the weight of the package or by the resulting low neutron-level measurement.

In a typical test, it required 6 seconds to detect a ½-pound bomb.



DISTORTION CANCELLATION

Patent No. 3,135,927

Peter G. Smee, Lynchburg, Va. (Assigned to General Electric Co.)

This pentode audio stage omits the usual screen bypass capacitor. Audio signal appears at the screen, which acts like an anode. A voltage divider (R1, R2) feeds some of the distortion in the screen circuit back to the control grid via capacitor C.

The plate circuit has two distortion components: the usual output available at the plate, and the screen component which has been fed to the control grid and reamplified. They are out of phase, since the screen component has passed through the tube twice, so they cancel.

The inventor claims a typical distortion of 0.3% from this circuit as against 1.8% from a conventional stage.

R3 puts the control grid at a positive potential with respect to ground, making it possible to use a large cathode resistance to stabilize the dc operating point. END

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D.C. Amps	50Piv 35Rms	100Piv 70Rms	150Piv 105Rms	200Piv 140Rms
3	.08	.14	.17	.24
12	.30	.55	.70	.85
18**	.20	.30	.50	.75
35	.70	1.00	1.35	1.50
100	1.65	2.05	2.50	3.15
240	3.75	4.75	5.75	8.75

D.C. Amps	300Piv 210Rms	400Piv 280Rms	500Piv 350Rms	600Piv 420Rms
3	.29	.30	.40	.48
12	1.00	1.35	1.45	1.70
18	1.10	1.50	Query	Query
35	2.15	2.45	2.75	3.30
100	3.75	4.60	5.50	8.00
240	11.70	19.80	27.90	Query

Sil. Pressfit 18A up to 100 Piv .... 4 for $1
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Full Leads Factory Tested & Gtd! U.S.A. Mfg.

PNP/HiPower/15Amp Round TO36 Pckg!
2N441 442, 277, 278, D5501 up to 50 volts VCBO $1.25 @, 5 for $5
2N278, 443, 174 up tc 80v @ 2 for $5.
PNP Diamond/3A-2N155, 156, 235, 242, 254, 255, 256 257, 301, 351 ¢35 @, 4/$1.
PNP/Signal up to 350Mw TO5 ¢25 @, 6 for $1
NPN/Signal IF, RF, OSC, TO5, OV5. ¢25 @, 6 for $1
PNP 2N670/300Mw ¢35 @, 4 for $1
PNP 2N671/1watt ¢50 @, 3 for $1
Silicon PNP TO5 & TO18 Pckg ¢ 25 @, 5 for $1
Power Heat Sink Finned 100Sq" $1 @, 6 for $5
STABISTOR Diodes Fwd Regulators 1watt 5 for $1
Zenner Diodes up to One Watt 6to200v ¢70 @, 3for$2
Zener Diodes Ten Watt 6 to 150v $1.45 @, 4 for $5
Zener Diodes 1watt/5% Tolerance $1.25 @, 3 for $3
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COLOR TV TROUBLESHOOTING PICT-O-GUIDE, edited by John R. Meagher. *Electronic Components & Devices, Radio Corporation of America, Harrison, N. J. 6 x 9¼ in., 153 pp. Paper $5.75.*

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continued from page 105

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HANDBOOK OF CHEMISTRY AND PHYSICS, (45th Edition), Robert C. Weast, editor in chief. *Chemical Rubber Co., 2310 Superior Ave. N.E., Cleveland, Ohio. 7½ x 11 in., 1,459 pp. Cloth, College edition $9, Deluxe edition $15.*

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INTRODUCTION TO MICROWAVE THEORY AND MEASUREMENTS, by Algie L. Lance. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 6 x 9 in., 308 pp. Cloth, $8.50*

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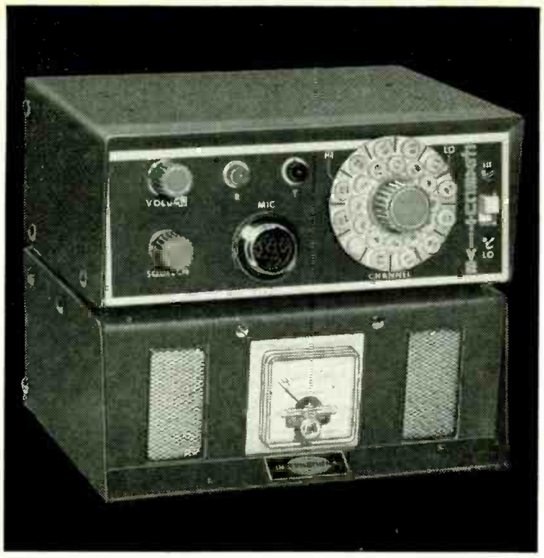

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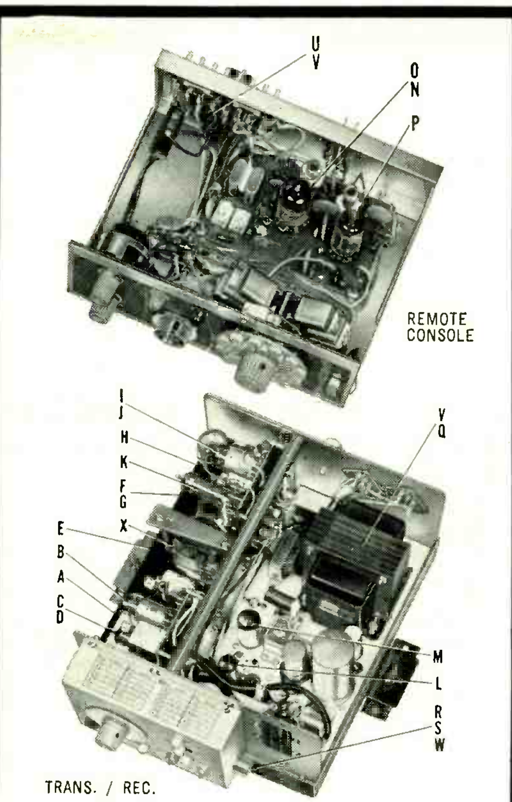

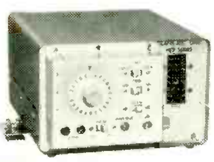

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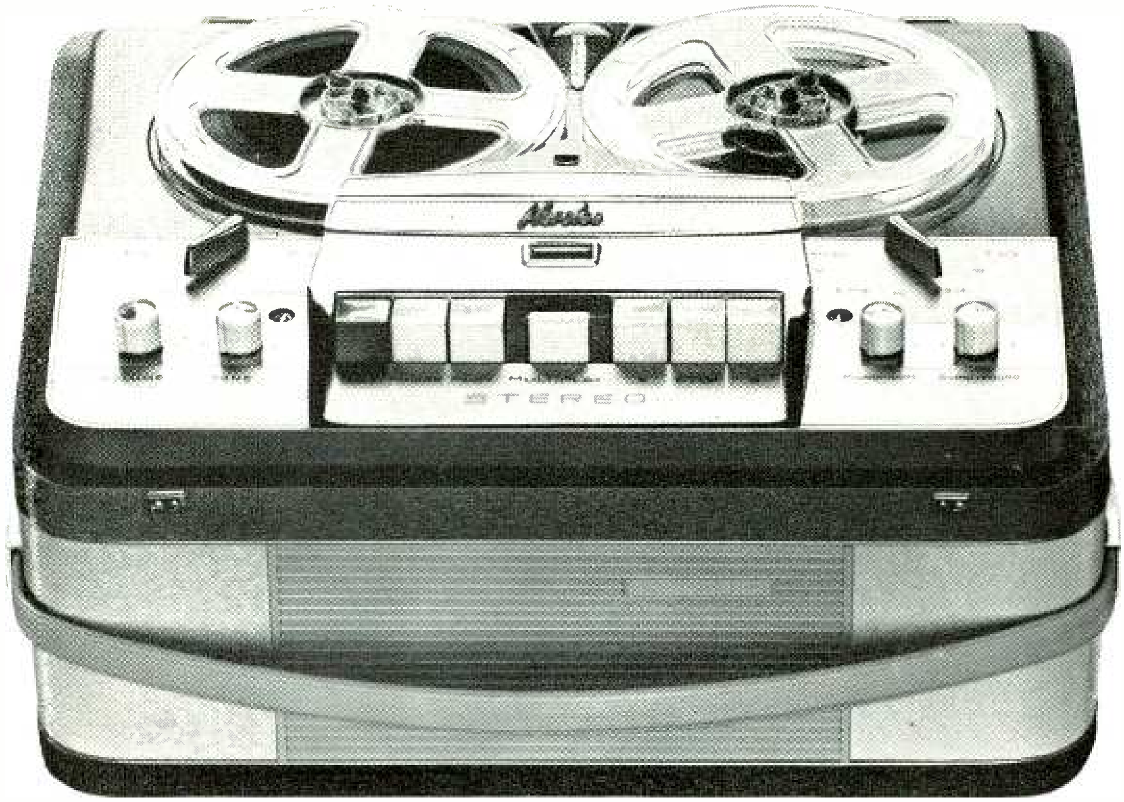
F	2nd IF Amp. Cathode		
G	2nd IF Screen	R	Reflected RF Power
H	Rec. "S" Meter-Trans. Audio Out	S	RF Power Output
		T	Bat.+Volts Neg Gnd.
I	1st Audio Plate	U	Bat.—Volts Pos Gnd.
J	2nd Audio Cathode	V	Fil. Voltage Level
K	Audio P.A. Cathode	W	Percentage of Mod.
L	Buffer Grid	X	Rec. & Trans. Audio Level
M	Rec. Relay Voltage-		

International's Executive 750-HM2 transceiver with 24 built-in test circuits, is truly the most versatile transceiver manufactured for Citizens Radio communication. • At the turn of a switch, the test circuits provide a fast and positive check on the operating performance of receiving and transmitting circuits within the set. • This "years ahead" test feature checks the filament, plate and input voltages, transmitter forward and reflected power, modulation, etc. A 24-position switch, located on the transmitter/receiver unit, is used to select individual test circuits. Tune-up and servicing is easy. • The transceiver has a sensitive and selective dual conversion receiver combined with a highly stable and efficient transmitter. The 23-channel crystal controlled transmit and receive frequency selector circuits are housed in the remote console. • Features include a new delayed/expanded AVC, new speech clipper/filter amplifier, new built-in S/meter and transmit meter. Operates on 115 vac, 6 or 12 vdc. The 750-HM2 includes remote console, speaker S/meter, transmitter/receiver unit, push-to-talk microphone, cables, and mounting racks.

Write today for the name of your nearest International dealer. Trade-in/trade-up to a 750-HM2.

INTERNATIONAL CRYSTAL MFG. CO., INC.
18 NORTH LEE. OKLA. CITY. OKLA.

all signal no noise



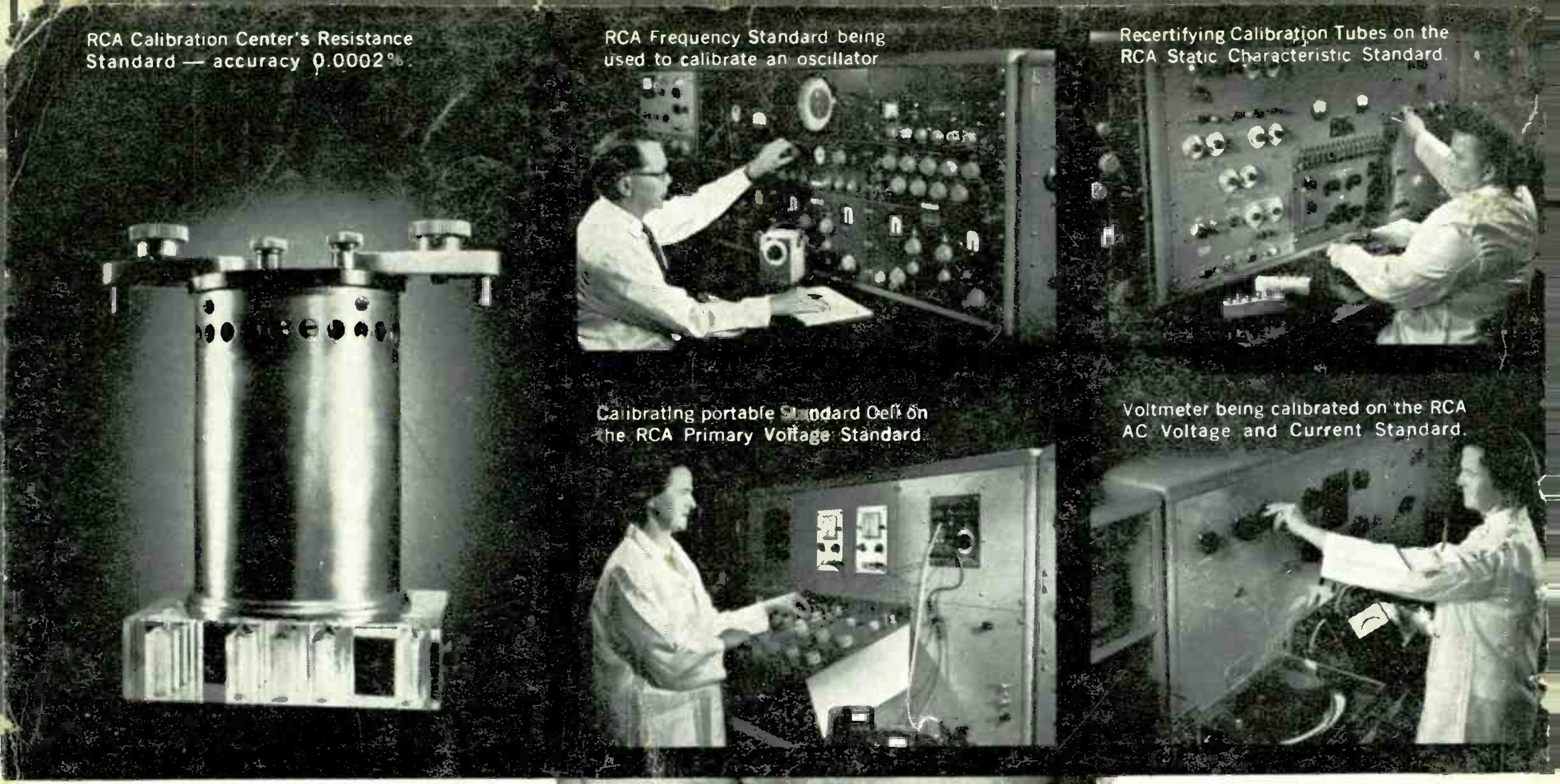
The most noise-free recordings you have ever heard are to be made on the new all-transistorized Norelco Continental '401' Stereo Tape Recorder, the only recorder using the newly developed AC 107 transistors in its two preamplifiers. The only transistor specifically designed for magnetic tape head preamplifiers, the AC 107 utilizes specially purified germanium to achieve the extraordinary low noise figure of 3 db, measured over the entire audio band (rather than the usual single frequency). This noise figure remains stable over large collector-emitter voltage swings and despite large variations in source resitance.

Hear the new transistorized Norelco Continental '401' • 4-track stereo/mono record and playback • 4 speeds: 7½, 3¾, 1⅞ and the new 4th speed of 15/16 ips which provides 32 hours of recording on a single 7" reel • fully self-contained with dynamic stereo microphone, two matched speakers (one in the removable cover for stereo separation) dual preamps and dual recording and playback amplifiers • self-contained PA system • mixing facilities • can also play through external hi-fi system • multiplay facilities.

SPECIFICATIONS: Frequency response: 50-18,000 cps at 7½ ips. Head gap: 0.00012". Signal-to-noise ratio: better than −48 db. Wow and flutter: less than 0.14% at 7½ ips. Recording level indicator: one-meter type. Program indicator: built-in, 4-digit adjustable. Inputs: for stereo microphone (1 two-channel); for phono, radio or tuner (2). Foot pedal facilities (1). Outputs: for external speakers (2), for external amplifiers (1 two-channel); headphone (1). Recording standby. Transistor complement; AC 107 (4), OC 75 (6), OC 74 (2), OC 44 (2), 2N1314 (2), OC 79 (1). Line voltage: 117 volts AC at 60 cycles. Power consumption: 65 watts. Dimensions: 18¼" x 15" x 10". Weight: 38 lbs. Accessories available include monitoring headset, dual microphone adapter, foot control, slide synchronizer and telephone pickup coil.

Write for Brochure HS-3. North American Philips Company, Inc., High Fidelity Products Department, 100 East 42nd Street, New York, New York 10017.

Norelco®



RCA Calibration Center's Resistance Standard — accuracy 0.0002%.

RCA Frequency Standard being used to calibrate an oscillator

Recertifying Calibration Tubes on the RCA Static Characteristic Standard.

Calibrating portable Standard Cell on the RCA Primary Voltage Standard.

Voltmeter being calibrated on the RCA AC Voltage and Current Standard.

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DEPENDABLE PERFORMANCE IS THE END RESULT

No reliability program for receiving tubes can be better than the test instruments and equipments it employs.

That's why RCA maintains the extensive Calibration Center in its Harrison, N. J., tube manufacturing plant (see photos above). The Center's responsibility: to assure that all measuring instruments and equipments, used in tube development from initial design through volume production, are accurate within rigidly specified limits. Here is how this is accomplished:

1 The Calibration Center's own equipments are calibrated by standards (voltage, resistance, capacitance, frequency) whose values are regularly checked against standards of the National Bureau of Standards.

2 Measuring instruments used in all research, design, development and application laboratories are calibrated directly from the Center's equipments.

3 Sets of Calibration Tubes, selected to cover every type and family of tubes, are measured in the Calibration Center and used by the Center's personnel to periodically verify the accuracy of all factory tube-testing equipments.

4 Sets of Control Tubes, evaluated under the supervision of the Calibration Center, constantly monitor the repeatability of factory tube-testing equipments.

Our Harrison Calibration Center is another example of the effort we make to assure the specified and dependable performance of every receiving tube that bears the emblem of RCA... performance that benefits you through customer satisfaction.

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