Special Issue: STEREO STEREO STEREO STER

Radio-Electronics

MARCH 1959

HUGO GERNSBACK, Editor

Directory of Stereo Cartridges

Stereo Control Units

Will Multiplexing Bring Us FM Stereo Broadcasts?

Is Your Stereo in Phase?

Build a Stereo Control

Inside a Stereo Cartridge

See page 43

35c
U.S. and Canada

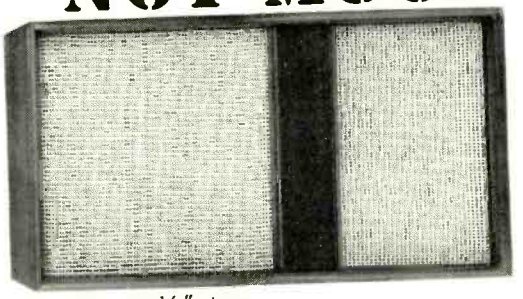
STEP-UP TO STEREO...ON A BUDGET

with Stereo's Standard

STEREO'S STANDARD

IF THIS IS YOUR PRESENT or PROPOSED SPEAKER SYSTEM

NOT MUCH BIGGER THAN A BREADBOX, BUT...



Size: 13½" deep
14" high, 25" wide

Figure A

the amazing Electro-Voice Regal gives you bass so low you can feel it— bass sounds you'd expect from a conventional enclosure three times the size.

"OPTIMIZED BASS" is just one of the many extras in the new E-V Regal integrated speaker system. You get *balanced*, full-range flat response without attenuation or peaks, from bass-you-can-feel to beyond audibility. And, you can drive the Regal systems to concert volume with just 20 watts. (The Regal is more than 2½ times as efficient as other low-efficiency systems.) Now, double your listening area with wide, w-i-d-e dispersion, made possible by E-V's patented *Hoodwin diffraction horn. The Regal's exclusive right-up-front Presence and Brilliance controls (see A) give you infinite adjustment of treble and VHF compression-driver ranges. You will thrill to smooth, high-frequency response *without breakup* due to E-V's patented **Avedon Throat design. ¶The Regal's ultra-compact enclosure is finished on all four sides. You can place it *anywhere*—floor or shelf, vertically or horizontally. ¶Each Regal is a triumph of acoustical engineering . . . made up of the finest components E-V can assemble. Choose either the Regal III with separate 3-way system using precision-built E-V woofer, treble and VHF compression drivers. Just $147.00 net. Or the Regal IA separate 2-way system with E-V woofer and VHF driver. Only $103.00 net. Choose from luxurious tropical mahogany, limed oak or rich contemporary walnut. ¶Know the excitement of the E-V Regal. Compare its sound . . . compare its price at your franchised Electro-Voice high-fidelity showroom. ¶Electro-Voice also makes enclosures of every size, to meet every need, every budget . . . from the ultra-compact Coronet at $35.50 to the luxurious Patrician at $970.

*Patent No. 754,901 ** Des. Patent No. 182,351

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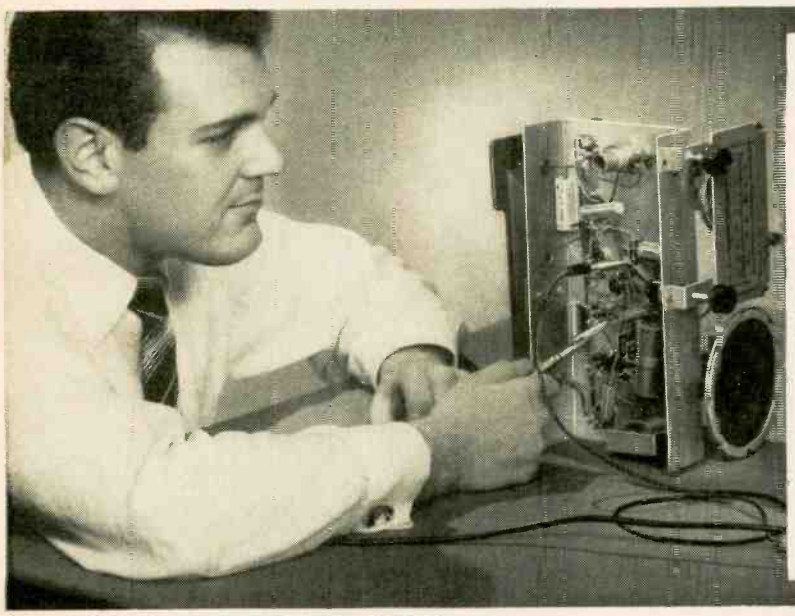

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MARCH, 1959

Radio-Electronics

Formerly RADIO-CRAFT ■ Incorporating SHORT WAVE CRAFT ■ TELEVISION NEWS ■ RADIO & TELEVISION

EDITORIAL

STEREO

RADIO

TEST INSTRUMENTS

ELECTRONICS

TELEVISION

ON THE COVER

(Story on page 43)

The photographer used his artistic license to represent the heart of a stereo phono cartridge in an unusually striking manner.

Color original by Washburn-Locker

RADIO-ELECTRONICS is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

RADIO-ELECTRONICS, March, 1959, Vol. XXX, No. 3. Published monthly at Mt. Morris, Ill., by Gernsback Publications, Inc. Second-Class mail privileges authorized at Mt. Morris, Ill.
SUBSCRIPTION RATES: U.S., U.S. possessions and Canada, $4.00 for one year; $7.00 for two years; $10.00 for three years; single copies 35c, Pan-American countries $5.00 for one year; $9.00 for two years; $13.00 for three years. All other countries $5.50 a year; $10.00 for two years; $14.50 for three years.
SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscription Dept., 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.
GERNSBACK PUBLICATIONS, INC. Executive, Editorial and Advertising Offices, 154 West 14th St., New York 11, N.Y. Telephone Algonquin 5-7755. Hugo Gernsback, Chairman of the Board; M. Harvey Gernsback, President; G. Aliquo, Secretary.
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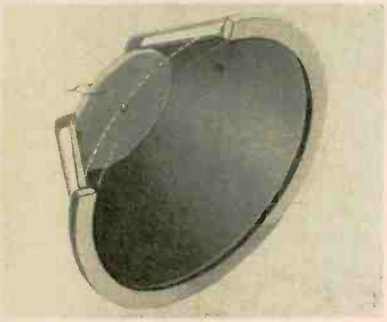
NEWS BRIEFS

CERAMIC LOUDSPEAKERS, without voice coil or magnet, are made possible by a newly developed barium titanate compound. They may open the way to cheaper, lighter and more compact radios and other audio devices.

Experimental quantities of the speakers have been made, using thin ceramic–metal–ceramic sandwich discs riveted to the speaker frame at the hub and



glued to the floating apex of the speaker cone at the rim.

The ceramic is electrostrictive—that is, it responds to electrostatic fluctuations by contracting radially. In the ceramic speaker, the cupping action of the ceramic pulls the metal diaphragm into a saucer shape, pulling and pushing the speaker cone.

Promoters of the experimental speaker say it may be adapted to conventional audio circuitry—for example, each disc may be connected to a plate circuit in push-pull amplifiers. The ceramic's breakdown voltage is 1,500–3,000. The new ceramic and loudspeaker were developed by Mullenbach Division of Electric Machinery Manufacturing Co., Los Angeles.

NEW COLD-CATHODE TUBE, unveiled by the Signal Corps and Tung-Sol Electric Co., may give tubes a life comparable to that of transistors, reduce the temperature of radios and television sets greatly, and simplify the problems of portable TV's by reducing power requirements.

The new tube uses a specially processed magnesium oxide cathode coating. It is necessary to heat it or use other means to start an electron flow, but, once started, the flow continues without further excitation. If a standby current of 10 μa or more is applied while equipment is not in use, the tube will keep alive and be ready to go into action when suitable plate or grid biases are restored. Heat, ultra-violet rays or radioactive material mixed with the magnesium oxide can provide the initial excitation. It has been suggested that a little cesium applied to the coating would excite it when exposed to ordinary light.

The tube using the new cathode operates on the space-charge principle, with the nearest grid to the cathode biased to a high voltage, in the order of 200 volts. The control grid (grid 2 in the new tube) is biased 150 volts positive, and the screen and plate 300 and 350 volts, respectively. A plate voltage of 300 is necessary at present, but the inventor, Dr. Dietrich Dobischek of the Army Signal Research and Development Laboratory at Fort Monmouth, N. J., believes that it can be reduced to at least 190 in future models.

The tube at present being made is a power type. At a demonstration by the Signal Corps and Tung-Sol, relays were operated and music played through and amplifier with the new tubes in the output stage. Tung-Sol Electric is producing the experimental tubes under a Signal Corps contract. No commercial production is planned till a complete line of tubes has been designed.

The new tube will be described completely in next month's RADIO-ELECTRONICS.

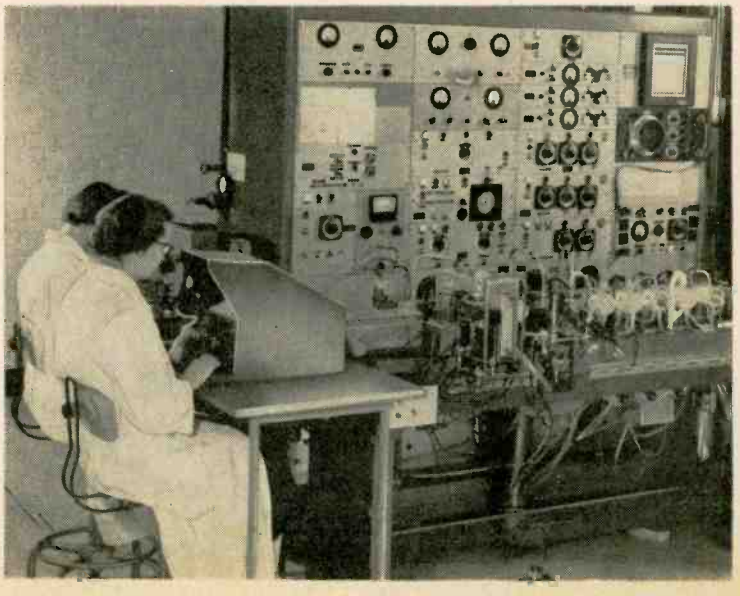
TRANSISTOR TV'S and more and bigger transistor radios were predicted by Wm. J. Peltz, general manager of Philco's Landsdale Tube Co. Division, as the result of a new automatic production line just opened at the Lansdale (Pa.) tube plant. (Substance was given to the predictions by an announcement of immediate price cuts on a number of Philco transistors.)

The new line produces transistors at the rate of 450 per hour, with 24 of 27 operations completely automated. Automation of the other operations, and an output stepup to at least 600 transistors per hour, was under way and would be complete in the near future.

The transistor blanks are attached to stainless steel "carriers" vaguely resembling old-time crystal phonograph cartridges and moved step by step through a number of etching stages alternated with rinses, then to a second machine which attaches the emitter and collector "whiskers." Next the transistors are completely cleaned, mounted, dried and sealed. Feedback is used freely throughout the mechanism; for example, to control depth of etching and to position the whiskers—1 or 2 mils in diameter—in the exact center of the collector and emitter spots. This requires a degree of precision that could not be obtained in a manual operation. It is done with two phototubes, which focus on the whisker and report its position to servomechanisms which in their turn reposition it till it is in the correct spot.

The illustration shows the first part of the operation, in which germanium blanks are soldered onto tabs in the carriers, blank thickness is measured and the blanks are etched to the required thickness in the cylindrical etching chambers seen above the bench at the far right.

CRACKDOWN on unlicensed TV booster stations was ordered by the FCC as it ended a lengthy study by deciding not



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to "legalize" the tiny vhf rebroadcast transmitters.

It is estimated that 1,000 to 1,500 unauthorized booster stations are currently in operation, mostly in the northwestern US (RADIO-ELECTRONICS, February, 1959, page 98). Usually located on mountaintops, they pick up and amplify signals from distant TV stations and retransmit them on the same channel, bringing TV to valleys beyond normal television service.

The commission ruled that vhf boosters may cause "serious interference" to TV and other radio services allocated to the vhf band, and pointed out that the needs of isolated communities can be met by the FCC-approved uhf translators, which rebroadcast TV signals on uhf channels. The FCC set a March 31 deadline for booster operators to switch to uhf translator operation—otherwise, it will "take steps" to close them down. Past actions by the FCC indicate that the March 31 deadline may be postponed if booster operators have difficulty purchasing translator equipment in time.

ATOM POWER supply that uses an improved thermocouple to produce electricity and a radioactive element to furnish heat is expected to solve the problem of transmitting data from space satellites, now capable of transmitting for only short periods.

The new A-battery was demonstrated to President Eisenhower early in the year and was the occasion of a special White House statement. Known as

Wide World Photo

SNAP (System for Nuclear Auxiliary Power) III, it is in essence a thermocouple. One leg consists of lead telluride doped with bismuth to cause it to have a shortage of electrons. The other leg is lead and magnesium telluride, with a sodium doping to give it a surplus of electrons. Heat in the order of 700°F is furnished by polonium 210. The exact voltages and currents supplied by the unit have not been stated, but the power was given as 5 watts.

The ⅔ gram of radioactive polonium which supplies the heat is placed in a carefully shielded capsule at the center of an assembly of 20 thermocouple pairs arranged in a wheel-like formation. Used because it was readily available whereas other theoretically more practical substances were not, its cost

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Model EL 3516/G53
Technical Specifications

Three Tape Speeds—7½, 3¾, and 1⅞ ips

Tracks—Dual

Heads—Stacked

Head-Gap—0.0002 inches

Frequency Response—at 7½ ips; 50 to 16,000 cps
at 3¾ ips; 60 to 10,000 cps
at 1⅞ ips; 60 to 5,000 cps

Wow and Flutter—0.15% at 7½ ips
0.2% at 3¾ ips
0.35% at 1⅞ ips

Volume Indicator—Magic Eye (Type EM-84)

Loudspeaker—Integrated, heavy magnet, wide range

Controls—Piano-key pushbutton

Fast Forward and Reverse—Less than 2 minutes for 1200 ft. of tape

Automatic Stop—At ends of reel (with metalized strips)

Program Indicator—Built-in, adjustable

Inputs—(1) radio/phono; (1) microphone (with mixing facilities)

Outputs—(1) for external speaker; (2) for external amplifiers with controls; (1) for external amplifier without controls; (1) for headphone monitoring recording circuit

Microphone—High-Impedance Dynamic

Tubes—EF-86 (2), ECC83 (2), ECL82 (1), EZ90 (1), EM84 (1)

Line Voltage—117 volts AC 60 cycles

Power Consumption—80 watts

Dimensions—15¾" x 13" x 8"

Weight—32 lbs.

Case—Rugged, European-designed, portable carrying case (internally designed for optimum acoustic baffling)

A matching companion piece, identical in appearance, containing a second amplifier and speaker, is available to those who seek the convenience of a complete portable stereo-tape playback system

The STEREO version of the *Norelco* 'Continental' TAPE RECORDER Developed & Guild-Crafted by Philips of the Netherlands

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of $30 million for the ¾ gram used would render it impractical for general use. Cerium 144 has been suggested, at a cost of about $600 per generator. Cerium also has a longer half-life, 280 days against polonium's 140. With equipment designed to use with it, a fuel could give satisfactory service for at least two half-lives. Other radioactive products—with half-lives ranging up to 97 years—could also be used, and it was suggested that some radioactive wastes, which now have to be buried, might become useful fuels.

The new generator was developed by the Martin Co., of Baltimore, Md., in conjunction with Minnesota Mining & Manufacturing, who supplied the thermocouple material.

Calendar of Events

Western Joint Computer Conference, Mar. 3–5, Fairmont Hotel, San Francisco, Calif.

Denver Hi-Fi Music Show, Mar. 6–8, Hotel Cosmopolitan.

British Electrical Engineers' Exhibition, Mar. 17–21, London, England.

Baltimore Hi-Fi Music Show, Mar. 20–22, Lord Baltimore Hotel.

IRE National Convention and Radio Engineering Show, Mar. 23–26, Waldorf-Astoria Hotel (convention), New York Coliseum (show).

Symposium of Millimeter Waves, Mar. 31–Apr. 2, Engineering Society Building, New York, N. Y.

Pittsburgh Hi-Fi Music Show, Apr. 3–5, Penn-Sheraton Hotel.

British Radio and Electronic Component Show, Apr. 6–9, Grosvenor House and Park Lane House, London, England.

Buffalo (N. Y.) Hi-Fi Music Show, Apr. 10–12, Hotel Statler.

Conference on Industrial Instrumentation and Control, Apr. 14–15, Illinois Institute of Technology, Chicago, Ill.

Southwestern IRE Conference & Electronics Show, Apr. 16-18, Dallas (Tex.) Memorial Auditorium and Baker Hotel.

Conference on Analog & Digital Recording & Controlling Instrumentation, Apr. 20–21, Bellevue-Stratford Hotel, Philadelphia, Pa.

British Industrial Photographic & TV Exhibition, Apr. 20–24, London, England.

Annual Technical Conference on TV & Transistors, Apr. 21–22, Cincinnati, Ohio.

PHONES IN AUTOS would be as commonplace as home telephones under a proposal by the Bell System (American Telephone & Telegraph Co.) for a new type of low-cost mobile telephone service geared to "America on the move."

In a statement issued in connection with the FCC's current deliberations on allocation of frequencies from 25 to 890 mc, the Bell System revealed plans for a direct dial system—virtually a mobile extension of the home phone. The statement declares: "It seems a certainty that with good service and attractive rates a large proportion of passenger cars will have a telephone just as they have so many other accessories."

Bell System already is seeking the cooperation of other industries, and has disavowed any intention of building or maintaining the mobile phone sys-

tem itself. A company policy statement says: "We hope that the radio and the automobile and other industries will design, build, merchandise and service two-way mobile radio units in the same way as they do for broadcast receivers or other optional features in automobiles."

As with any new radio service, there is a price tag in valuable spectrum space. And in the case of a people's mobile phone service, it's a relatively expensive one and is certain to cause controversy for many years to come! The Bell System is asking the FCC to earmark for eventual mobile use a 75-mc band between 765 and 840 mc—now occupied by uhf television channels 63 through 75. Bell maintains the uhf band is now so sparsely used that this 13-channel portion could be scooped out, without major disruption to TV, and used far more efficiently for the new service.

ONE NEW TV STATION started programming since we last reported:

KOED-TV, Tulsa, Okla.....11

WTAS, Albany–Schenectady–Troy, which just recently changed its call letters from WTRI (see February, 1959), has switched channels from 35 to 13.

Our count of operating stations in the US goes up to 547. The vhf number 463, and the uhf, 84. With our new station, KOED-TV, the noncommercial total rises to 36.

PROTON KNIFE had its debut as an instrument for brain surgery at the University of Uppsala, Sweden, when two nerve tracts in the brain of a 55-year-old patient were severed in a painless operation. The operation has apparently freed the patient from chronic pains and depression.

The proton beam was supplied by a synchro-cyclotron 60 feet from the patient, and focused by special coils to apply a small dose 20 times, each time reaching the part from a slightly different angle, thus confining the cutting effect to the area where the 20 beams crossed.

The proton-beam technique was developed at the University of California by Drs. Tobias and Lawrence and was used by them in a pituitary operation, but never directly on the brain itself. Dr. Tobias spent 3 months at Uppsala, helping the Swedish team get their program under way.

ELECTRONIC MUSIC in the United States has been greatly encouraged by a grant of $175,000 from the Rockefeller Foundation, to be administered jointly by Princeton and Columbia Universities. One of the first uses will be to construct a studio at Columbia, where two of the country's leading workers with "concrete music," Profs. Vladimir Ussachevsky and Otto Luening, have been working for several years, much of the time in inadequate quarters. The studio's electronic facilities will be available to competent composers and researchers in the electronic music field. END

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2. This vivid musical painting has become an American classic

3. 16 favorites—Sweet Violets, Down by the Old Mill Stream, etc.

4. Pianistic fireworks abound in these two romantic scores

5. Where or When, The Way You Look Tonight, Be My Love, 9 more

6. 43 hits for listening and dancing—in the smooth Lanin style

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11. The great tunes from Rodgers and Hammerstein's fabulous hit

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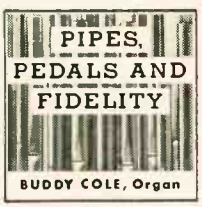
Terre Haute, Indiana



13. Organist Buddy Cole plays 11 tunes—Mine, Caravan, Carioca, etc.

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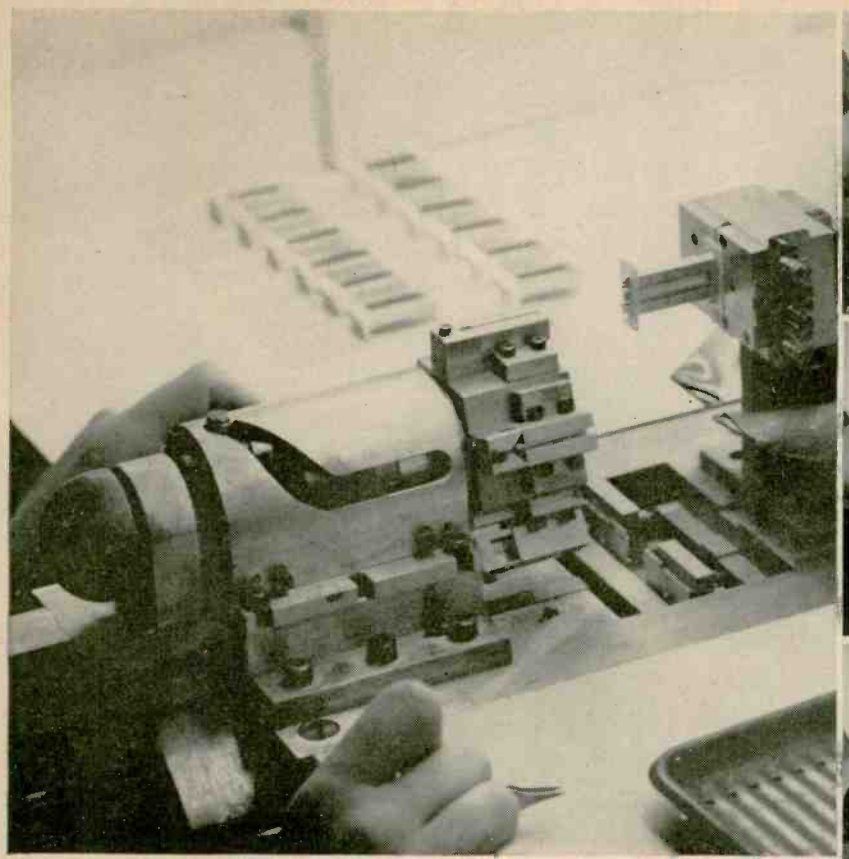
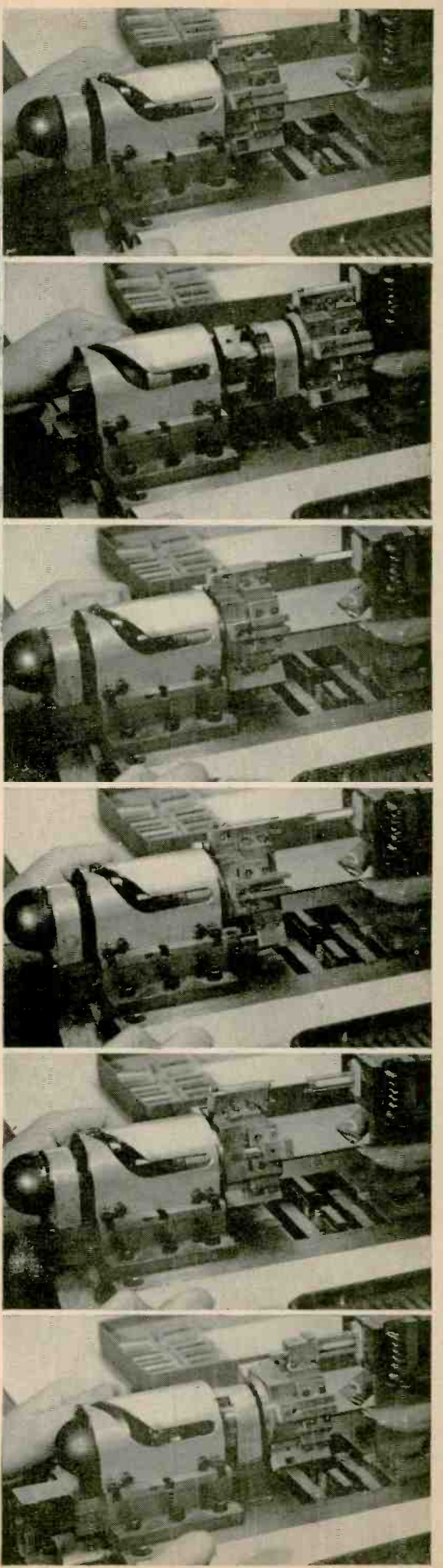
2. Grofe: Grand Canyon Suite
3. Sing Along With Mitch Miller
4. Grieg Piano Concerto; Rachmaninoff Rhapsody
5. 'S Marvelous — Ray Conniff
6. Lester Lanin at the Tiffany Ball
7. Bells Are Ringing — Original Broadway Cast
8. Firebird; Romeo and Juliet
9. Black, Brown and Beige
10. Beethoven: Eroica Symphony
11. Percy Faith Plays "South Pacific"
12. Roumanian Rhapsodies 1, 2; plus two more works
13. Pipes, Pedals and Fidelity
14. Cugat Cavalcade
15. Tchaikovsky: Pathetique Symphony
16. Listening in Depth (Available in stereo only)





Large illustration shows operator completing the critical assembly work on a 6V6GTA mount in new CBS-Hytron automatic rotary assembly machine. Strip photos (top to bottom) catch six progressive steps: cathode positioned for insertion into bottom mica . . . cathode being inserted . . . A grid, B grid, and beam plate ready for assembly . . . top mica being added to complete the mount cage.

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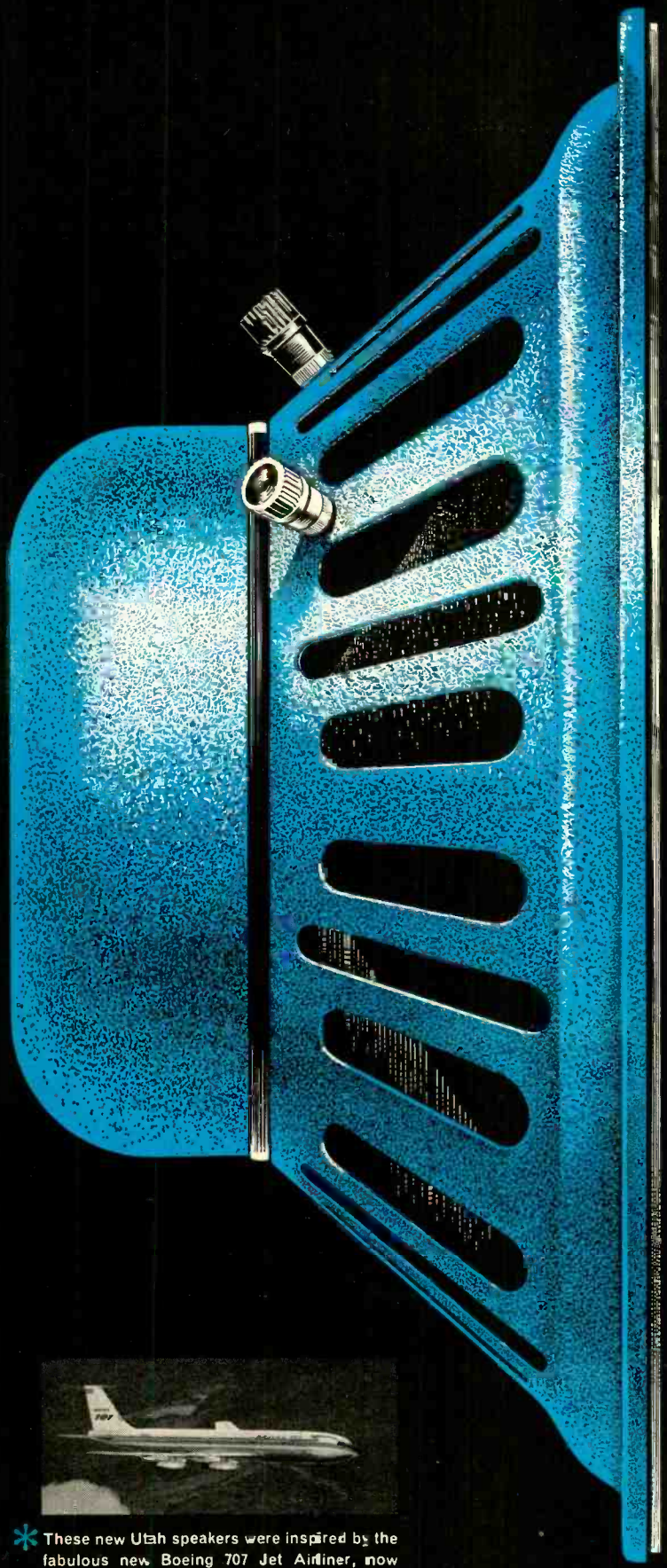

* These new Utah speakers were inspired by the fabulous new Boeing 707 Jet Airliner, now streaking coast to coast in just 4½ hours! Utah speakers, *too*, pack more power per pound, feature Jet Airliner slim-line design to meet modern demands for more compact Stereo and High Fidelity applications.

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utah SPEAKERS

Utah Radio & Electronic Corp., Huntington, Ind.

Correspondence

IF YOU CAN'T GET A SA5-M

Dear Editor:

The SA5-M silicon solar cell, used by Ted Ladd in a light meter (page 123, December, 1958) and myself in a light-powered frequency standard (page 58, February, 1959), is an excellent unit. Unfortunately, the manufacturer has discontinued it. Good replacements for SA5-M are the Hoffman types P-100 and S-1A. Both are silicon photocells. The less expensive selenium cells are not good enough for these applications —output is too low.

RUFUS P. TURNER

Los Angeles, Calif.

AUTHOR'S COMMENTS

Dear Editor:

I must thank you for the many complimentary things you said when introducing me to your readers (page 48, January, 1959, issue).

The standard procedure of not telling authors beforehand what is to be said about them occasionally lets errors creep in and, that, I regret has occurred on this occasion. In the introduction you credited me with the design of the "fabulous" PM-2. As I was not responsible for the whole of that design it would not be proper for me to accept all the praise.

On this continent (North America) there has been some confusion about the matter and I would like to clear this up even though it means going back into some of the early history of hi-fi in Great Britain.

It was in the 1920's while at Edison Bell, England, that I learned enough about magnets to design high-flux-density loudspeaker magnets properly. Those design principles were discussed in detail in my British Patent No. 331,209.

Excited field speakers, made under my patent by Edison Bell, supplied with 40 to 50 watts excitation power gave a flux density of 16,000 to 17,000 gauss across a 2-mm gap, and were used with straight Tractrix horns for cinema work, high-quality public address, etc. Edison Bell "died" in the slump (1933), so my own business, Voigt Patents Ltd., was started to keep the speaker alive.

By the outbreak of World War II, 10 years after the design originated, the basic magnet was unchanged except for minor modifications which included replacing the curved outline of the center pole with two straight tapers. We had experimented with permanent-magnet arrangements in which the PM material was on the outside, but the

(*Continued on page* 20)

BIG JOB BOOM FORECAST!

Can You Get Ready in Time?

Right now job opportunities are tight all along the line. Economists now predict a period of mild ups and downs. Look for the "big break" to come in the next three years, they say. That's when good jobs will open up as never before. And men who are preparing themselves *now* will ride the crest of the boom.

DARK OUTLOOK FOR UNSKILLED WORKERS

Those with little or no training will find the going tough. Fewer openings. More competition for existing jobs. The tide is against the unskilled worker. It's getting stronger. Nor will the boom help. The new opportunities will go first to the skilled, next to the semi-skilled.

BIGGEST DEMAND IN THESE FIELDS

What's ahead? According to the best estimates, here are the industries due for the sharpest employment rise: Heavy transportation equipment. Mechanical, electrical, chemical, aeronautical and highway engineering. Industrial electronics. All metals. Business services. Natural gas and oil. Paper products. On the other end of the scale, employment may lag in agriculture and leather. Check the trends in *your* field. Are you prepared to switch, if necessary?

GETTING YOURSELF READY—NOW

All the experts agree: Education, skill, specialized training will net the greatest rewards in the coming boom. The time you spend improving yourself is perhaps the wisest investment you can make *right now*. Your future success and happiness could hinge on your mastering a certain subject or acquiring a special skill. But there are obstacles. You may have a family to support. Or a job to hold down. You may feel you're too old to learn.

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- ☐ Painting Contractor
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- ☐ Auto Body Rebuilding and Refinishing
- ☐ Auto Engine Tuneup
- ☐ Auto Technician

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—Julius L. Burke,
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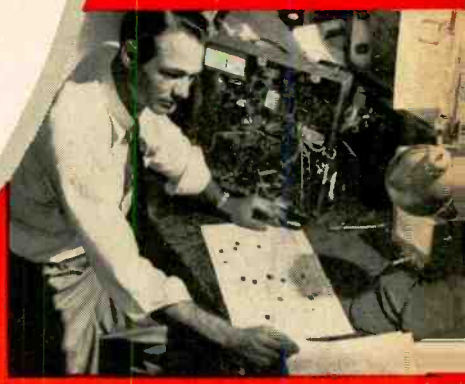

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CORRESPONDENCE *(Continued from p. 16)*

pre-war magnetic materials just were not powerful enough to compete with 40 to 50 watts of electrical excitation.

In 1939, when Hitler walked into Poland, Britain had sterner tasks on hand and speaker research stopped in its tracks. By the time the war was in its last stages, newer magnetic materials, known variously as Ticonal, Alcomax and Alnico V, had proved their worth and were able to provide a magnetomotive force far exceeding that obtainable with 40 to 50 watts of electrical excitation. When research could be resumed, it was with these newer materials in mind.

This time I concentrated on producing a PM unit with the magnetic material in the center, and as a matter of policy retained the old styling as far as possible. The idea was that it might eventually be practical to convert existing excited-field speakers to PM, thus enabling Voigt speaker owners to bring their speakers up to date at minimum expense.

Our policy on diaphragms had been similar, and when the twin cone came out in 1933 they were mounted so as to make them interchangeable with earlier single cones. Again in 1938, when the *Light coil twin* was introduced, this too was interchangeable. As that required a gap of 1½ mm, liners were made which could be fitted to existing magnets. With these the flux density went up to the 18,000–19,000-gauss region.

Now a loudspeaker depends on what is fed into it for its performance. In pre-war days, we had a very friendly alliance with the Lowther Manufacturing Co., who made excellent tuners and amplifiers. These together with Voigt speakers made up the Lowther Voigt Radiogram, which set a very high standard of performance.

In the post-war period, Mr. Chave, once Mr. Lowther's chief technician, who had become owner of the firm, shared my opinion that an excited-field speaker would be regarded as obsolete and that therefore a PM version of it was required.

Mr. Chave pushed on with experiments he had started on a PM version of the excited-field speaker, using the magnetic material externally, while I carried on with my experiments, using an internal magnet block. At my suggestion we worked independently and did not compare notes till completion.

The outcome of Mr. Chave's work was the Lowther PM series (British Patent Nos. 618,802 and 628,432), and the outcome of my work was reviewed in *Wireless World*, March, 1949. Subsequently, the design was improved still further, but it is no longer in production as my company became dormant some years after I emigrated to Canada.

The diaphragms used on the early Lowther PM speakers were supplied by my company, so the speakers were in more ways than one a true Lowther–Voigt combination and were sold as such.

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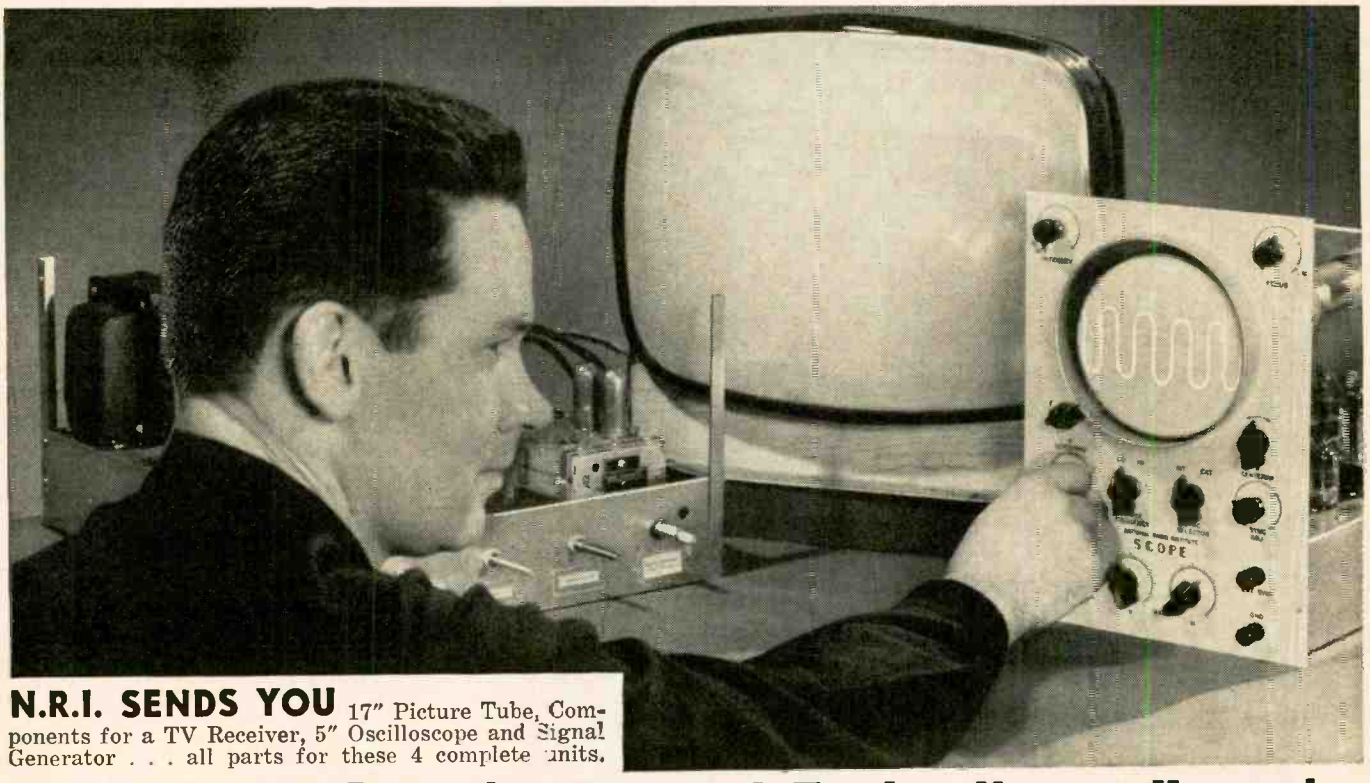

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CORRESPONDENCE *(Continued)*

The diaphragms used by Lowther's even now differ but little from genuine Voigt diaphragms of 10 or even 25 years ago. The reason is simple. When my health started giving me trouble in 1946/7, I realized that I could no longer supervise the manufacture of hand-made diaphragms and that I would have to subcontract this work and that we would continue only the final test and inspection. All special tools and jigs needed were loaned to the subcontracting firm and I taught them all the special techniques involved. That subcontracting firm was the Lowther Manufacturing Co. and so, when I am credited with being responsible for the "fabulous" PM-2, this is partly correct, but Mr. Chave is responsible for the transition from Voigt excited-field to Lowther PM. His work has merit and it would not be proper for me to accept all of the credit.

P. G. A. H. VOIGT

Toronto, Canada

"SERVICING RACKETS"

Dear Editor:

While I am not in the television servicing game myself, I got quite a kick out of reading of a servicing racket in your publication. I have spent my life as an electronic techrep working for all the large companies and thus understand more than a little about this situation.

While visiting a friend in Boston last weekend, I ran into one of the dirtiest rackets I have ever heard of. My friend lives in a large apartment house where an outside antenna is a necessity. When she moved in, the landlord informed her no private antennas were allowed on the roof and that she must contact a certain TV technician. The technician connected her set to the common antenna for $40.

Three months later my friend's picture disappeared, so she contacted the technician again and paid a $2.50 service charge for "antenna repairs." This happened several more times—and finally the lady became suspicious and took a look on the roof. Her antenna had been disconnected and another installation made on the same antenna in her place!

On contacting the technician, she was informed that if she read the fine print in her contract she would find that it contained only a 90-day guarantee. He added that for $15 more he would guarantee a full year's service on the antenna. The lady has notified the Better Business Bureau and is putting the case in the hands of a small-claims lawyer.

My solution of the problem was to offer her the use a pair of bolt cutters to cut his antenna into 6-inch bits. After this bird had replaced several antennas maybe he would wise up.

I wanted to mail you his business card, but the lady wants to go about the thing legal and nice.

PAUL J. KANE

Truro, Mass.

END

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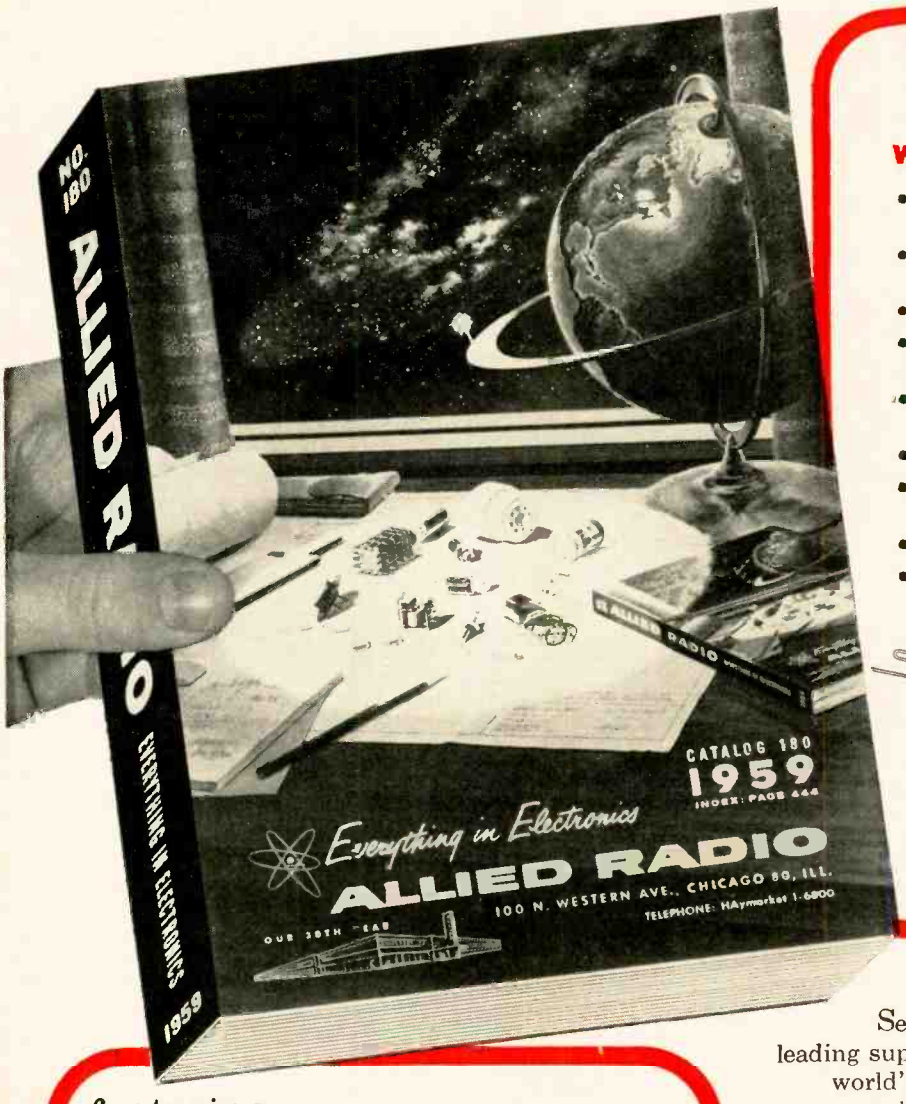

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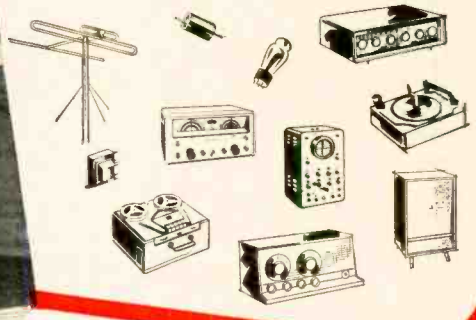

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How University uses one woofer for two channel bass

This can be achieved in two ways, depending upon the kind of woofer you have. A conventional woofer—with a single voice coil—can receive these frequencies only after they are combined by the special stereo adapter network Model A-1. However, with University's exclusive DUAL VOICE COIL WOOFER† . . . containing two electrically separate voice coils . . . no such network is required. Instead, the stereo amplifiers can simply be connected one to each voice coil, thus feeding the full bass directly to this unique woofer.

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†University woofers having dual voice coils are models: C-15W, C-12SW, C-15HC and C-12HC. These are employed in speaker systems: Debonaire-12 S-3S; Senior S-5S; Master S-6, S-6S; Dean S-7, S-7S; Classic S-8, S-8S; S-9, S-9S; Ultra Linear S-10, S-10S; S-11, S-11S; Troubadour S-12, S-12S. (System models in light type are fully stereo adapted. System models in bold type, or any home built system with a dual voice coil woofer, can be easily and inexpensively prepared for stereo with kit SK-1. User net: $5.95)

MODEL SLC is housed in an attractive fibreglas shell of charcoal grey with gold anodized grille and adjustable stand, **STEREOFLEX-1**, in a handsome wooden cabinet with fine woven grille cloth. Each occupies less than one cubic foot, making them easy to place on bookshelf, "lite-pole," or wall. Double horn-loaded, with 6" mid-range driver and 2000 cps crossover wide-angle tweeter. User net: Model SLC—$43.50. Stereoflex-1—Mahogany $54.50, Blond or Walnut — $56.50.

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RESIDENT CLASSES—The Grantham Communications Electronics Course is offered in both DAY and EVENING classes in Washington, Hollywood, and Seattle. The DAY course meets five days a week, from 9 a.m. until 1 p.m., and prepares you for a *first class* F.C.C. license in 12 weeks. The EVENING course meets two nights a week, from 6:30 p.m. until 10:30 p.m., and prepares you for a first class F.C.C. license in 30 weeks. All courses "begin at the beginning"—NO previous electronics training required or assumed.

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John A. Hayes, 1519 Madison Ave., Memphis, Tenn.	1st	14
Robert A. Morgan, 25 Barrow St., New York, N.Y.	1st	9
Hal Moon, Cook Hotel, 1334 Central, Kansas City, Mo.	2nd	5
W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Erskin D. Davis, 4220 Clay St., NW, Washington, D.C.	1st	12
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Robert H. Moore, 807 Grace St., Baldwin, L.I., N.Y.	1st	12
Otis A. Towns, 3638 Bates St., St. Louis, Mo.	1st	12

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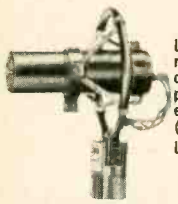

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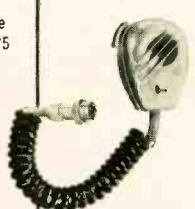

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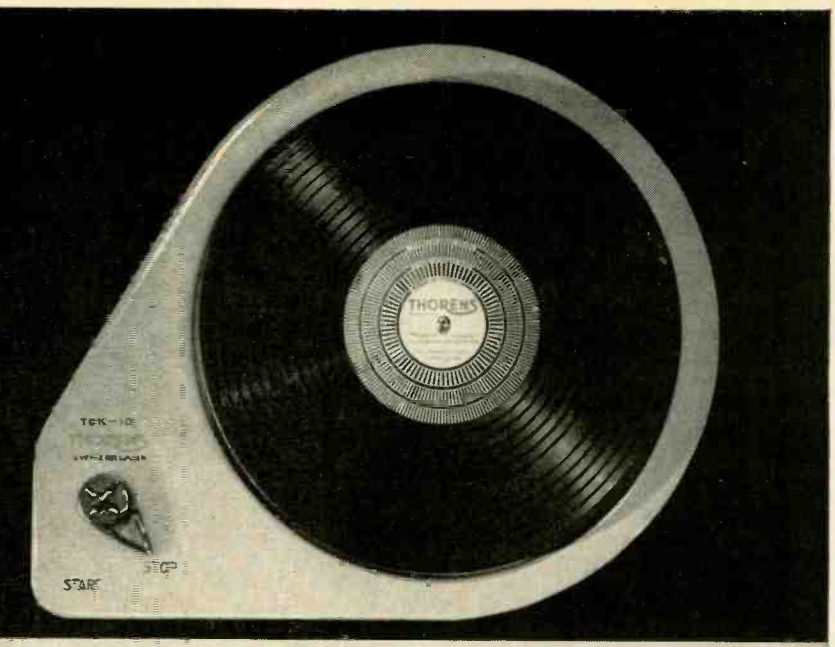

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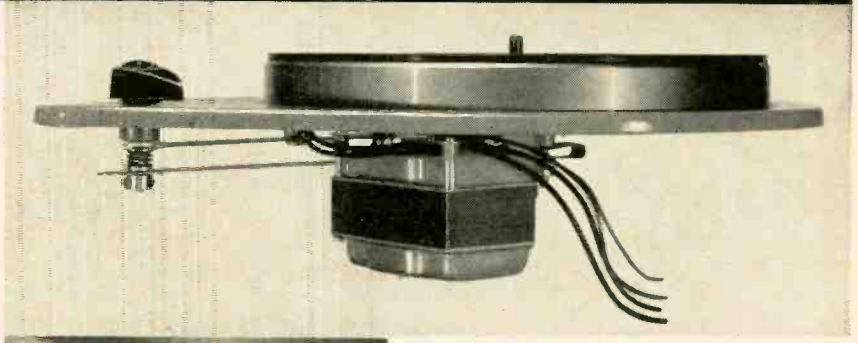

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Features:
Same compliant belt-plus-idler drive as on more expensive TD units; provides complete motor isolation. Single, retained, ball-thrust bearing, plus mirror-finished main bearing, for absolute minimum of rumble, both vertical and horizontal—so necessary for stereo. Single-speed 33⅓. Adjustable speed (±3%, a total of about one musical semitone). Built-in strobe allows setting to exact speed. Automatic disengagement of idler when unit is switched off. Drive mechanism completely enclosed—no "string" belts or external belt shields. Accessory wooden base is available in walnut, blond, or mahogany; $9.00 net.

9.5

Write Dept. E-3 for catalog on complete Thorens hi-fi line.

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TD-124. Absolute tops for stereo or mono records . . quietest, smoothest, most exact. 11½ lb. table; clutch for fast, noise-free starts with needle in groove. 4 speeds, all adjustable (±3%) for perfect pitch; built-in illuminated strobe; built-in level. All assembled TD turntables are 100% tested electronically and aurally for wow, rumble and flutter before shipment. **$99.75 net. Base $9.00.**

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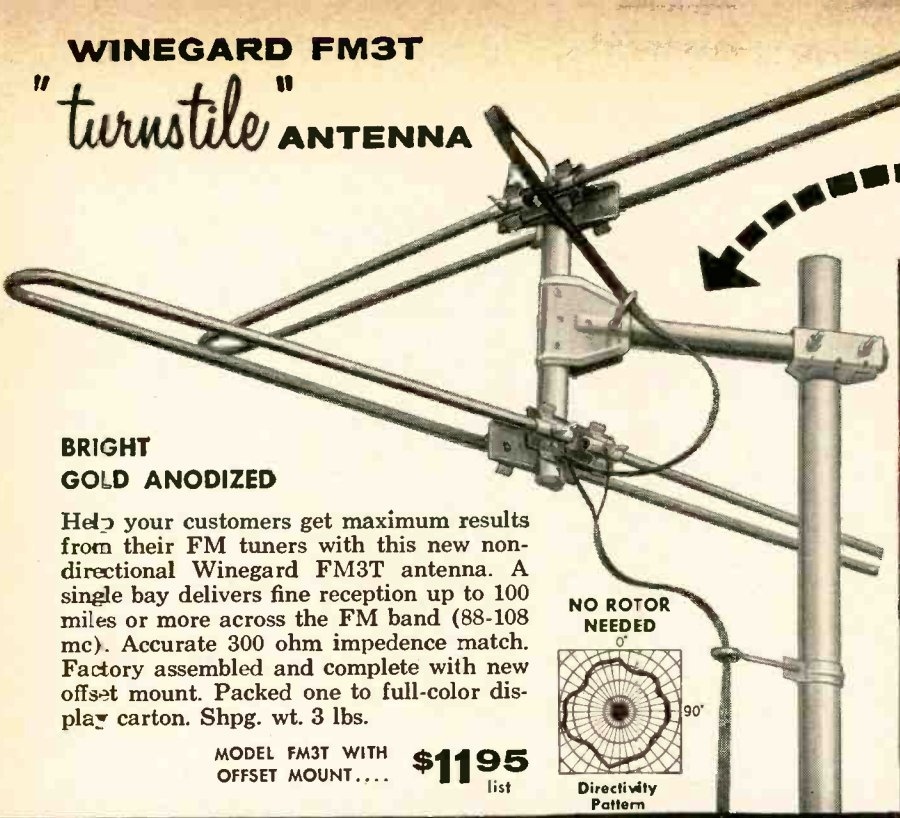

BRIGHT GOLD ANODIZED

Help your customers get maximum results from their FM tuners with this new non-directional Winegard FM3T antenna. A single bay delivers fine reception up to 100 miles or more across the FM band (88-108 mc). Accurate 300 ohm impedence match. Factory assembled and complete with new offset mount. Packed one to full-color display carton. Shpg. wt. 3 lbs.

MODEL FM3T WITH OFFSET MOUNT.... **$11.95** list

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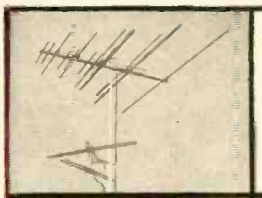
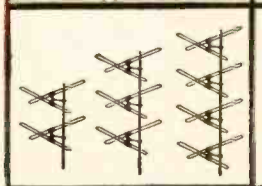


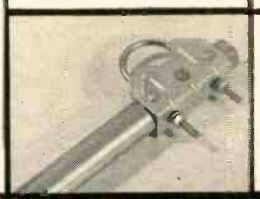
MOUNTS ON SAME MAST WITH TV ANTENNA

Easiest antenna you ever installed. Factory assembled. Mounts quickly on any mast. No extra mounting parts needed.



STACKS EASILY IN 2, 3 OR 4 BAYS

Unique Winegard offset mount allows you to stack up to 4 bays for greater power and distance, using regular 300 ohm line.



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New, super-strong "wrap around" mast clamp aligns antenna automatically. Can't crush boom no matter how much you tighten it.

Winegard

Shows you how to cash-in on the FM Market with the

MOST COMPLETE LINE OF FM ANTENNAS

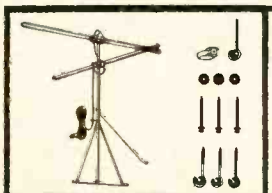
Did you know that high gain TV antennas are worthless for good FM radio reception? This is true because the gain is purposely reduced across the FM radio band on most TV antennas to eliminate possible FM interference on TV.

Thousands of people who own precision FM tuning equipment *don't know this* and as a result are *ruining* their reception and picking up only a few of the stations they should be getting.

A well engineered tuner with a modern Winegard FM antenna can consistently bring in excellent reception on stations from close in, up to 100, even 300 miles away. Add to your profits by displaying and selling Gold Anodized Winegard FM antennas. Choose from 7 different models and kits.

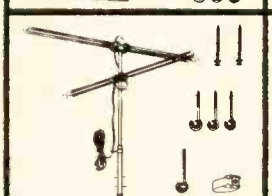
WINEGARD FM ANTENNA KITS

BRIGHT GOLD ANODIZED



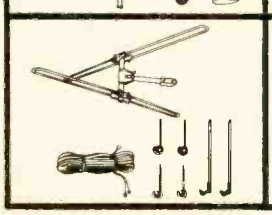
MODEL FM3A

Same antenna head as FM3T, but with Winegard's universal tripod mount. Complete with all mounting parts and 50-ft lead-in. Model FM3A, list.... **$17.95**



MODEL FM3S

Same antenna head as FM3T, but includes mast with sleeve mount. Complete with all mounting parts and 50-ft. lead-in. Mode FM3S, list **$16.95**



MODEL FM3K

Same as Model FM3T, but includes 50-ft. lead-in, 2 mast stand-offs and 2 wood screw stand-offs. FM3K, list..... **$14.95**

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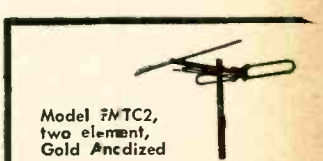
For Long Distance Reception... 200 Miles and More!

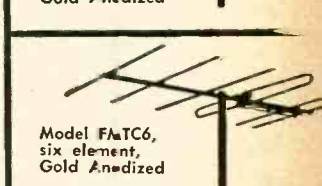
Choose from three directional, high gain FM Yagis With Exclusive New TransCoupler

Three new FM yagis, the ultimate in FM antennas. Bright gold anodized heavy-duty aluminum. Flat frequency response across entire FM band. Extremely high gain and sharp directivity.

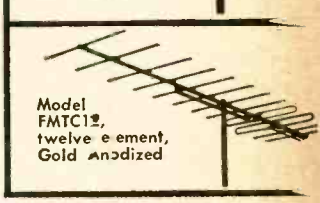
Winegard's exclusive TransCoupler bars fold down for easiest and most accurate stacking ever devised. Perfect 300 ohm match on single bay or when stacked. No extra bars needed.



Model FMTC2, two element, Gold Anodized



Model FMTC6, six element, Gold Anodized



Model FMTC12, twelve element, Gold Anodized

Winegard Co.

3013-3 Scotten Burlington Iowa

Write Today for Technical Bulletins on Winegard FM Antennas

ROHN TOWERS on the MARCH to bring you NEW, EXPANDED PROFITS!

✳ NEW TOWERS

ROHN engineering presents new, dramatic tower lines for your consideration. Be sure to get complete catalog details on this as they are proving to be *tremendous* profit-makers!

✳ MORE DESIGNS

Outstanding, well-engineered designs of various types are available to suit your *every* requirement.

✳ COMPLETE SELECTION

The ROHN tower line is now one of the *largest* (and growing larger daily) tower lines of its kind in the nation! By selling and servicing the ROHN line you capitalize on *many* fields and markets that others *cannot* possibly fulfill.

✳ MORE SALES FEATURES

ROHN towers and its full line of accessories offer *more* sales features and *sooner* than anyone else! Careful inspection always proves the superiority of ROHN towers. Why settle for less than the best? All ROHN products have the *finest* of finishes too . . . completely hot-dipped galvanized *after* fabrication!

✳ BIGGER PROFITS

It all adds up to the indisputable fact that ROHN towers make jobber, dealer, serviceman and user *more* money. ROHN has the proof . . . ask to be shown!

FABULOUS ROHN "SS" TOWER

A Completely Self-Supporting Tower to 130′ in a Completely Different Design!

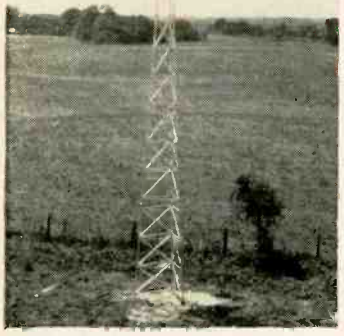
This special self-supporting tower is constructed by using 13 different tower sections of varying weight, size, structural strength and taper. Using all 13 sections gives a heavy-duty self-supporting 130 foot tower. However, the individual sections of this tower can be used in various combinations to build a tower to practically any height from 130′ on down, and of *specific* strength in order to handle the *particular* antenna that is to be placed on the tower. This means that you can have a ROHN tower *exactly* to meet *your* requirements. Shipping this tower is convenient and installation is simple.

NO. 50 TOWER

This tower is a special one utilizing sections of the "SS" tower and is suitable for installations of guyed heights up to 450 feet.

NO. 60 TOWER

Special tower using above "SS" tower sections and is suitable in guyed heights up to 600 feet!



NO. 25 FOLD-OVER TOWER

This general-purpose communication tower with the zig-zag cross-bracing design is now available as a "fold-over" tower. Amateurs and others requiring a "fold-over" tower are invited to inspect this tower to see its superiority and its many advantages that it has to offer you.

ROHN LINE ALSO INCLUDES:

NO. 40 TOWERS—the communications tower having a structural strength so as to be installed in guyed heights up to 300′. . . thousands are in use today for all types of communication and industrial uses.

NO. 30 TOWER—similar to the above No. 40 tower but utilizing different design.

NO. 6 TOWER—the widely used tower with the "magic triangle" especially suitable for home television reception.

P. T. TOWERS—package towers for easy shipping and storage.

ROOF TOWERS—especially designed short height roof installations.

TUBING—complete line.

BASES—for practically every use.

Also, guying and installation accessories of all types to give **complete** television, amateur or communication towers.

See your ROHN representative in your area, your distributor or contact:

ROHN *Manufacturing Company*

116 Limestone, Bellevue
Peoria, Ill. Phone 4-9156

ROHN MANUFACTURING COMPANY
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GENTLEMEN: Please send me the catalog and information on the following:

☐ TV Towers ☐ Amateur Towers
☐ Communication Towers ☐ Full line of Rohn products

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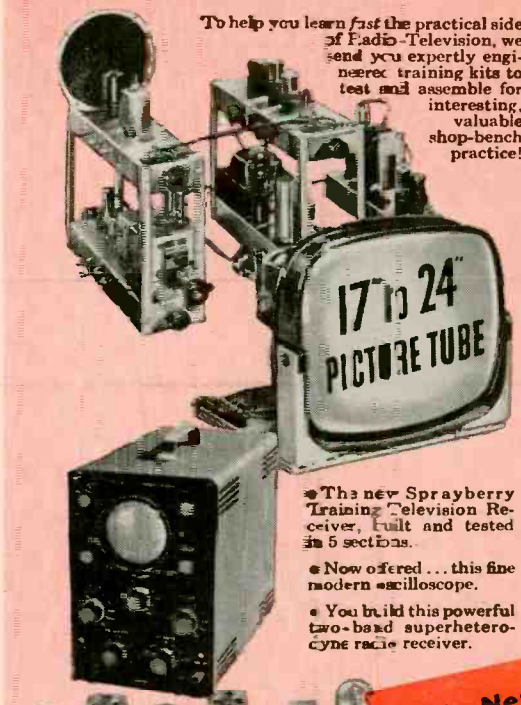
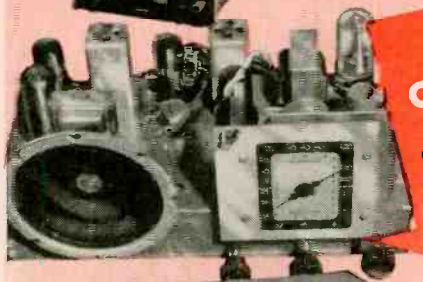
25 BIG, COMPLETE KITS of PARTS & EQUIPMENT

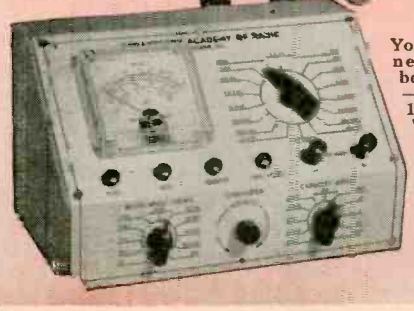
To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered . . . this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



Big New CATALOG AND Sample Lesson FREE!



You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands . . . trained Radio-Television Service Technicians . . . are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need . . . to step into a fine job or your own Radio-Television Service Business.

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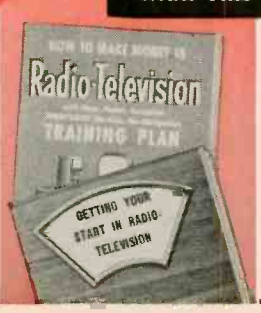

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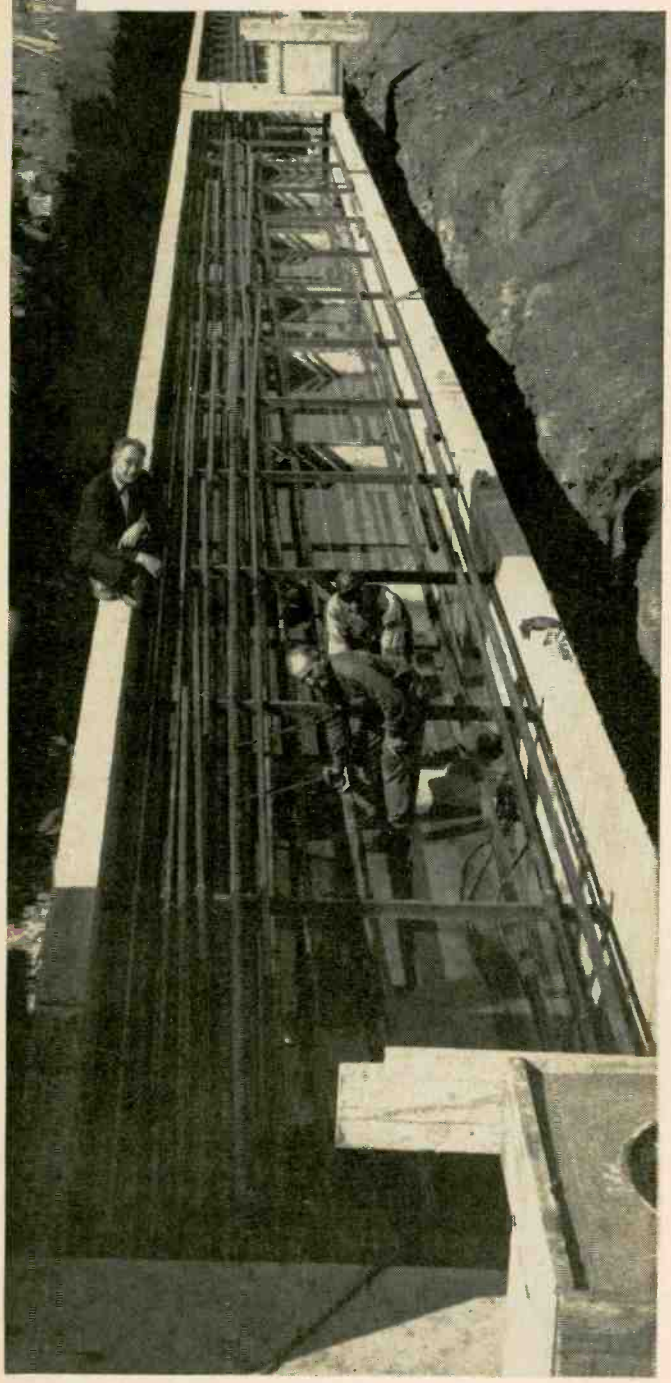
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

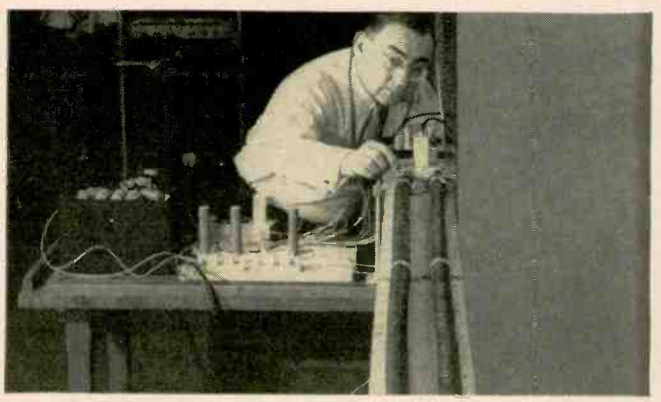


"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

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RESEARCH AND DEVELOPMENT

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World-famous EICO advantages guarantee your complete satisfaction:

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Over 1 MILLION EICO instruments in use throughout the world

NEW STEREOPHONIC EQUIPMENT

HF85: Stereo Dual Preamplifer is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source—tape, discs, broadcasts. Superb variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any 2 high-quality power amplifiers such as EICO, HF14, HF22, HF30, HF35, HF50, HF60. Kit $39.95. Wired $64.95. Includes cover.

HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. **"Its performance is excellent, and the operation is uncomplicated."**—HI-FI MUSIC AT HOME. **"Excellent"**—SATURDAY REVIEW. Kit $69.95. Wired $109.95. Incl. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HF65: superb new design. Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit $29.95, Wired $44.95. **HF65** (with power supply) Kit $33.95. Wired $49.95.

HF61: "Rivals the most expensive preamps" — Marshall, AUDIOCRAFT. **HF61A** Kit $24.95, Wired $37.95, **HF61** (with power supply) Kit $29.95. Wired $44.95.

MONAURAL POWER AMPLIFIERS (use 2 for STEREO)

HF60: 60-Watt Ultra Linear Power Amplifier with Acro TO-330 Output Xfmr.; **"One of the best-performing amplifiers extant; an excellent buy."** AUDIOCRAFT Kit Report. Kit $72.95. Wired $99.95. Cover E-2 $4.50.

HF50: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60, same specs at 50W. Kit $57.95. Wired $87.95. Cover E-2 $4.50.

NEW HF35: 35-Watt Ultra-Linear Power Amplifier. Kit $47.95. Wired $72.95. Cover E-2 $4.50.

HF30: 30-Watt Power Amplifier. Kit $39.95. Wired $62.95. Cover E-3 $3.95.

NEW HF22: 22-Watt Power Amplifier. Kit $38.95. Wired $61.95. Cover E-2 $4.50.

NEW HF14: 14-Watt Power Amplifier. Kit $23.50. Wired $41.50. Cover E-6 $4.50.

MONAURAL INTEGRATED AMPLIFIERS (use 2 for STEREO)

HF52: 50-Watt Integrated Amplifier with complete "front end" facilities & Chicago Standard Output Transformer. **"Excellent value"**—Hirsch-Houck Labs. Kit $69.95. Wired $109.95. Cover E-1 $4.50.

HF32: 30-Watt Integrated Amplifier. Kit $57.95. Wired $89.95. Both include cover.

HF20: 20-Watt Integrated Amplifier. "Well-engineered" — Stocklin, RADIO TV NEWS. Kit $49.95. Wired $79.95. Cover E-1 $4.50.

HF12: 12-Watt Integrated Amplifier. "Packs a wallop"—POP. ELECTRONICS. Kit $34.95. Wired $57.95.

SPEAKER SYSTEMS (use 2 for STEREO)

HFS2: Natural bass 30-200 cps via slot-loaded 12-ft. split conical bass horn. Middles & lower highs: front radiation from 8½" edge-damped cone. Distortionless spike-shaped super-tweeter radiates omni-directionally. Flat 45-20,000 cps, useful 30-40,000 cps. 16 ohms. HWD 36", 15¼", 11½". **"Eminently musical; would suggest unusual suitability for stereo."**—Holt, HIGH FIDELITY. Completely factory-built: Walnut or Mahogany. $139.95; Blonde, $144.95.

HFS1: Bookshelf Speaker System, complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. Capacity 25 w. 8 ohms. HWD: 11" x 23" x 9". Wiring time 15 min. Price $39.95.

FM TUNER

HFT90: surpasses wired tuners up to 3X its cost. Prewired, pre-aligned, temperature-compensated "front end" — drift-free. Precision "eye-tronic" tuning. Sensitivity 1.5 uv for 20 db quieting — 6X that of other kit tuners. Response 20-20,000 cps ±1 db. K-follower & multiplex outputs. **"One of the best buys you can get in high fidelity kits."** — AUDIOCRAFT KIT REPORT. Kit $39.95*. Wired $65.95*. Cover $3.95.

*LESS COVER, F. E. T. INCL.

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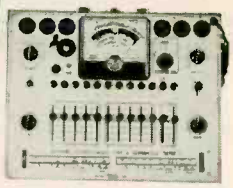


NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. Tests all receiving tubes (and picture tubes with adapter). Composite indication of Gm, Gp & peak emission. Simultaneous sel of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). New series-string voltages: for 600, 450, 300 ma types. Sensitive 200 ua meter. 5 ranges meter sensitivity (1% shunts & 5% pot). 10 SIX-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. Direct-reading of inter-element leakage in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors: separate meter readings of collector leakage current & Beta using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. CRA Adapter $4.50

New!

Series/Parallel R-C COMBINATION BOX #1140

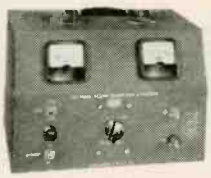
KIT $13.95 WIRED $19.95

TUBE TESTER #625

KIT $34.95 Wired $49.95

- tests 600 mil series string type tubes
- illuminated roll-chart

Pix Tube Test Adapter $4.50



6V & 12V BATTERY ELIMINATOR & CHARGER #1050

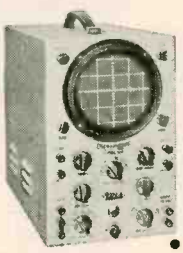
KIT $29.95 WIRED $38.95

Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95

NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased incremeter for excellent linearity. Extremely flat RF output; new AGC circuit automatically adjusts osc. for max. output on each band with min. ampl. variations. Exceptional tuning accuracy: edge-lit hairlines eliminate parallax. Swept Osc. Range 3-216 mc in 5 fund. bands. Variable Marker Range 2-75 mc in 3 fund. bands; 60-225 mc on harmonic band. 4.5 mc Xtal Marker Osc., xtal supplied. Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.



COLOR and Monochrome DC to 5 MC LAB & TV 5" OSCILLOSCOPE #460

KIT $79.95 WIRED $129.50

- Features DC Amplifiers!

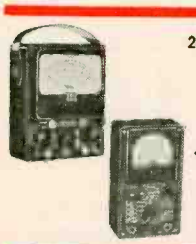
Flat from DC-4.5 mc, usable to 10 mc. VERT. AMPL.: sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull thruout; K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. SWEEP: perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); preset TV V & H positions; auto. sync. ampl. & lim. PLUS: direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

5" PUSH-PULL Oscilloscope =425: Kit $44.95, Wired $79.95.
7" PUSH-PULL Oscilloscope =470: Kit $79.95, Wired $129.50.

New!

Miniaturized MULTI-SIGNAL TRACER #145A

KIT $19.95 WIRED $28.95



20,000 Ohms/Volt V-O-M #666

KIT 24.95 Wired $29.95

1000 Ohms/Volt V-O-M #536

KIT $12.90 Wired $14.90

NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. 6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%; 6:1 vernier tuning & excellent spread at most important alignment freqs. Etched tuning dial, plexiglass windows, edge-lit hairlines. Colpitts RF osc. directly plate-modulated by K-follower for improved mnd. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. amplifier: only 3.0 v needed for 30% mod. Turret-mounted coils slug-tuned for max. accuracy. Fine & Cnarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5-way jack-top binding posts for AF in/out; cnaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

NEW! PEAK-to-PEAK VTVM #232 & UNI-PROBE (pat. pend.)

KIT $29.95 WIRED $49.95

Half-turn of probe tip selects DC or AC-Ohms.

Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide ranges & versatility. Calibration without removing from cabinet. New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. 7 non-skip ranges on every function. 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. Zero center. One zero-adj. for all functions & ranges. 1% precision ceramic multiplier resistors. Measure directly peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v. with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

Reads 0.5 ohms −500 megs, 10 mmfd−5000 mfd, power factor.

KIT $19.95

Wired $29.95

R-C BRIDGE & R-C-L COMPARATOR #950B

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
High Voltage Probe-1		$6.95
High Voltage Probe-2	$4.95	
SCOPE PROBES		
Demodulator	$3.75	$5.75
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

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MICROMUSIC

... *Electronics Is the Mother of Future Music* ...

THE evolution of modern music technique goes back to the invention of the vacuum tube. Electronic amplification of sound opened entirely new vistas undreamt of before in recording as well as in audio reproduction. Yet far greater audio accomplishments, which can be glimpsed only faintly today, are in store for us in the immediate future. The recent past has taught us that music is a field of ultra-rapid change. Every time a composer ventures into a "new" domain, be it in rhythm, time or phrasing, it usually takes quite a while before his music is understood. Wagner was bitterly attacked in his native Germany for composing his opera "Tannhäuser." He was unable to produce it there, so it had its première in Paris. Igor Stravinsky's "Sacre du Printemps" was neither understood nor accepted for years—it often takes a long time to attune one's ear to unorthodox sound and rhythm.

This is particularly true of Edgar Varèse's *Poème Electronique* (Electronic Poem),* composed by him for the Brussel's World Fair, as well as other compositions of his. Varèse, the composer of this bizarre genre of music, manufactures a variety of weird sounds, which are then registered on magnetic tape. Often there is no theme or rhythm and the result to most ears is unconnected sounds, which some critics claim are really not "music". Nevertheless, Varèse is very successful as a composer of this new and abstract musical expression, and it is quite certain that he is responsible for an entirely new school of music. Moreover, as most of his sounds are created electronically, this alone would seem to insure its future success, due to the extraordinarily vast range of this almost unexplored field.

We now come to another allied audio field, so far also hardly touched, which we may term *microsound or micromusic*. Practically all modern music is played with standard musical instruments, the exception being electronic music produced by vacuum tubes or transistors, or the Varèse type of electronic treatment of sound in which unusual sound effects are produced in various unorthodox ways.

There are, however, an unlimited number of sounds all around us which rarely find their way into music, because these sounds are seldom heard. Most of them are so weak that they must be amplified to become audible. They belong to a different sphere which we may term *microsound*. Let us clarify this:

Many materials under stress or pressure give out various —often surprisingly beautiful—sounds. Wood, metals, plastics, crystalline substances when bent produce weak sounds which can easily be amplified and recorded. For example, a bar of tin, which is distinctly crystalline, gives off a characteristic crackling sound, called the "cry" of tin, when the bar is bent. Liquids and gases under pressure or elevated temperatures emit a variety of sounds. Thus we have the well-known singing gaseous flames. A storage battery while being charged gives off characteristic effervescing sounds which lend themselves well for amplification.

A large catalog can be compiled from a myriad of insect sounds, most of them barely audible normally. Yet amplification brings out these hidden sounds, few of which have been recorded so far. They are not necessarily produced by the beating of the insect's wings—the mosquito's wing hum "song," by the way, *has* been recorded to attract the mosquito's mate. Many insects produce distinctive sounds, some, like the cricket, surprisingly loud. Here the male insect has a stridulating instrument which produces the familiar chirping sound due to 130 transverse ridges on the underside of the wing cover which are rapidly scraped over a smooth projecting rib of the wing.

A team of entomologists and musically inclined electronic technicians could easily compile a vast array of insect sound tapes for a future "Insect Symphony" or even an "Insect Opera." It is a vast and rewarding field.

We should also speak of *involuntary biological* sounds, such as sounds produced by digestion. Thus, a microphone attached to the animal abdomen gives out a most surprising and odd series of squealing whistles.

Possibly the most fertile sources of micromusic are crystals of various categories. The electronic art has used a succession of crystals for a long time for specific purposes. Oscillating quartz crystals are well known, as are the piezoelectric properties of Rochelle salt crystals and barium titanate ceramic. The latter are chiefly interesting for our present discussion in so far as they generate electric currents under mechanical pressure. This has given us the piezoelectric microphone which generates current when voice vibrations impinge on the crystal. Reversed, when connected to a microphone, the crystal becomes a loudspeaker. It follows that it thus becomes feasible to create pure musical sounds by manipulating a multiple-crystal assembly in various ways. A *piezo-crystal piano* could be made in such a manner.

The resonant quality of metal or glass *lametta* (exceedingly thin tines) mounted on suitable resonators and agitated appropriately, then amplified, gives rise to excellent musical sounds of a high quality. Such musical instruments will be minuscule, yet with proper amplification can fill a concert hall.

We have given here only a few random suggestions of the future sophisticated art of micromusic. Admittedly, a vast amount of research and work lie ahead, but it would seem certain that entirely new musical developments and esthetic pleasures will stem from such an endeavor. Nor should we fail to emphasize that micromusic can, of course, be stereophonic at will.

—H. G.

*See "400 Loudspeakers" in the October, 1958, issue of RADIO-ELECTRONICS.

STEREO CONTROL CIRCUITS

Analysis of circuit features in new stereo amplifiers and preamps

By ROBERT F. SCOTT
TECHNICAL EDITOR

Bogen DB212 is a dual 12-watt stereo amplifier.

H. H. Scott makes this stereo preamp—the 130.

SP-6 stereo control center is produced by Arkay.

ANYONE interested in the techniques of stereophonic reproduction will enjoy studying the circuit diagrams of preamps, control units, adapters and complete amplifiers, and comparing various design solutions to common problems. Basically, an ideal stereo setup consists of two monophonic systems of identical characteristics. The controls duplicate those of a monophonic system, with the possible addition of two or three peculiar to stereo. We have analyzed the control circuits of much of the new stereo equipment and will describe some of the most interesting circuit innovations. Others will be described in subsequent articles as material becomes available.

Preamp–equalizer

In the Madison Fielding series 320 stereo amplifier, all controls are separate and independent except for the master volume and channel-function selector. The selector has six positions providing for monophonic and stereo tape, phono and radio. Phono cartridges and tape heads are connected through two-stage preamps like the one shown in Fig. 1.

When the *variable* equalization control—marked PREAMP—is turned fully counterclockwise to the TAPE HEAD position, the dpst switch opens. Feedback from the output plate to the input cathode through the 150,000-ohm resistor and 680-$\mu\mu$f capacitor provides bass boost from 1,600 cycles to conform to

Madison Fielding combines dual 20-watt amplifiers in model 320 stereo amplifier.

Grommes model 208 is a stereo preamp.

the NARTB curve for 7.5-ips tape.

Rotating the PREAMP control clockwise closes the switch. One section adds a .0015-μf capacitor to the feedback loop to shift the turnover to 500 cycles for most phonograph playback curves. The other section connects the 50,000-ohm PREAMP control and the series 3,300-ohm resistor across the preamplifier's input jack. Varying the control adjusts the high-frequency end of the equalization curve by loading the cartridge. The control dial is calibrated LP, RIAA, AES, and 78.

The twin preamp stages in the Arkay series SP-6 (Fig. 2) have NARTB equalization for tapes and RIAA equalization for magnetic phono cartridges. Correct equalization is switched in when the SELECTOR is turned to TAPE or PHONO. In the PHONO position, feedback is taken from the output plate and fed to the output grid through 47,000 ohms and .002 μf in series. A second .002-μf capacitor is connected in series with the feedback loop to raise the turnover point to approximately 1,600 cycles in the TAPE position.

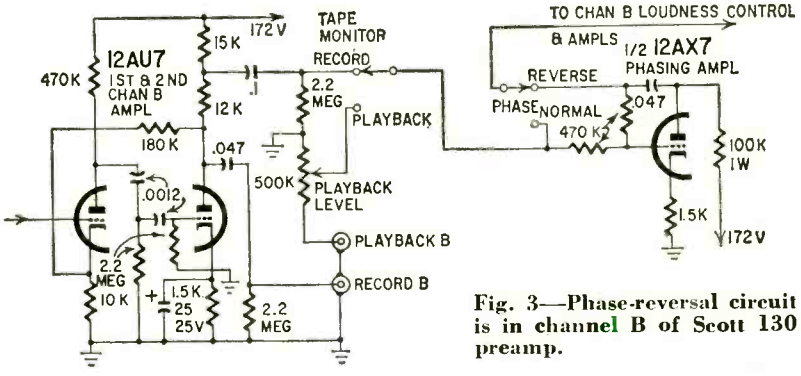


Fig. 3—Phase-reversal circuit is in channel B of Scott 130 preamp.

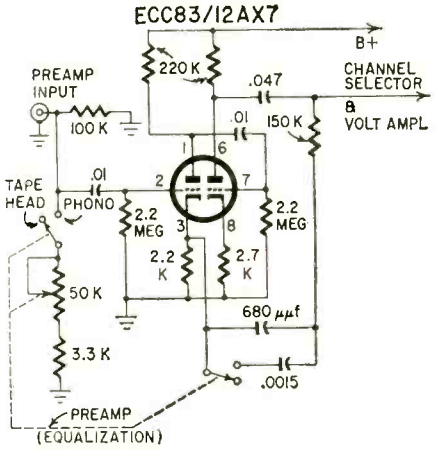


Fig. 1—One of pair of preamp circuits in Madison Fielding series 320.

Channel phasing

A control for reversing the phase of the signal in one of the stereo channels is a feature of comparatively few units and we feel that it would be a worth-while addition to all systems that do not include it. Channel phasing is not always correct on records and prerecorded tapes and some method for inverting or reversing the phase of one channel must be included in the playback equipment.

Fig. 3 is the circuit of the phasing amplifier and its connection to the preceding and following circuits in the channel-B section of the H. H. Scott model 130 preamp. When the PHASE switch is at NORMAL, the signal goes straight through from the TAPE MONITOR switch to the LOUDNESS control. Throwing the switch to REVERSE takes the inverted signal from the plate of the 12AX7 phasing amplifier. The signal level is held substantially constant by operating the phasing amplifier as a zero-gain stage. Gain is reduced by negative feedback from plate to grid through the 470,000-ohm resistor.

In the H. H. Scott model 299 complete stereophonic amplifier, signal phase is reversed in the output circuit. The arrangement is similar to that used in the Bogen DB212 amplifier illustrated in Fig. 4. Sliding the switch from NORMAL to REVERSE transposes the voice-coil leads to the channel-2 speaker.

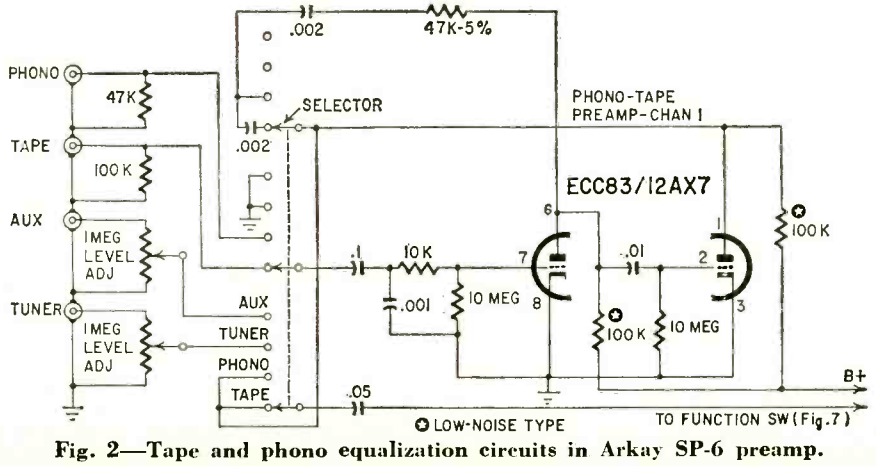


Fig. 2—Tape and phono equalization circuits in Arkay SP-6 preamp.

Channel balance

Balance or focus controls vary the output of one or both channels to compensate for unbalance in program levels as from AM–FM stereo broadcasts and differences in amplifiers, speakers, room acoustics and unequal distances between the two speakers and the usual listening position. Balance controls are of several types. Some provide complete cutoff of either channel, some have a control

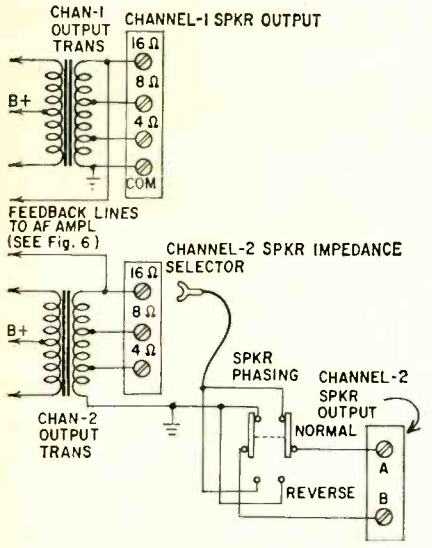


Fig. 4—A popular phase-reversal circuit transposes leads to speakers in one channel.

range limited to a few db in either direction in one channel and most increase the gain of one channel while decreasing the gain of the other channel by the same amount. Some systems have built-in tone generators that feed identical signals to both channels. A few stereo amplifiers have meters or electron-ray indicator tubes to indicate power output.

Balance controls are required for satisfactory stereo reproduction. But, unfortunately, balance is not constant at all settings of the master volume or gain control. Generally, the pots used in ganged controls are not well matched and there may be a 2-db or greater difference between the signals in the two channels as the master volume control is moved from the position used for balancing.

Fig. 5 illustrates one of the more common balance controls. This circuit is from the Grommes model 208 preamplifier. The signal for the grid of each af amplifier is taken from a tap on a voltage divider consisting of 220,000- and 22,000-ohm resistors and a portion of the 1-megohm BALANCE or FOCUS control. Rotating the control so its arm moves away from center adds resistance in the grid circuit of one amplifier and removes a corresponding amount from the grid circuit of the other. The signal applied to each grid varies directly as the resistance in its grid circuit.

The balance control used in the Bogen DB212 is shown in Fig. 6. Here, the balance potentiometer is a 3-megohm unit with its center *open*, making it in effect two 1.5-megohm variable resistors in a single case. Moving the control in either direction from center bridges a portion of the control resistance and a 10,000-ohm series resistor across the volume control of one channel. The voltage applied to the grid of the 7199 decreases as the resistance left in the balance control. The gain of the other channel is not affected until the control is turned in the opposite direction so its volume control is bridged by the BALANCE pot.

The 7199 amplifier and phase inverter are connected in a starved-current circuit for extremely high gain and low noise. The triode grid is direct-coupled to the pentode plate. The pentode, in turn, operates with its screen supplied with a very low voltage derived from the cathode circuit of the triode. The screen voltage is bypassed and stabilized by the 0.47-μf capacitor. (The starved-current circuit is beginning to pop up more and more in modern equipment.)

The Madison Fielding series 320 amplifier does not have a balance control. The gain of each channel is adjusted with an independent LOUDNESS—VOLUME control. Balance may be adjusted precisely by balancing the shadows on the dual-beam 6AF6 electron-ray tube used as an indicator in vtvm circuits. See Fig. 7.

Closing either CALIBRATE switch applies a small 120-cycle voltage to the associated channel. The two POWER controls are set to the same points on their scales and the individual volume controls are then adjusted so both shadows of the indicator just close. When this occurs, the outputs of the two channels are equal. However, this assumes that identical speaker systems are used and that the halves of the 12AX7 eye driver are balanced.

The POWER controls are calibrated in steps from 0.25 to 20 watts in six steps. They may be used to measure power output. With the volume controls set to the desired level, you can measure power output by rotating the POWER control until the corresponding shadow closes and then noting the control setting. Conversely, you can adjust the output to the desired level by setting the POWER control and then adjusting the volume control until the eye just closes.

The FUNCTION selector, BALANCE and GAIN control circuits of the Arkay SP-6 are shown in Fig. 8. The BALANCE potentiometers are ganged and connected so the resistance in one increases as the other decreases. The BALANCE and GAIN potentiometers form voltage dividers supplying signals to the input grids of 12AX7's in each channel. The voltage on each grid increases as the resistance in the BALANCE control decreases. The BALANCE control sections are connected so the resistance in one increases as the other decreases.

The FUNCTION control is conventional in its first three positions. In the reverse (REV) position, the input from

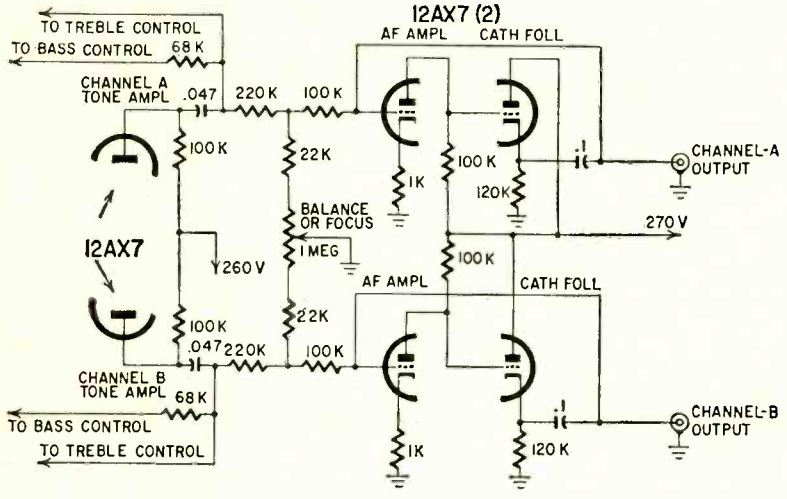
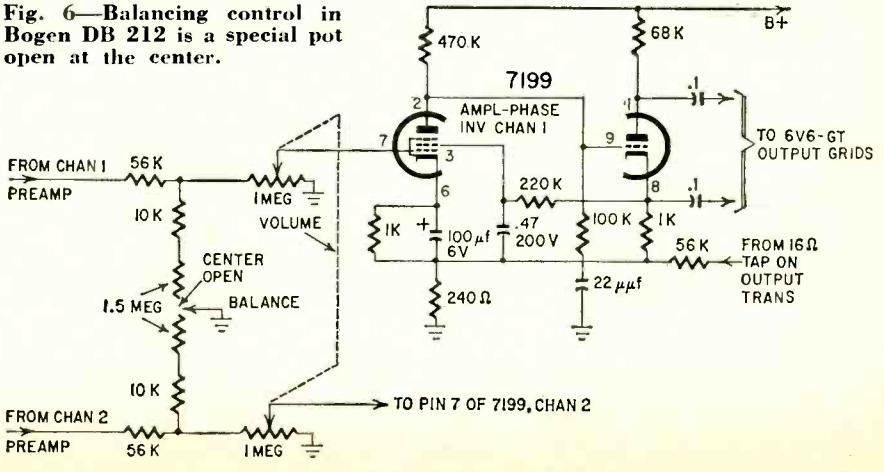


Fig. 5—Balancing circuit in the Grommes model 208 preamp.

Fig. 6—Balancing control in Bogen DB 212 is a special pot open at the center.



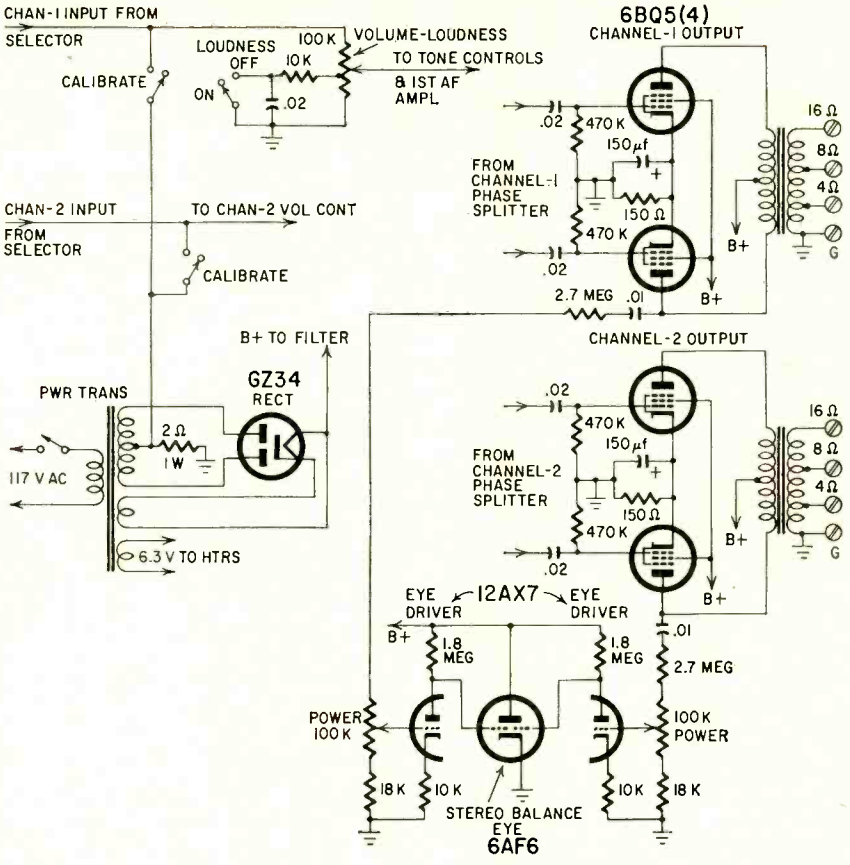


Fig. 7—Balance is set precisely by setting loudness controls for equal shadows on 6AF6 indicator tube with CALIBRATE switches closed.

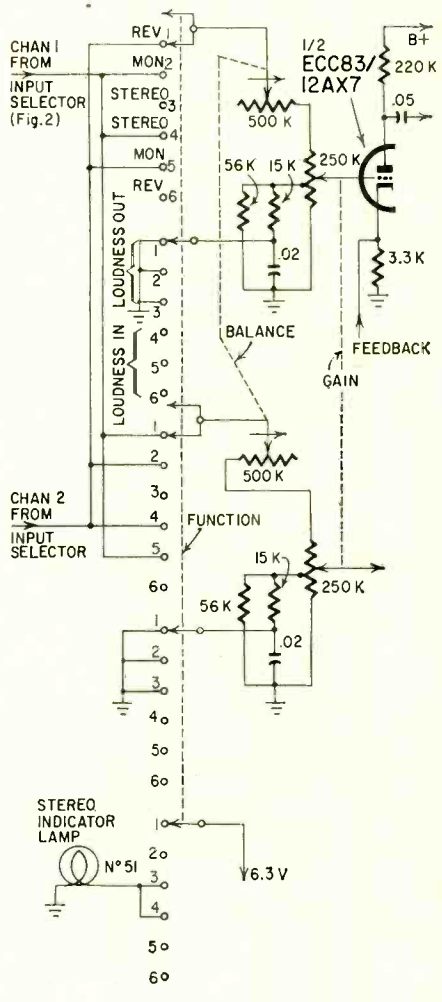


Fig. 8—Arkay SP-6 has balance and gain controls in series.

channel-1 is fed through the channel-2 circuits and the input from channel-2 feeds through the channel-1 amplifier circuits. In the monophonic (MONO) position, the inputs are paralleled and fed to both channels in phase. The STEREO positions feed the individual inputs straight through their respective amplifiers.

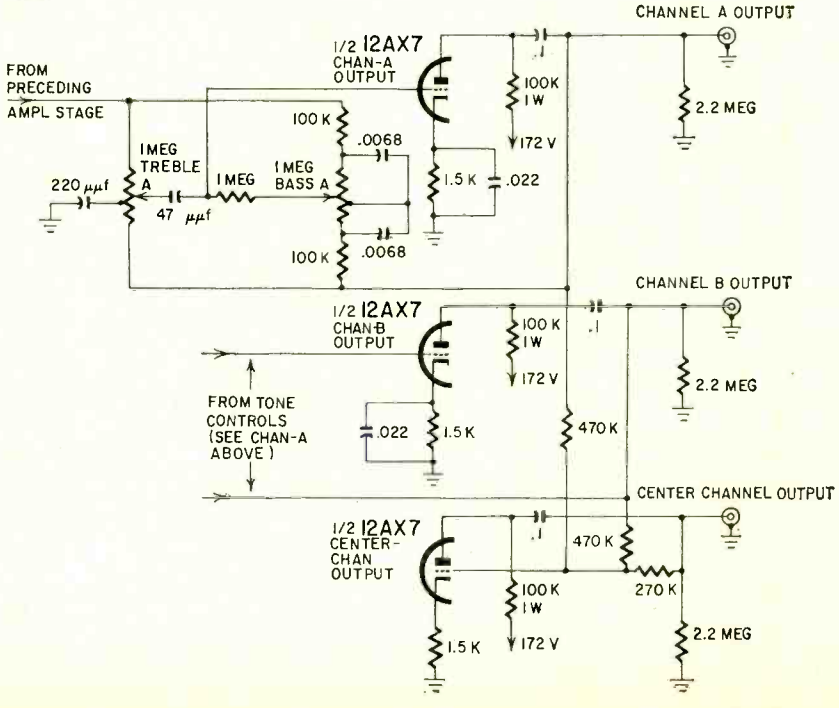
Two sections of the FUNCTION switch are tied into the loudness-compensation circuits bridged across the GAIN control. Loudness compensation is disconnected in the first three positions and available in the others. A fifth section of the switch lights an indicator lamp in the STEREO positions. It seems that the indicator should be wired to work in the reverse position as well. After all, stereo is stereo regardless of channel polarity.

Center channel

On some stereo tapes and records the channel separation is exaggerated intentionally. This may produce a "hole-in-the-middle" effect that usually becomes annoying after the listener has become used to stereo.

Fig. 9 shows how the center-channel signal is derived in the Scott 130 preamp. A part of the outputs of channels A and B is fed to the grid of the center-channel amplifier through 470,000-ohm resistors. The resulting signal is the sum of the signals tapped off the two outside channels. It can be used to feed a center-channel amplifier and speaker. END

Fig. 9—Outputs from channels A and B are mixed to provide signal for center-channel amplifier.



Is your STEREO in phase?

By EDWARD TATNALL CANBY

IS your stereo in phase—*all of it?* Are you sure that *all* your equipment, cartridges, preamps, amplifiers, tape decks, switching systems, mixers, balancers, transformers, microphones—and of course, your speakers—are *uniformly* in phase with each other? Are you confident that every one of your stereo discs and all your stereo tapes are also in phase, so that under no circumstances will there ever be a reversal of speaker phasing at your stereo listening spot, no matter what you play, what equipment you use, what stereo source you tap, whether you play straight stereo or listen to monophonic sound fed to stereo speakers?

If you think yes, you're being grossly optimistic. Phasing is so utterly simple that it has mostly been ignored in favor of much more complex problems of basic stereo engineering. It's child's play. There are only two possibilities, two choices. To change phase, you merely reverse the connections to one speaker.

Unfortunately, right speaker phasing is essential in stereo listening—and "right" is not merely a matter of the speaker connections alone. There is a "right" and a "wrong" alternative, too, in every microphone, cartridge, tape player, disc cutting head and so on, and in a hundred different connections within many of these elements. In most, the "right" way is purely arbitrary, distinguished from the "wrong" merely in being opposite. In some—for example, the cutting heads and playing cartridges for stereo disc—the right way has been defined specifically, as a standard. (But it wasn't until fairly recently.) In much circuitry the "right" way is simply that which does not reverse the signal phasing en route.

In theory, there should be no problem now. Manufacturers are supposedly checking phase on every aspect of stereo production. Stereo mikes in the recording studios are scrupulously phased—or so we hope. Maybe in a year or two there really won't be any phasing problem; it will all be taken care of automatically.

But not yet. It is amazing how many loopholes are still open! The deadly part of it is that a single reversal at any point in the chain of stereo reproduction reverses the entire system. True, any two wrongs add up to make a right. But this merely adds to the confusion, since the falsely "right" phasing may show up when another switching position or another piece of equipment is used.

At least (you may think) commercially produced stereo discs and tapes must be uniform in phase, as a starter. Not necessarily! Most of the new discs are in themselves correct. But stereo tape is far from new and the older tapes are now appearing everywhere in disc form. Some of these tapes are 3 or 4 years old, dating from a time when phasing was highly problematical. Unless somebody with sharp eyes and ears has corrected the early phasing mistakes, they are passed straight on to you via the stereo discs.

Most recordings today are uniformly phased, but you can't count on it.

Home stereo equipment is simple compared to professional recording equipment, but nevertheless there are a number of tricky areas where inadvertent phase changes may be hidden in the circuitry, perhaps without the manufacturer's knowledge. When this happens the confusion is compounded because most of us, in tracing the cause of the phase reversal, will look everywhere else *but* inside our professionally produced equipment!

Does phasing matter?

Why is stereo phasing so important? Simply because the very basis of stereo is the interaction of two speaker systems working together, blending their differing outputs into one spatially shaped sound. If these speakers are fighting each other, one pushing while the other pulls, there is bound to be a sort of shifting acoustic no-man's land between them, and no true blending. Wrong phasing means musical distress, spatial falseness, a very positive lack of "middle"—thanks to the in-between no-man's land of battling, interfering waves. Ever hear of the "hole in the middle"? That's it.

In view of all this, do you have any regular method of checking stereo phasing—not just once, but again and again as each new complication arises? Do you, for example, have that simplest and most essential of all stereo controls, a speaker phasing switch? If not, you lack a vital aid to stereo listening.

How do you tell wrong stereo phasing by ear? Ah, that's the big problem! You *can't* always tell, instantly. Sometimes you are sure that one way is right, only to reverse your own feelings the next time.

The ear is easily tricked, at first. There are so many variables involved, so many kinds of sound, types of miking, sorts of music, and so many room situations, that confusion is likely. Remember, stereo sound in not static. It is dynamic, alive, ever-changing. The interaction of the two channels shifts and flickers like sunlight through leaves (I like to think).

If you are tired, if your ears are fed up, you may drive yourself into a tizzy trying to make up your mind which phasing is right. The harder you try, the worse it gets. But if once you actually hear the difference between wrong and right—clearly, unmistakably A–B style—then you'll never doubt again that it is important, that it must be right always, even when (for the moment) you can't seem to hear any difference. Once your ear begins to notice, you will quickly learn the sound of correct phasing and the false effect of wrong phasing, in more and more varied situations.

The nice thing about this do-it-yourself phasing by ear is that once the basic either–or sound is recognizable to your ears and you can spot your phasing most of the time successfully, you can figure out all sorts of phasing problems from the speakers backward, by sheer logic. If so-and-so sound is in phase and so-and-so other sound is out, then the trouble must be right here. Process of elimination.

Stereo-cartridge phasing

Let's look at the cartridge. The phasing of the two stereo output signals is such that *lateral* grooves produce *in-phase* signals. Beginning with the disc cutter, the phasing is defined specifically as that in which two identical (in-phase) signals are fed to the two cutter circuits, the stylus cuts lateral grooves.

There are some interesting consequences here. If you visualize an ideal-

ized 45/45 pickup cartridge in action, you will see that to move laterally the stylus must displace the two generating elements *oppositely*. When one element moves upward and outward, at the diagonal, the other must move contrarily, downward and inward. It is easiest to imagine this motion for a pair of pistonlike magnetic coils, moving roughly like two opposite pistons of a V-8 auto engine. Lateral stylus motion moves them oppositely.

To demonstrate this action, take a couple of feet of string or hookup wire and fasten a small weight in the middle. Hold it by the two ends so the weight draws the string down into a V. Then move your hands diagonally in the planes of the V. If you move one hand downward diagonally while the other moves upward, the weight travels laterally—side to side. If you move both hands down, or both up, the weight moves vertically.

The stereo pickup's elements—coils or crystals—must be wired so when their motion is *opposite* the signals are the *same*, or in phase. This is a matter of electrical connections and mistakes are easy to make.

In four-contact cartridges you can take your choice—but the right way is normally indicated—that is, two of the pins are marked L and R for left channel and right channel, and these two outputs are in phase (or should be) for lateral groove signals. Connect them together and you'll have an additive in-phase signal from the lateral groove on any standard record. Your stereo disc will also be in phase at this point. (But if you get your connections reversed, the joined lateral signals will be out-of-phase and cancel. The cartridge will respond only to vertical stylus motion.)

Trouble spots

Here are some likely danger areas in respect to stereo phasing. Keep an eye on them and be sure your mind is on the alert to spot them.

1. Earlier tapes (those that haven't been copied and rephased to standard)—also stereo discs made from them—may be out of phase, requiring speaker reversal to bring them back. It is quite possible for a recording to be out of phase at one point and in phase at another, though this is rare!

2. Stereo speaker systems—final links in the chain—may be shipped and sold out of phase. They must be reconnected. Tweeters and woofers may themselves be wrongly phased within each channel.

3. In many complex switching circuits, hard-to-spot phasing changes may occur. Two reversals, remember, add up to correct phasing—until another switching setup shows up the trouble.

4. An important point—most amplifier circuits change phase for each stage of gain. Amplifiers with unequal numbers of stages will reverse the phasing of a stereo system.

5. Beware of such inconspicuous items as miniature pickup transformers, transistor preamps for mikes and pickups, etc. Any device, especially one that involves coils, is subject to easy phase reversal. Always check them.

6. Although stereo pickup cartridges are supposedly standardized, the four-wire system allows you to make reversed connections. This is particularly likely when the pins are not labeled on the cartridge or when the positioning is out of the ordinary. (Pin position is not fixed; you're likely to run into various arrangements and have to experiment to find the right connections.)

How to check phasing

Now the Big Question: Are there positive ways to check phasing? Consider these points.

1. Never use any stereo system without providing a phase-reversal switch in one of the final outputs. Preferably it is wired to run out to your listening spot and back. A few stereo systems now are sold with built-in phase switch.

2. As far as listening goes, note that the more pronounced the stereo effect, the harder it is to determine correct phasing by ear. Some jazz and pops stereos have such extreme right and left separation that there is virtually no interaction at all between speakers.

3. A monophonic sound fed to the two stereo channels is the best phase check of all. To check your stereo record setup, play a *mono* disc, via the stereo cartridge. Properly phased, *the monophonic sound bunches up between the two speakers* and does not seem to come from either one. Out of phase, the sound jumps out to the sides and there are pulsing "waves" of unevenness at the center, as you move your head or walk back and forth. *The center position is noticeably not filled.*

4. Though the easiest phase check is with a mono disc, you can hear phasing with most stereo discs, though not as easily.

With proper speaker phasing, some of the stereo sound in most recordings comes from dead center and straight ahead. With reversed phasing, even though the overall sound may seem about the same, the center may be noticeably weakened — some sounds seem to move over toward the sides as you switch. More sound comes from the sides; less—or none—comes from the middle.

Moreover, there is often that same odd "flutter" or pulsing effect, as one walks back and forth before the stereo speakers. It may be momentary, can be much more pronounced in some recordings than others, but sooner or later you'll run into it clearly in an out-of-phase stereo sound.

A few quick A–B trials in this fashion, with plenty of walking back and forth, will resolve most stereo sound, in most situations, into right and wrong phasing. Some stereo sounds, though, remain enigmatic and impossible to phase by ear, no matter how hard you try.

5. An ingenious and enormously useful switching gadget for stereo discs parallels the two channels of the cartridge, joining the outputs into one signal. It aids mono discs immensely since it removes the vertical response of the pickup (by cancelling the signal in the vertical groove) and, in effect, converts the cartridge into a mono unit feeding two channels.

The switch also makes a double phasing check. It insures correct connection of the cartridge—for if you join the wrong two pins, you get vertical response only, instead of lateral—a thin, weak sound, without bass and far down in level. I discovered one wrongly installed cartridge in this fashion. If the connections are right and your cartridge in phase, the combined output will be lateral only, with full normal volume. All records, *both stereo and monophonic*, will play mono sound through the stereo speakers.

This fact provides the other phase check. Since monophonic sound is easier to phase than stereo sound, switch to lateral-only response and you may then phase a stereo disc as though it were monophonic.

6. A popular stereo speaker configuration puts a third speaker at the center, sharing both stereo signals. The extra speaker helps widen the listening area and keeps the image at the center.

This speaker happens to be an excellent phase check. When the two main channels are out of phase, the center speaker will respond mainly to the weaker stereo *difference* signal, the originally out-of-phase element in the stereo sound. The sound will be thin and lacking in bass. With correct phasing of the two outer channels, the center speaker is much louder in volume or in bass, according to its capacity.

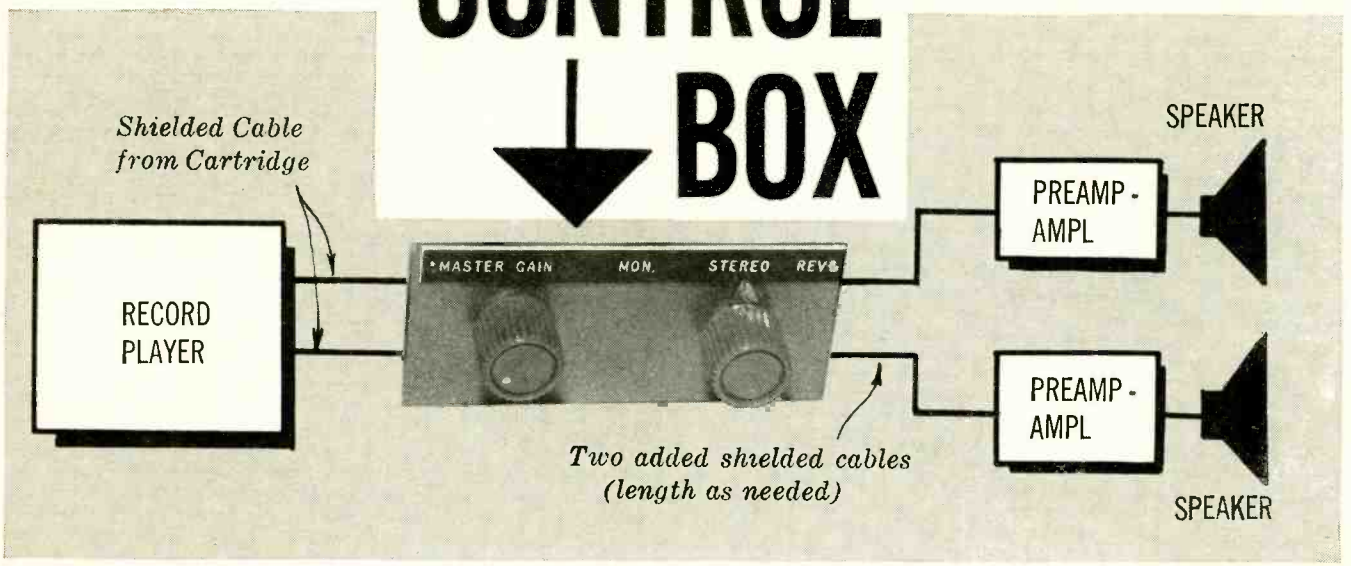
So don't jump too quickly to conclusions. But do open your ears and eyes. You can't afford to leave it to chance—yet. END

Edward Tatnall Canby is one of the country's foremost authorities on recorded music. He is the co-author of *Saturday Review Home Book of Recorded Music and Sound Reproduction* and author of *Home Music Sytems* and *High Fidelity for the Music Lover*. Since 1947, Mr. Canby has been doing a record review column for *Audio*, and for *Harper's Magazine* since 1952. His radio broadcast, *The New Recordings*, continues on WNYC, New York City.

STEREO CONTROL BOX

Planning stereo? Have an amplifier or two that you want to use instead of buying a new dual-channel unit? If so, this article is for you

By R. J. MEAGHER*

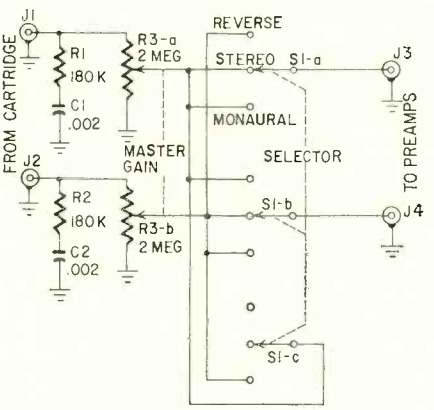


RECENTLY a friend and fellow hi-fi enthusiast presented me a situation—one that is by no means unique today. That is, he had a good record changer with a treasured preamp and amplifier, and he wanted to try stereo without making his present system obsolete. For his second channel he planned to use another amplifier he had built. If this arrangement proved unsatisfactory, he intended to build a duplicate of his better unit.

With this in mind we went to work. It was easy to install a Columbia Constant Displacement stereo cartridge in his changer. After removing the old cartridge and balancing the tone arm to zero weight by increasing the spring-load tension, we mounted the new stereo cartridge with the hardware supplied. The proper stylus pressure, incidentally, is supplied by the weight of the cartridge itself. The additional shielded cable included with the cartridge was fed through the tone arm alongside the original shielded cable.

We plugged these two cables into the amplifiers. One was an amplifier with separate preamp. The other was a preamp–amplifier combined on a single chassis. Both were good units. A borrowed second speaker and cabinet identical to his original completed the second channel.

The system was fired up, adjusted for equal volume, tone controls balanced, and a stereo record placed on the turntable. The result—highly satisfactory stereophonic sound. Momentary interruptions, however, made it necessary to rebalance the volume of each amplifier separately, a bothersome cut-and-try task. While the gain of each channel could be continuously varied, the gain of the system could not. In the course of our experiments, it was interesting to "swap" performers from one channel to the other by reversing the cartridge leads. We also found that when playing monophonic records it was desirable to feed a ba'anced signal to both channels. This was assured by placing a jumper across the cartridge's two outside terminals.



R1, 2—180,000 ohms, ½ watt
R3—dual pot, 2 megohms per section, log taper (Mallory UR-26A and UF-26A or equivalent)
C1, 2—.002 μf, 600 volts, disc ceramic
J1, 2, 3, 4—phono jacks
S1—3-pole 3-position rotary
Chassis box, 5 x 2¼ x 2¼ inches (Bud CU2104 or equivalent)
Knobs, setscrew type (2)
Lengths shielded cable with phono plugs on each end (2)
Miscellaneous hardware

Fig. 1—Circuit of the passive unit.

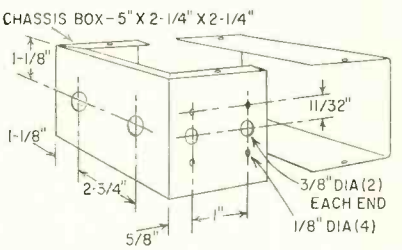
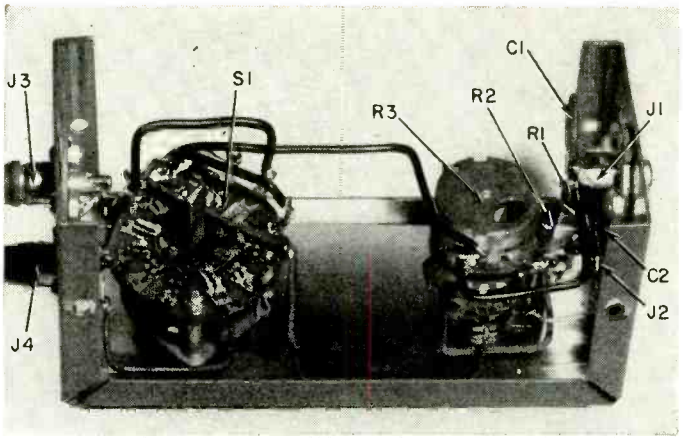


Fig. 2—Where to punch the holes in the chassis box housing the unit.

It was obvious that some sort of master volume control and stereo–monophonic switching arrangement was desirable to make the switching we were doing simple. As a result I came up with the circuit shown in Fig. 1, designed for use between the stereo cartridge and the preamps. Parts were easily obtained and a chassis box laid out to hold them (see Fig. 2).

The circuit consists of compensating networks R1–C1 and R2–C2 for the Columbia SC-1 cartridge. Values shown may be different for other makes. If so, the values suggested by the manufacturer should be used. The dual potentiometer, R3, is a Mallory double-shaft unit. Cut the shaft to proper length and file a flat section on it for the knob's setscrew, filing all the way through the outer shaft so the setscrew locks both shafts together. Be sure to keep both controls all the way to the left or all the way to the right when filing, so that they will be set for equal

*Senior engineer, CBS-Hytron.



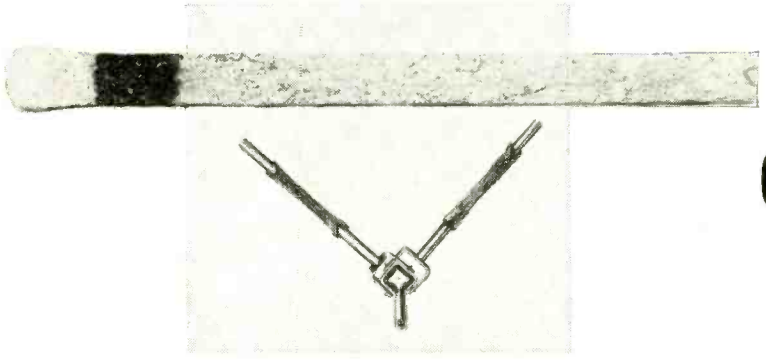
Parts layout inside the stereo control unit.

resistance throughout their ranges. Parts are then mounted as shown in the photos. Input jacks are on the left, output jacks on the right.

There is only one precaution. Make sure that the input resistances of the amplifiers are about 2 megohms. If less, the shunting effect may alter bass response. The ideal cartridge load for flat response is 1.2 megohms per channel, and consists of the gain control in parallel with the amplifier's input resistance. The 2-megohm control and an amplifier input resistance of 2 megohms give an effective cartridge load of 1 megohm, which is quite satisfactory. A higher amplifier input resistance will have no effect but a lower one, perhaps on the order of 1 megohm, will begin to reduce bass response significantly.

The compact unit proved very useful. In fact, I built one for use with my own dual-channel stereo amplifier. Placed next to my record changer, I use it for semi-remote control, with the master gain control of the amplifier set to the maximum which I might use. END

COVER FEATURE



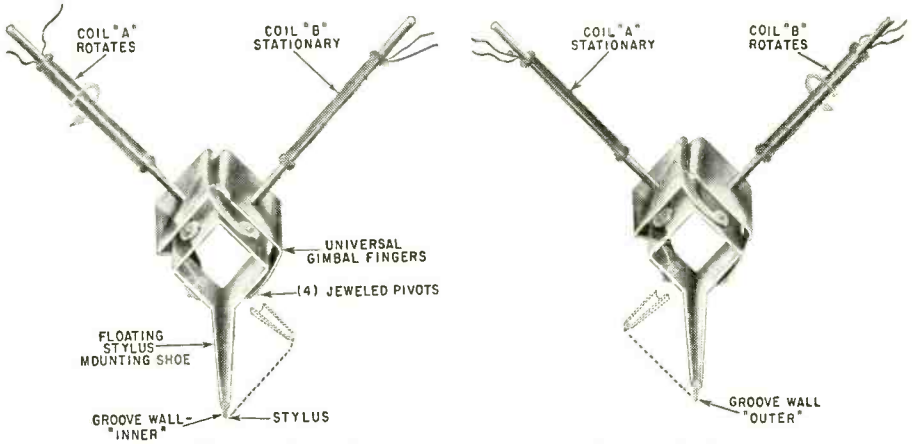
GYRO-JEWEL for STEREO

TAKE one part gyroscope and two parts moving coil. Assemble properly and you get the stereo heart of a modern stereo phono cartridge.

Compared to an ordinary paper match, the assembly is small. Put one in the palm of your hand and you'll have trouble finding it. But add an Alnico-V magnet and two sets of pole pieces, place in a cartridge housing, connect the coil leads to terminals and you end up with an Electro-Sonic Labs C-100 stereo phono cartridge.

The one part gyroscope lets the ingenious coupling system work—makes it possible for the stylus to relay the information on a stereo disc to the proper moving-coil element of the cartridge. The miniature gimbal structure, similar to ones used in gyroscopes, lets the stylus move freely in following the stereo groove, yet restricts coil movement to the necessary circular motion. By using tiny jeweled pivots the stylus movement is very free—compliance measures 5 × 10^{-6} cm/dyne, vertically or laterally.

Each of the two coils is made up of 60 turns of very fine wire—its diameter is only one-quarter that of a human hair. These tiny coils are mounted at a 90° angle between a V-shaped pair of pole pieces. The single magnet supplies the necessary flux. As a coil rotates—due to stylus movement—it breaks the magnetic lines of force between the pole pieces. Naturally, this produces an electrical output from the coil. The output reflects, of course, the information recorded on the disc.



How independent coil movement is attained through set of universal gimbals.

At a stylus velocity of 10 cm/sec each channel (coil) delivers a 2-mv output. As this is a little low for many preamps, a pair of matched transformers is provided with each cartridge. These step up the output to an adequate level. END

Tape Amplifier for STEREO

A pair of tape record–playback amplifiers in one compact unit

By EARL E. SNADER

MUCH of the amateur stereo tape recording nowadays is being made with two single-channel recording amplifiers that have been lashed together with a stereo tape deck. The method gives excellent results and is a fine arrangement for the person who already has a single-channel tape recorder and wants to convert to stereo.

There are some real advantages to having a single recording amplifier that will handle two channels simultaneously for stereo. Only one power supply is needed. This reduces size and weight and increases efficiency. It is easier to mount a dual unit with a single power supply so that tape heads do not pick up hum from the inductive field created by the power transformer.

The controls of a dual-channel recording amplifier can be ganged. This simplifies operation. With a switching arrangement to select either monophonic or stereophonic operation, the amplifier retains most of the advantages of a single-channel unit.

Tape recording amplifiers are touchy projects at best. If you combine two in a single unit, the job becomes even more complicated. These problems have been considered and the stereo tape recording amplifier described here is one that is effective and worthy of the designation "high fidelity" (see Fig. 1). It is a complete monophonic and stereophonic recording amplifier which includes the features of a mono–stereo tape playback preamp. NAB equalization is employed for recording as well as playback. The NAB standard for 15-ips tape has been modified for the 7½-ips speed commonly used in nonprofessional recording. Monophonic or stereophonic operation is selected by flipping a switch on the front panel.

The overall design is simplified by using a single VU meter for both channels. A dpdt slide switch connects the meter driver circuit to one channel or the other. The VU meter functions in both recording and playback, and is connected in such a way that does not introduce distortion.

Printed circuits

Each amplifier and tone equalization channel is a separate printed-circuit assembly. The December, 1955, and January, 1956, issues of RADIO-ELECTRONICS carried a two-part series by Richard H. Dorf on preparing printed circuits. These were followed in making the boards used in this amplifier.

The left-channel amplifier printed circuit (see photo) is used by itself for monophonic recording and playback. A second printed circuit is provided for the right channel. Aerovox No. RA9AX right-angle printed-circuit tube sockets are mounted on the printed-circuit assemblies, for the 12AX7 and 12AU7 amplifier tubes in each channel. (If you can't get the RA9AX sockets, use the nonruggedized RA9A.) The printed circuits are installed in the chassis so the tubes project through holes punched in the rear panel of the chassis. See Fig. 4 and rear-view photo.

All the printed-circuit components are readily accessible when the top and bottom covers are removed from the amplifier, with the exception of C9 in the left channel and C8 in the right channel. The critical low-level sections of each amplifier channel are well shielded when the top and bottom chassis covers are in place. A single shield housing formed from perforated metal fits over the amplifier tubes where they project through the rear chassis panel.

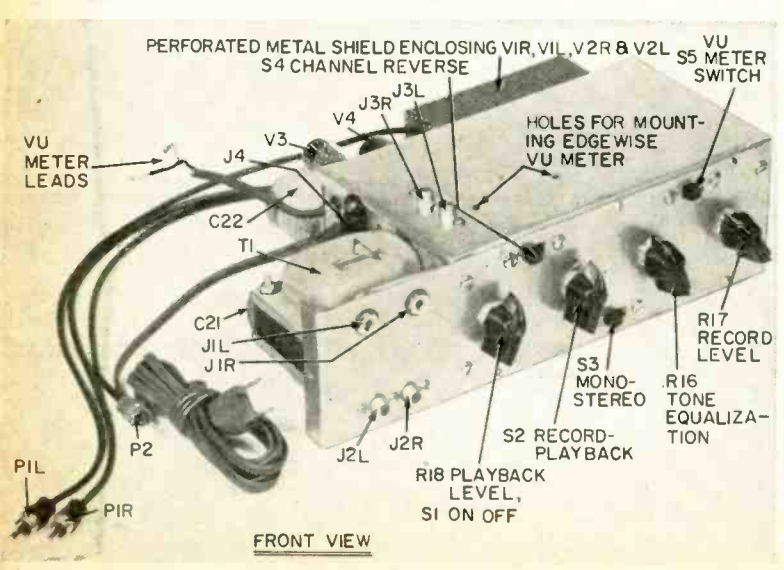
Drawings for the left- and right-channel printed circuits are shown in Fig. 2 and Fig. 3, respectively. These can be used to prepare photoetched printed-circuit boards. They are shown actual size and must be adhered to strictly if the contacts of the tube sockets are to fit in the right places.

The printed-circuit assemblies are mounted so that there is a spacing of about ½ inch between each printed-circuit board and the adjacent chassis cover. The tube sockets fit between one another inside the chassis rear panel. Connections to the printed circuits are made at the points identified by circled letters of the alphabet.

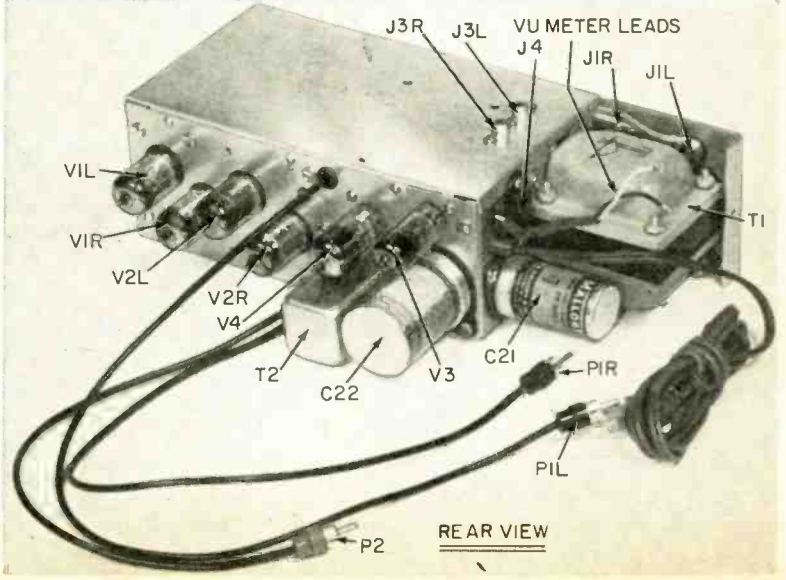
Circuit-wise, each amplifier channel consists of three triodes in a resistance-coupled amplifier, followed by a fourth triode which is switched into the circuit for recording only and adds the necessary recording equalization.

In playback, a treble-losser attenuation circuit is employed at the plate of the first amplifier. It gives a 15-db bass boost at 40 cycles with a low-frequency turnover at about 180 cycles. There is a 6-db-per-octave drop in response from about 300 cycles to the high-frequency turnover at about 3,000 cycles. The tone control permits adjusting the high-frequency response from about 10 db above to 10 db below the NAB curve at 10,000 cycles.

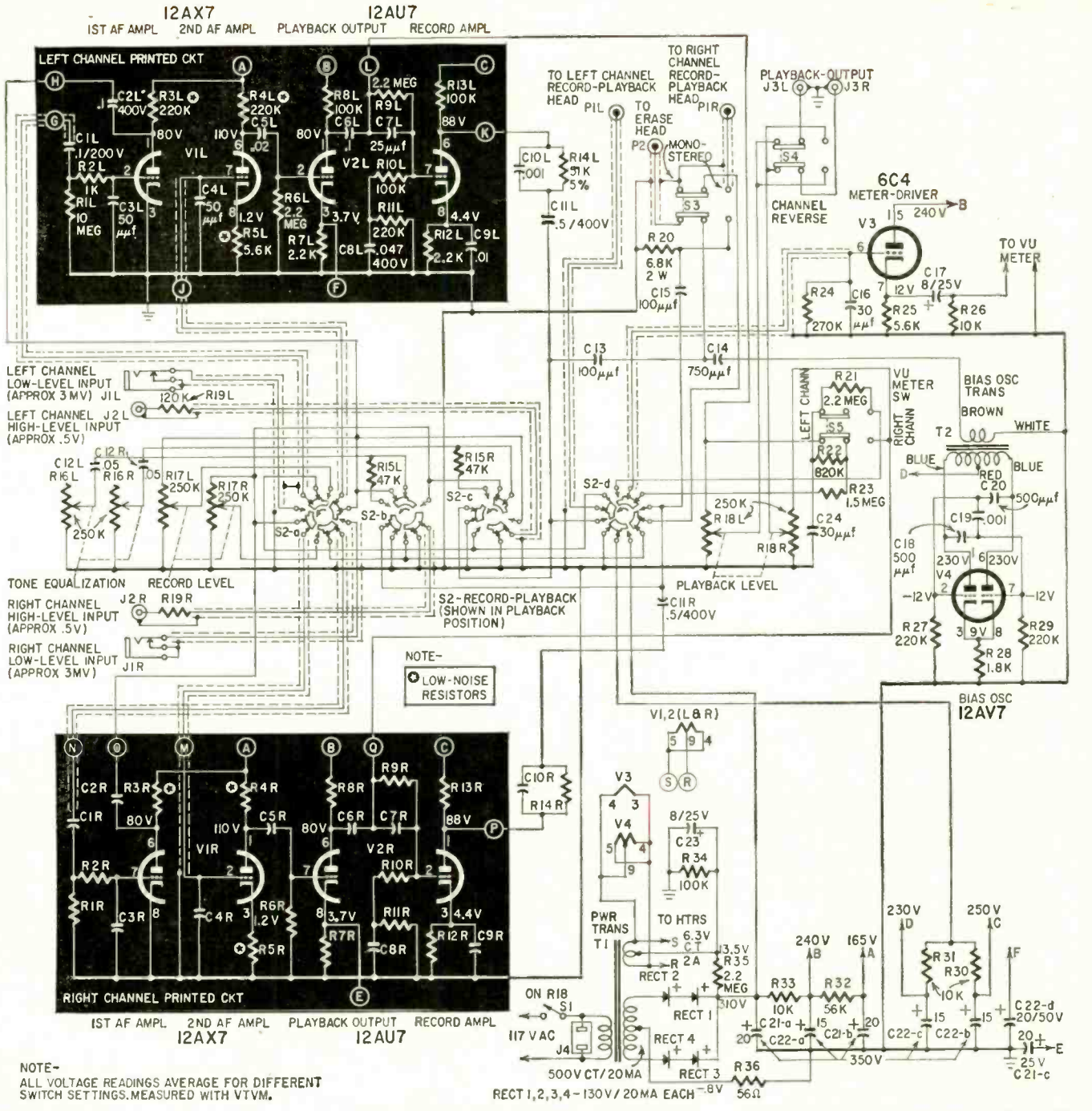
When the RECORD–PLAYBACK switch is set for recording, the fourth amplifier



Front view of the finished tape amplifier.



Tubes protrude through back of chassis.



NOTE-
ALL VOLTAGE READINGS AVERAGE FOR DIFFERENT SWITCH SETTINGS. MEASURED WITH VTVM.

*R1—10 megohms
*R2—1,000 ohms
*R3, 4—220,000 ohms, low noise
*R5—5,600 ohms, low noise
*R6, 9—2.2 megohms
*R7, 12—2,200 ohms
*R8, 10, 13—100,000 ohms
*R11—220,000 ohms
*R14—51,000 ohms, 5%
*R15—47,000 ohms
R16—ganged pots, 250,000 each section, linear taper
R17, 18—ganged pots, 250,000 ohms each section, audio taper R18 with spst switch
*R19—120,000 ohms
R20—6,800 ohms, 2 watts
R21, 35—2.2 megohms
R22—820,000 ohms
R23—1.5 megohms
R24—270,000 ohms
R25—5,600 ohms
R26, 30, 31, 33—10,000 ohms
R27, 29—220,000 ohms
R28—1,800 ohms
R32—56,000 ohms
R34—100,000 ohms
R36—56 ohms
All resistors ½-watt 10% unless noted

*C1—0.1 μf, 200 volts, metallized paper tubular
*C2, 6—0.1 μf, 400 volts, paper tubular
*C3, 4—50 μμf, ceramic disc
*C5—.02 μf, ceramic disc
*C7—25 μμf, ceramic disc
*C8—.047 μf, 400 volts, tubular
*C9—.01 μf, ceramic disc
*C10—.001 μf, ceramic disc
*C11—0.5 μf, 400 volts, metallized paper tubular
*C12—.05 μf, ceramic disc
C13, 15—100 μμf, ceramic disc
C14—750 μμf, ceramic disc
C16, 24—30 μμf, ceramic disc or tubular
C17, 23—8 μf, 25 volts, subminiature electrolytic
C18, 20—500 μμf, ceramic disc
C19—.001 μf, ceramic disc
C21—20-20-20-20 μf, 350-350-25 volts, electrolytic (Mallory FP 329.5 or equivalent)
C22—15-15-15-20 μf, 350-350-350-50 volts, electrolytic (Sprague TVL 4623 or equivalent)
All capacitors 600 volts unless noted
*J1—phone jack, subminiature, closed-circuit (Telex 8570 or equivalent)
*J2, 3—phono jack
J4—chassis-mounting ac socket
*P1—phono plug with 18-inch shielded lead
P2—phono plug with 18-inch shielded lead

RECT 1, 2, 3, 4—20 ma, 130 volts, miniature (Federal 1159 or equivalent)
S1—spst on R18
S2—3-gang miniature rotary switch made from 2 Centralab PA-37 phenolic 4-pole 2-position switch sections, 1 Centralab PA-9 steatite 6-pole 2-position switch section, with a Centralab PA-300 shaft and index assembly
S3, 4, 5—dpdt slide
T1—power transformer: primary, 117 volts; secondary, 500 volts ct, 20 ma; 6.3 volts, 2 amp, ct (Triad R-3A or equivalent)
T2—bias oscillator transformer (Viking D501 or equivalent)
*V1—12AX7
*V2—12AU7
V3—6C4
V4—12AV7
Sockets, right-angle printed-circuit, 9-prong (Aerovox RA9AX or equivalent) (4)
Socket, 7-pin miniature
Socket, 9-pin miniature
Chassis, case, see Fig. 4
Miscellaneous hardware

Indicates two components needed of each part number: one for right channel; one for left channel.

Fig. 1—Circuit of the up-to-the-minute audiophiles dream. Letter-coded leads connect to similarly marked terminals on printed-circuit board.

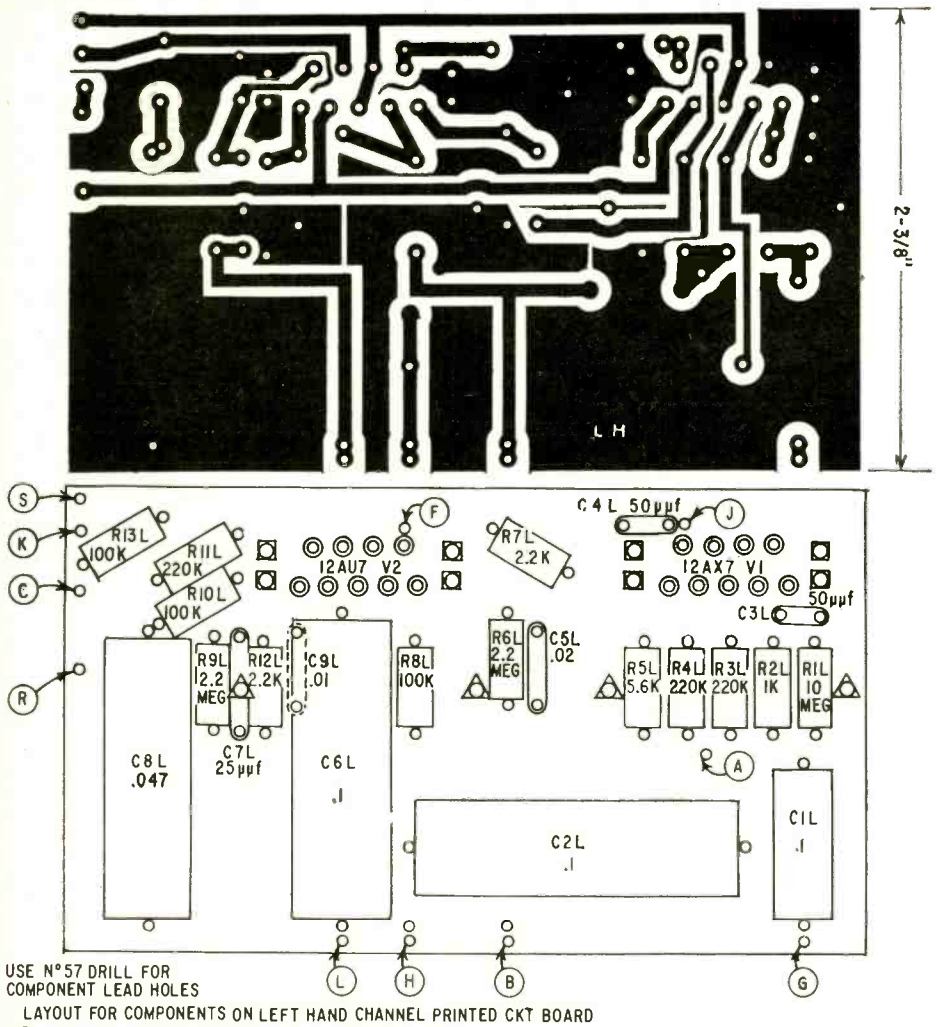


Fig. 2—a—Actual-size printed-circuit board for left channel; b—parts layout. Components are mounted on wiring side of board.

stage is switched into the circuit. Resistive–capacitive networks in series with the grid drive to this fourth amplifier stage and in its cathode circuit have the combined effect of producing a pronounced high-frequency boost of better than 20 db at 10,000 cycles. The response drops to about −3 db at 100 cycles. A 47,000-ohm resistor is connected in series with the treble-losser circuit at the plate of the first amplifier, and this, along with the effect of the resistive–capacitive network in the grid return circuit of the fourth amplifier tube, produces a slight bass boost below 100 cycles instead of the 15-db boost provided for playback. The combined effect of the equalization characteristics during recording and playback is an overall record–playback cycle with frequency response flat within 3 db from about 30 to 12,000 cycles.

Switching and control circuits

The switching and control circuits provide the simplest possible control of the various functions of the recording amplifier. The playback level, equalization and record-level controls for both channels are ganged. No balance control is included. It is assumed that the recording amplifier will be used with program sources and playback power amplifiers that have a balance control.

Record or playback operation is selected by a single RECORD–PLAYBACK switch. This is a three-section switch assembly with four circuits to the first section, six to the second and four to the third. S2-a and S2-d are Centralab No. PA-37 four-pole two-position, nonshorting, miniature phenolic switch sections. The second section, S2-b and c, is a Centralab No. PA-9 six-pole two-position, nonshorting, miniature steatite switch section (it has contacts on both sides of the wafer). The switch is assembled with a Centralab No. PA-300 shaft and index assembly. The switch sections are shown as they appear looking at the switch from the top rear of the amplifier.

The RECORD–PLAYBACK switch is a critical part of an amplifier of this kind. It must handle both the input and the output ends of a high-gain amplifier. Any capacitive coupling between the two parts of the circuit causes oscillation. Isolation can be provided in a single-channel recording amplifier by spacing the switch sections far enough apart and using circuitry that tends to isolate the input and output ends of the amplifier further. This is done here. But the small space available inside the amplifier chassis for the switch limits the degree of isolation possible through wider spacing. The problem is solved by using the center section (b and c) of the switch for all low-impedance or ground switching circuits. These act as a shield between the input end of the amplifier, which is connected to the switch section nearest the front panel (a), and the output end of the amplifier, which is connected to the third (d) or rear section of the switch.

The CHANNEL-REVERSE switch circuitry is very simple. This switch reverses the playback channels or the monitoring channels when the PLAYBACK OUTPUT jacks are connected to monitor amplifiers. No impedances lower than about 150,000 ohms should be connected across the PLAYBACK OUTPUT jacks, to avoid shunting the recording amplifier channels when the RECORD–PLAYBACK switch is turned to the RECORD position with the playback output jacks connected to external equipment.

The VU-METER switch connects the grid of the VU-meter driver tube to one or the other of the two channels in the amplifier, so a single VU meter can be used to check the recording and playback levels in both channels. A second VU meter could be added, but it would increase the drain on the power supply by about 2 ma, as well as increasing the number of circuit components and the space needed for them.

The MONO–STEREO switch is connected at the bias oscillator output, between the right-channel input–output contacts of the record–playback switch and the right-channel record–playback head lead. When it is set for monophonic recording and playback, it connects the output of the bias oscillator to the single erase-head lead and grounds the output from the right-channel amplifier. The RECORD–PLAYBACK switch is between the right-channel amplifier and the MONO–STEREO switch so the input of the right-channel playback amplifier is automatically grounded when the RECORD–PLAYBACK switch is in the PLAYBACK position. The right-channel amplifier is supplied with high-voltage dc at all times, even when the MONO–STEREO switch is in the MONO position and that channel is not actually being used. Current drain is relatively low and better power supply regulation is possible under these conditions.

When the MONO–STEREO switch is set for STEREO, the erase-head lead is disconnected and the output of the bias oscillator is switched to a 100-μμf capacitor (C15) which feeds recording bias to the right channel. A 6,800-ohm resistor between the bias oscillator output and ground provides a dummy load for the bias oscillator in lieu of the erase head when the MONO–STEREO

switch is in the STEREO position. The other section of the switch connects the right-channel amplifier to the right-channel head for either recording or playback, depending upon the setting of the RECORD–PLAYBACK switch.

Erasure is provided for monophonic recording but not for stereo. Again the desire for simplicity dictated the final circuit arrangement. A second bias oscillator would be needed for dual-channel erasing, with provisions for synchronizing the two bias oscillators to the same frequency. Or one bias oscillator would have to provide enough output to drive a full-track or two half-track erase heads in addition to supplying recording bias for both channels. Either way, the drain on the power supply would be increased and more space would probably be required for the amplifier.

Erase facilities are expected in a monophonic tape recording system because a monophonic tape may be a half-track recording and the only way to erase one half-track of a tape is with an erase head. Both tracks must be erased when a previously recorded tape is prepared for stereo rerecording, and bulk erasure is the quickest and best way to do this. The residual noise level is lower on a tape that has been bulk-erased, permitting a wider dynamic range in the new recording.

Power supply

The total power requirements for this amplifier have been kept down to simplify the power supply problem. An ordinary power transformer can generate enough of an inductive ac field to be picked up by the tape head and reduce the signal-to-noise and hum ratios in playback by 10 or 15 db. A signal-to-noise ratio of 50 db or better is necessary if high fidelity is the objective. By keeping the power supply requirements down, it is possible to get by with a low-flux-density type power transformer such as the Triad R-3A. Less than 20 ma is required at 300 volts dc for the plates, and less than 2 amperes at 6.3 volts ac for the filaments.

Separate filtering is provided for the bias oscillator and the recording amplifier. This permits precise adjustment of the relative output of the two by individually selecting the filter resistors. This filtering follows the section of the RECORD–PLAYBACK switch that removes dc from the bias oscillator and recording amplifier during playback. When the switch is set for RECORD, there is a gradual buildup of voltage while the two filter capacitors C22-b and C22-c are charging. When the switch is set in the PLAYBACK position, there is a gradual decay of the voltage in these capacitors. The overall effect eliminates undesirable switching transients.

Resistors R35 and R34 form a voltage divider across the power supply output and provide a 13.5-volt dc potential that is applied to the heater

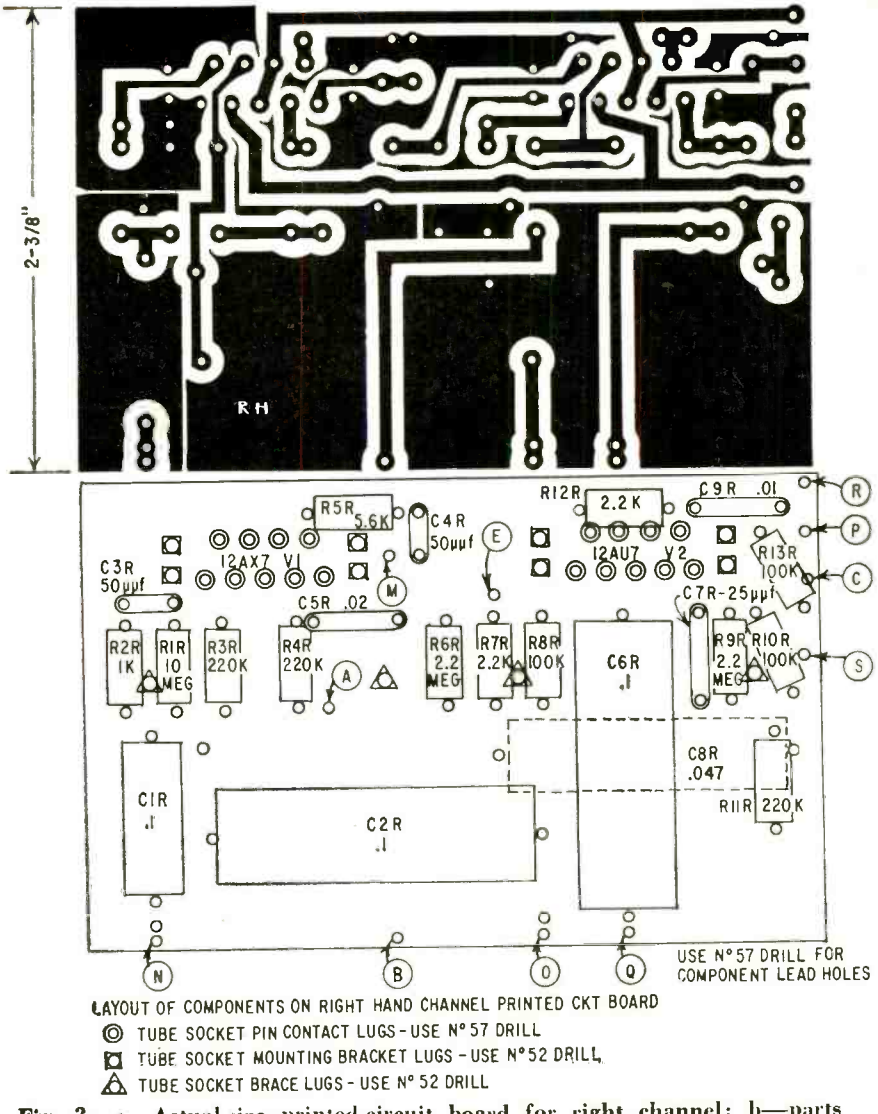


Fig. 3—a—Actual-size printed-circuit board for right channel; b—parts layout. Components, except for C8R, are mounted on wiring side of board.

string through the center tap of the heater winding in the power transformer. This helps minimize hum that might otherwise result from heater-to-cathode leakage in the amplifier tubes. A miniature 8-μf 25-volt capacitor is connected between the heater center tap and ground to reduce ripple in the output of this voltage divider.

Resistor R36 between the power transformer's high-voltage-winding center tap and ground is necessary to keep surge currents through the filter capacitors from damaging the selenium rectifiers.

Bias oscillator

A single 12AV7 tube is connected in a balanced bias oscillator circuit to provide erase and recording bias. The oscillator transformer is a special type available from Viking of Minneapolis (9600 Aldrich Ave. South, Minneapolis, Minn.). It is designated as their part No. D501. [The D501 transformer has a round can rather than the square type shown in the photos. (The Dynamu transformer is no longer obtainable.) Its extra secondary winding—used for driving the full-track erase heads with the Viking RP61 preamplifier—is not shown on the diagram and should be ignored in this application.] The Nortronics P60E bias-erase oscillator transformer is also suggested. A set of contacts on switch section S2-d removes the high-voltage dc from the bias oscillator plates when the RECORD–PLAYBACK switch is in the PLAYBACK position.

In the RECORD position, the RECORD–PLAYBACK switch applies high-voltage dc to the bias oscillator plates and the recording amplifier output stages simultaneously. The bias oscillator operates between 60 and 70 kc. This permits an upper-limit recording frequency response of 12,000 cycles, based on the principle that the fundamental of the bias oscillator output frequency should be at least five times the highest fundamental frequency handled by the recording amplifier.

High-impedance erase and record heads require an erase current of about 12 to 14 ma and a recording bias current of 0.8 to 0.95 or 1.0 ma. Bias oscillator filter resistor R31 provides the correct amount of current to the erase head when the MONO–STEREO

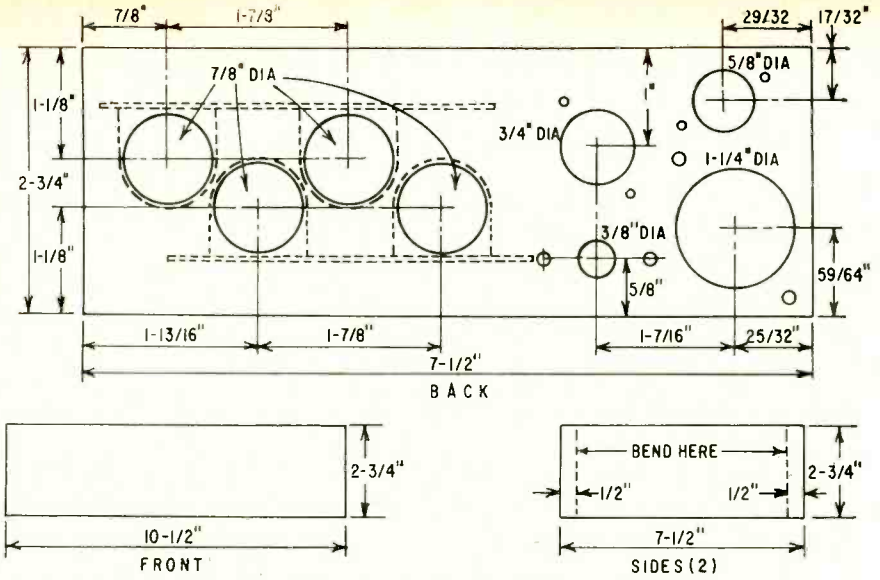


Fig. 4—Amplifier chassis details. Make top and bottom covers to fit. See front- and rear-view photos.

switch is in the MONO position. A resistor can be inserted in series with the 100-$\mu\mu$f recording bias-current feed capacitor C13 to give the correct amount of recording bias at the head when the MONO–STEREO switch is in the MONO position. Load resistor R20 is adjusted for the right amount of recording bias current to both sections of the stereo head when the MONO–STEREO switch is in the STEREO position. It is assumed that high-impedance heads will be used for recording as well as erasing.

VU-meter driver

A 6C4 in a cathode-follower configuration drives the VU meter. The circuit is designed so the VU meter reads the actual level of the tape being played back rather than the level of the signal at the playback output jacks. The reading in playback is independent of the playback level-control setting.

Separate VU-meter calibration resistors are provided for recording and for playback. The recording calibration resistor is mounted across two unused terminals on the VU-meter switch. It is adjusted to a value that gives a meter deflection of 100 on a B-scale VU meter while recording at a level about 12 db below saturation. The VU meter can be calibrated by checking the output of the recording amplifier against the output of a recording amplifier with a VU meter that is already calibrated. It can also be calibrated by connecting a 100-ohm resistor in series with the record head, removing the bias oscillator tube and setting the VU meter for a reading of 100 (using a B-scale meter) when the output to the record head is sufficient to cause a drop of .008 volt ac rms across the 100-ohm resistor. A 1,000-cycle signal is fed into the high-level input jack to calibrate the VU meter.

The playback calibration of the VU meter is adjusted by playing back a tape recorded after VU-meter calibration has been completed for recording. A value is selected for playback calibration resistor R23 that gives the same VU-meter reading during playback as when the recording was made.

Capacitors C16 and C24 are included to bypass stray pickup of the bias oscillator signal. The VU meter should show no deflection when the RECORD–PLAYBACK switch is in the RECORD position and the record-level control is at zero (full counterclockwise position). Any deflection of the VU-meter needle under these conditions indicates the possibility of bias voltage getting into the meter circuit. The lead from record–playback switch section S2-d to the VU-meter driver grid is shielded to prevent stray pickup from the bias oscillator.

Other considerations

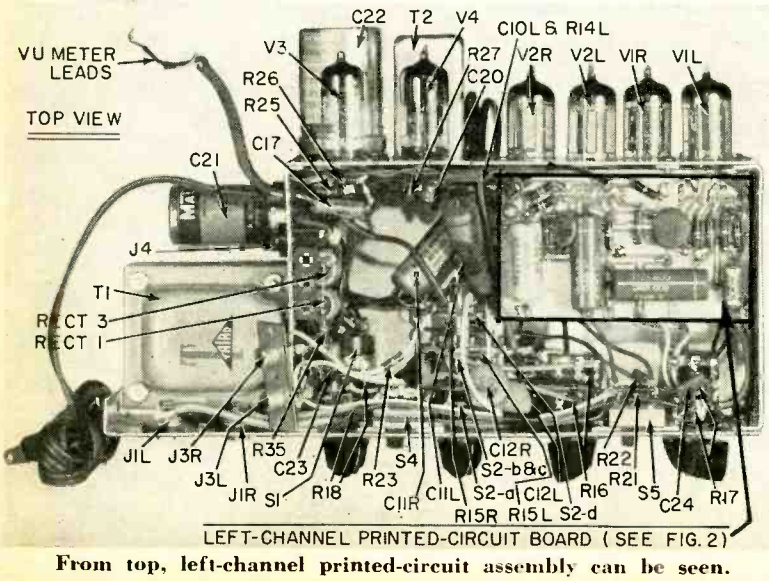
There are separate low- and high-level inputs for each channel. These are mounted in the front panel, adjacent to the power transformer. There may be a raising of eyebrows at the sight of low-level inputs located so close to a power transformer. Actually, the transformer shielding and its low flux density create a set of conditions which permit this with no noticable effect on the signal-to-hum ratio either in recording or playback. Input sensitivity of the low-level inputs is around 3 mv; of the high-level inputs, 0.5 volt rms.

Grounding techniques have an important bearing on the performance of an amplifier of this kind. Ground loops must be avoided. The printed circuits are grounded where they are mounted to the main chassis at the low-level end. The main ground bus is the wire that connects the ground side of all the variable controls together. All other ground connections are made to this, except the power supply, bias oscillator and VU-meter driver ground leads. These are grounded to the chassis through a soldering lug at one of the filter capacitor section mounting screws.

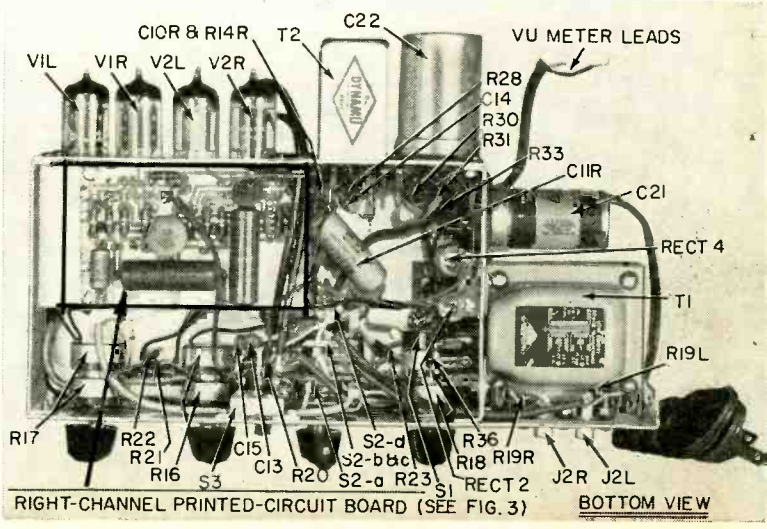
It may be possible to improve signal-to-hum ratio after the amplifier has been completed by reversing the heater leads to one of the printed-circuit assemblies.

It may be of particular interest to note that the original copper coating has been left on the printed-circuit laminate between the circuit lines. This provides shielding and reduces the chances of instability caused by inter-circuit capacitances. All of these areas are grounded and divided to avoid the possibility of undesirable inductive effects or ground loops in the printed circuits themselves.

Some decals to mark the controls, switches and jacks would help to give the amplifier a finished appearance. Up to now, no decal manufacturer has been found with the words "stereo" or "stereophonic" in his vocabulary. END



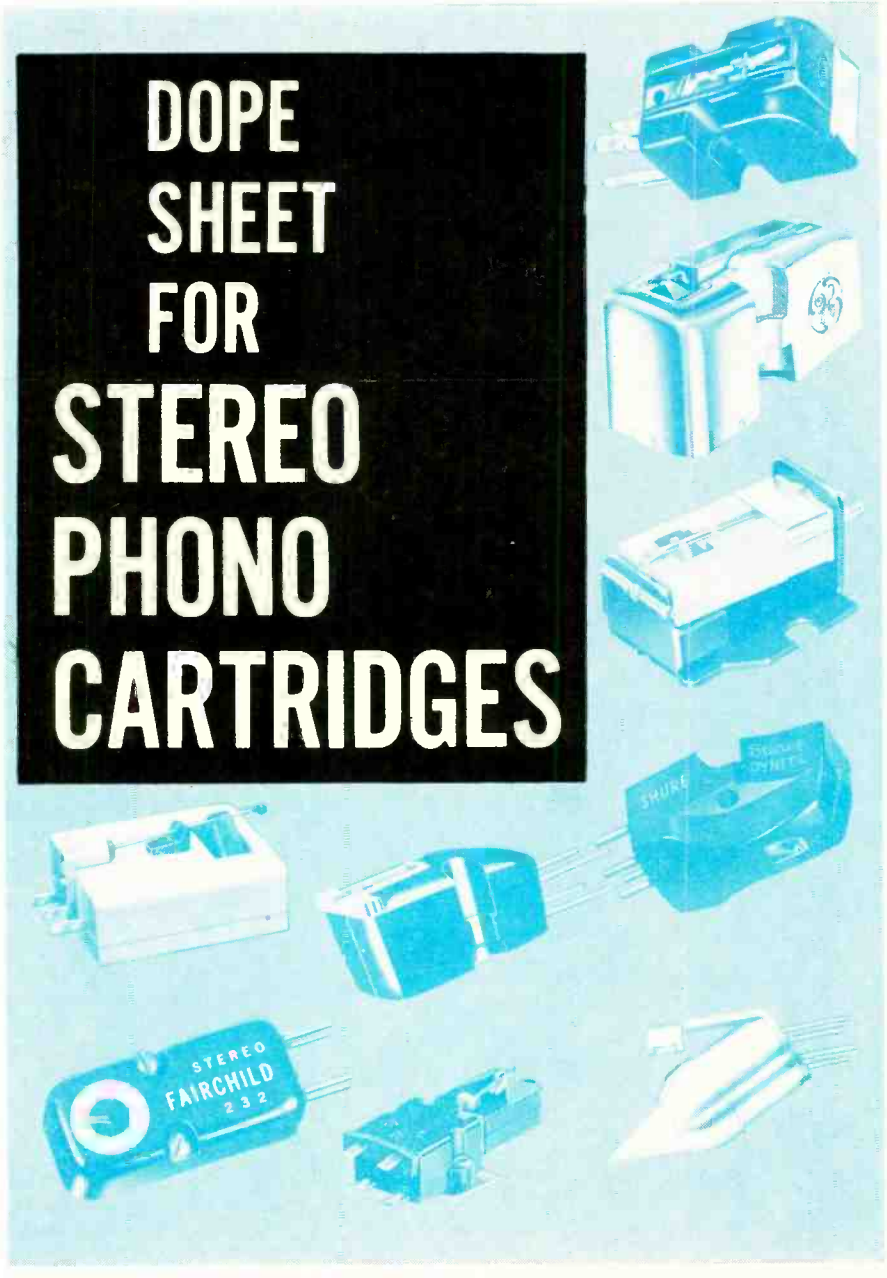
From top, left-channel printed-circuit assembly can be seen.



Bottom view of the wired unit.

DOPE SHEET FOR STEREO PHONO CARTRIDGES

BY LARRY STECKLER
ASSOCIATE EDITOR



ON March 25, 1958, the Westrex 45/45 system for making stereo discs was adopted by the record industry. Since that day many stereo cartridges, cartridges designed to play stereophonic discs, have appeared on the high-fidelity market. They come in assorted types and prices and, as for monophonic hi-fi cartridges, the price serves as a general guide to their quality.

Kinds of cartridges

Cartridges are classified in three major groups—piezoelectric, magnetic and capacitive. Crystal and ceramic units fall into the piezo group. Stylus movement in these cartridges flexes either a piece of rochelle-salt crystal or a ceramic element, producing a voltage output directly proportional to the stylus movement. Of course, in piezo stereo cartridges, two such elements are flexed simultaneously, one for each channel. For details of the coupling to the stylus that makes this possible see "Stereo Phono Cartridges," by Julian D. Hirsch, in the September, 1958, issue of RADIO-ELECTRONICS. There is even one ceramic stereo cartridge that has only one piezo element. Yet, two separate outputs are obtained by taking the outputs off different planes of the element.

Magnetic cartridges separate into three categories—moving-magnet, moving-coil and variable-reluctance (moving-iron) types. In the moving-magnet cartridge, the stylus is coupled to a tiny permanent magnet which is moved in close proximity to two coils of wire. When the magnet moves, the coils break the lines of magnetic force, inducing a voltage in them. This voltage is proportional to the stylus velocity.

The moving-coil cartridge is slightly different. Here, the coils are coupled to the cartridge and the magnet is stationary. The coils move in the magnet's field, again inducing a voltage in the coils equivalent to the audio signal impressed on the disc being played.

The last type of magnetic cartridge is the variable-reluctance unit. Here neither magnet nor coil moves. Instead the coils are wound around the magnet's pole pieces. The stylus moves a small piece of Mu-metal in the gap between these pole pieces. This changes the strength of the magnetic field and induces a voltage in the coils, producing a voltage output from the cartridge.

The capacitive pickup is unique. Stylus movement varies the capacitance in the grid circuit of an rf oscillator, frequency modulating it. The modulation varies the oscillator's plate voltage. This variation is used to develop an audio output proportional to the amplitude of stylus displacement.

For further details on how this cartridge works (in monophonic form) see "Modern Phonograph Cartridges," RADIO-ELECTRONICS, July, 1957.

What should a stereo cartridge have?

The audiophile knows what to look for in monophonic phono cartridges. First, he decides which type he wants—crystal, ceramic, magnetic, capacitive. Then he takes a look at the frequency response, tracking force, vertical compliance, stylus size, stylus material and, of course, what the cartridge will cost.

When it comes to stereo, you look for more or less the same things, but there are differences between mono and stereo cartridges which are confusing.

The first consideration is usually price. After all, we can spend only just so much. Once having determined the price range we are interested in, we can go on to the characteristics of the cartridges themselves.

All have a frequency response suitable for high-fidelity reproduction, and therefore this is not listed on the accompanying chart. A more important factor for stereo is the units' channel separation. In other words, how individual are the two channels? This seems to be directly related to frequency. At approximately 1,000 cycles, the largest separation is usually attained, about 25 db. As you go both up and down in frequency, channel separation decreases. At the low end, this may go down to 10 db or lower. At the high end, it also tapers off.

Several manufacturers supplied separation characteristics at 100, 1,000 and 10,000 cycles. Unfortunately, as with much electronic equipment, some of the less expensive units claimed the best characteristics. For this reason, these specifications are not listed. A sure test of channel separation would seem to be listening to the cartridge at work.

The channel separation is not as important at lower frequencies, for these sounds have the tendency to spread out anyway. On the high end, just the opposite is true, and lack of sufficient separation can make you hear two triangles, one on each side of the room, instead of

TABLE OF STEREO-CARTRIDGE SPECIFICATIONS

MANUFACTURER	MODEL	TYPE	OUTPUT (mv at 5 cm/sec at 1000 cycles)	COMPLIANCE (x 10^{-6})		TRACKING FORCE (grams)	STYLUS		LOAD PER CHANNEL (recommended)	TER-MINALS	MOUNTING CENTERS (inch)	CAN USER REPLACE STYLUS?	RECOM-MENDED PRICE
				VERTICAL	LATERAL		TYPE	SIZE (mil)					
AMERICAN MICROPHONE	S150BC (TURNOVER)	CRYSTAL	600	NI	NI	6	SAP SAP	0.7 3.0	NI	4	½	YES	$7.50
ARGONNE	AR-291 (TURNOVER)	CRYSTAL	400	3.5	3.5	4-6	SAP SAP	0.75 2.5	500K	4	½	YES	$2.75
ASTATIC	13-TB (TURNOVER)	CERAMIC	500	2	2	5-7	SAP SAP	0.7 3.0	2 MEGOHMS & 100-$\mu\mu$f CABLE	4	½ OR 7/16	YES[1]	$7.95
	13-TBX (TURNOVER)						DIA SAP	0.7 3.0					$16.50
AUDIOGERSH	STEREOTWIN 200	MOVING MAGNET	8	4	4	4-6	DIA	0.7	37K	4	½	YES	$44.50
BURNE-JONES	BJ STEREO	CRYSTAL	350[2]	NI	NI	4-7	DIA	0.5	2 MEGOHMS	3	½	YES	$18.00 APPROXIMATELY
CBS-HYTRON	SC-1D	CERAMIC	400	2	2	5-7	DIA	0.7	1.2 MEGOHMS	3	½ OR 7/16	YES	$24.25
	SC-1S						SAP	0.7					$17.00
DUNKIRK	200 (TURNOVER)	CRYSTAL	700	3.5	3.5	4-6	SAP SAP	0.7 3.0	500K	4	½	YES	$9.00
DUOTONE	GP-71D	CRYSTAL	NI	2	2	2-4	DIA	0.7	500K	3	NI	NI	$18.75
	GP-71S						SAP	0.7					$12.00
	GP-73 (TURNOVER)						DIA SAP	0.7 3.0		4	½ OR 7/16	YES	$14.70
							SAP SAP	0.7 3.0					$8.70
DYNACO	STEREOOYNE	MOVING IRON	7	5	5	2-6	DIA	0.7	10K AND UP	4	½	YES	$29.95
ELECTRO-SONIC	C-100	MOVING COIL	0.5[13]	5	5	2-4	DIA	0.7	47K NOT CRITICAL	4	½ WITH ADAPTER	NO	$69.95
ELECTRO-VOICE	21D	CERAMIC	500	4	4	4-6	DIA	0.7	3 TO 9 MEGOHMS	3	½ OR 7/16	YES	$19.50
	26DST (TURNOVER)						DIA SAP	0.7 3.0					$22.50
	66 (TURNOVER)			2.5	2.5		SAP SAP	0.7 3.0				YES[3]	$5.95
	21 MS	CERAMIC (LINEAR VELOCITY)	20[16]	4	4		SAP	0.7	22 TO 100K				$9.90
	26 MDST (TURNOVER)						DIA SAP	0.7 3.0				YES	$12.90
ERCONA	CONNOISSEUR	CERAMIC	50	6	6	4-5	DIA	0.5-0.6	50K	3	½ OR 7/16	YES	$29.95 $32.50[4] $59.50[5]
ERIE	ST-ERIE-O (TURNOVER)	CERAMIC	500	3	3	5-6	DIA SAP	0.7 3.0	2 MEGOHMS & 100-$\mu\mu$f CABLE	3	½ OR 7/16	NO	$24.50
FAIRCHILD	232	MOVING COIL	4	6	6	3-4	DIA	0.6	5K TO 1 MEGOHM	4	½ OR 7/16	NO	$49.50

MANUFACTURER	MODEL	TYPE	OUTPUT (mv at 5 cm/sec at 1000 cycles)	COMPLIANCE (x 10^{-6})		TRACKING FORCE (grams)	STYLUS		LOAD PER CHANNEL (recommended)	TERMINALS	MOUNTING CENTERS (inch)	CAN USER REPLACE STYLUS?	RECOMMENDED PRICE
				VERTICAL	LATERAL		TYPE	SIZE (mil)					
GENERAL ELECTRIC	GC-5	VARIABLE RELUCTANCE	8	2.5	4	2-4	DIA	0.5	47K TO 100K	4	½ OR 7/16	YES	$26.95
	GC-7			2	3	3.5-7	DIA	0.7					$23.95
	CL-7						SAP	0.7					$16.95
GRADO	GRADO STEREO	MOVING COIL	2.5[6]	NI	NI	4	DIA	0.7	5K AND UP	4	½	NO	$49.50
HEATHKIT	SF-1	MOVING MAGNET	3[7]	4.3	5	2-4	DIA	0.6	50K	4	½ OR 7/16	YES	$39.95
LONDON-SCOTT	1000	VARIABLE RELUCTANCE	7	3.5	3.5	3.5	DIA	0.5	47K	3	NA	NO	$89.95[5]
PICKERING	371.7D	MOVING IRON	5+	4-5	4-5	2-4[8] 4-6[9]	DIA	0.7	27K TO 47K	4	½	YES	$29.85 $59.85[5]
RCA	RMP 200 (TURNOVER)	CERAMIC	300	2	2	4-6	DIA SAP	0.7 3.0	3.3 MEGOHMS	3	⅝	YES	FOR NEW EQUIPMENT MANUFACTURERS
RECOTON	RG745-3SD (TURNOVER)	VARIABLE RELUCTANCE	6	4	4	3-5	DIA SAP	0.7 3.0	68K	4	½	YES	$29.95
	RG745-1SD (TURNOVER)						DIA SAP	0.7 1.0					
RONETTE	BINOFLUID BF40	CRYSTAL	350	3.5	3.5	2-5[4]	DIA	0.7	1 MEGOHM	3[10]	½ OR 7/16	YES	$10.80
						5.5-6[9]	SAP	0.7					$7.10
SHURE	PROFESSIONAL DYNETIC STEREO	MOVING MAGNET	6.8	4	4	3-6	DIA	0.7	47K	4	½	YES	$45.00
	CUSTOM DYNETIC STEREO		5	3.5	3.5	4-7							$24.00
SONOTONE	8T (TURNOVER)	CERAMIC	300[14]	2	2	4-6[8] 6-8[9]	DIA SAP	0.7 3.0	2.2 MEGOHMS & 100-$\mu\mu$f CABLE	3[11]	½ OR 7/16	YES	$24.50
							BOTH DIA	0.7 and 3.0					$34.50
							BOTH SAP						$14.50
TANNOY	VARI-TWIN	VARIABLE RELUCTANCE	7	4	4	3-4	DIA DIA	0.5 0.75	100K & 150-$\mu\mu$f CABLE	4	½	YES	$43.50
WEATHERS	C501D	CERAMIC	15	6	6	2-3[8] 4-6[9]	DIA	0.7	47K	5[12]	½	YES	$17.50
	C501S						SAP						$9.75
	SW10D[15]						DIA	0.7	FEED TO HI-LEVEL UNCOMPENSATED INPUT	2 INDEPENDENT CHANNELS	NA	YES	NI
	SW50S[16]	CAPACITIVE	1000[7]	20.5	20.5	1	SAP						
WEBSTER ELECTRIC	SC3-D (TURNOVER)	CERAMIC	500	2	2	5-7	DIA SAP	0.7 3.0	1 MEGOHM	4	½ OR 7/16	YES	$25.00
	SC1-D						DIA	0.7		3			$24.50
	SC2-D									4			$22.50

NA—not applicable
NI—no information
[1]plug-in needle-cartridge combination
[2]measured at 1.5 cm/sec
[3]'Power Point'* plug-in assembly
[4]with head for C-10L-S arm
[5]with head and arm
[6]stereo step-up transformer available, $23.50 additional
[7]measured at 7 cm/sec
[8]for pickup arms
[9]for changers
[10]BF40-4 has 4 terminals
[11]8T-4 has 4 terminals
[12]5th lead goes from cartridge shield to chassis of ac-dc set
[13]pair of TM100 transformers required, $16.05 additional
[14]measured at 3.9 cm/sec
[15]with arm & oscillators
[16]for magnetic inputs
*Registered Trademark

just the one that was in the orchestra.

Next in importance is cartridge output. Stereo discs are recorded at a level 3 db lower than that used for the standard monophonic disc. This is necessary if the manufacturer is to still get close to a half-hour of music on each side of a 12-inch 33⅓-rpm stereo disc. But this also means the cartridge cannot produce as great an output from a stereo disc as it could from a monophonic recording. If this output is too low, you will have to crank up your preamp's gain control rather high, introducing undesirable hum and noise. So make sure the cartridge you intend to use will drive your preamp without your having to turn the volume control up to the top.

To defeat the problem of low output, some manufacturers offer a matching stepup transformer to use with their cartridge. The transformer boosts the cartridge output to easily used levels.

In the mono disc, only lateral compliance is needed. Some of the best mono pickups keep vertical compliance down to practically zero, in an effort to reduce the effect of turntable rumble. But, to play a stereo disc properly, the stylus must be able to move freely in all directions if it is to reproduce the program material on the disc.

If a stereo cartridge had the same compliance as a monophonic one, it could not move up and down freely and both the quality of reproduction and the stereo disc would suffer. It is for this reason that stereo discs should not be played with a mono cartridge. Instead of moving rapidly up and down with the groove, it chops its way along, gouging out sections of recorded music as it goes. So the stereo cartridge should have equal and high compliance in all directions for best results.

Record wear

We are all interested in the life of our discs. This useful playing life is determined by three factors—stylus pressure, the condition of the stylus and the size of the stylus.

Let's take stylus pressure first. Every phono cartridge must bear down on the disc with a certain minimum amount of pressure if it is to follow the groove and reproduce the sound impressed there. This is called the tracking force. The lower the tracking force, the less the record wear, and the more times you can play each disc before the sound becomes distorted from excess wear.

The next factor is the condition of the stylus. Naturally, a worn stylus, with flats on some of its surfaces, or one that has developed a chisel tip will damage a record and shorten its life considerably. As for monophonic records, stereo styli are available made from sapphire or diamond. The diamond tip will play many more discs than the sapphire one before it must be replaced, but whichever type you should happen to select be sure to check it every month or two so you can detect signs of wear before the stylus gets a chance to harm favorite recordings.

The stylus in a stereo cartridge is generally of a smaller tip diameter—usually 0.7 mil—than the one used in a monophonic cartridge. It has to be if it is to follow the rapidly moving stereo record groove accurately. In general, the finer the stylus, the better the high-frequency response.

However, the finer tips, 0.5 mil, are not intended for use with record changers and the manufacturer may specifically advise against such use.

This smaller size of the stereo stylus, coupled with its greater movement, also means it will wear faster. Don't expect the same 1,000 hours of life from your 0.5- or 0.7-mil diamond stylus that you got with a 1-mil diamond mono stylus.

Now we are down to the last couple of points of stereo cartridge interest. In what value resistance or resistance–capacitance network should the cartridge be terminated for best results? A glance at the chart will answer this question for each of the cartridges listed. Where cable capacitance is listed, it represents the maximum permissible capacitance of the cable that connects the cartridge to the preamp.

Stereo cartridges have either three or four output terminals. Actually most are three-terminal units even though four protrude from the case—two may be connected internally. It is claimed that four separate terminals, two for each cartridge element, aid in better separation between channels and reduce the possibility of ground loops. Actually it may not be too important. If you do get a cartridge with three terminals, the two ground leads are connected internally and brought out to one lug.

You can avoid the possibility of hum caused by ground loops by securely grounding all your equipment together—both preamps, both amplifiers and the turntable motor or frame with ground straps. For a more complete discussion of this problem, see "Ready for Stereo, Part III" on page 50 of RADIO-ELECTRONICS, December, 1958.

Channel balance

An interesting situation brought out by Joseph Grado of Grado Labs is the problem of channel balance—Is the output of each of the two generators in the stereo cartridge equal? And are the resonant points for peak output at the same frequency for each element? If they are not within very close tolerance, you can run into trouble.

This shows up in two ways. Let's say you are playing a stereo disc and are listening to a trumpet solo. If the cartridge you are using has a peak at 6,000 cycles for one element and 7,000 cycles for the other, as the trumpet player hits various notes, he may seem to be walking from one side of the room to the other. When he comes close to 6,000 cycles, that channel seems loudest, moving him to that side of the room. When he hits 7,000 cycles, the other channel is louder and the trumpet moves to the other side of the room.

Imbalance of this type also hurts when you want to play a mono disc with a stereo cartridge. The imbalance makes it impossible to cancel the vertical component completely, and noise and rumble levels will not be as good as they should be. Also, pinch effect, causing an up-and-down movement of the stylus, is not completely cancelled and distorts the normal audio output.

To check for balance, hook up the cartridge to your stereo system and connect an audio vtvm across one of the speakers. Now, using a mono test record, play the various steady-frequency tones, noting what voltage output you get for each. Then flip the channel-reversal switch and run through the same thing again. Both sets of readings should be very close. If not, the cartridge's elements are not balanced and may detract from your listening pleasure.

Most stereo cartridges have standard mounting centers and can be used with almost any arm or changer. There are a few exceptions, and some come already mounted in an arm, so be sure the cartridge you select will fit the arm or changer you intend to use it in.

All the points that have been discussed are itemized in the chart. The listing is arranged alphabetically. As a final note, all specifications listed are those supplied by the manufacturer.

END

MANUFACTURERS

AMERICAN MICROPHONE MFG. CO., 412 S. Wyman St., Rockford, Ill.
ARGONNE ELECTRONICS, 165-11 South Rd., Jamaica 33, N. Y.
ASTATIC CORP., 250 Harbor St., Conneaut, Ohio.
AUDIOGERSH CORP., 514 Broadway, New York 12, N. Y.
BURNE-JONES & CO. LTD., 18 Brunswick Rd., Sutton, Surrey, England.
CBS-HYTRON SALES CORP., 100 Endicott St., Danvers, Mass.
DUNKIRK SALES CORP., 104-46 Dunkirk St., Jamaica 33, N. Y.
DUOTONE CO. INC., Locust St., Keyport, N. J.
DYNACO INC., 617 N. 41 St., Philadelphia 4, Pa.
ELECTRO-SONIC LABORATORIES INC., 35-54 36 St., Long Island City 6, N. Y.
ELECTRO-VOICE INC., Cecil & Carrol Sts., Buchanan, Mich.
ERCONA CORP., 16 W. 46 St., New York 36, N. Y.
ERIE RESISTOR CORP., 644 W. 12 St., Erie, Pa.
FAIRCHILD RECORDING EQUIPMENT CO., 10-40 45th Ave., Long Island City 1, N. Y.
GENERAL ELECTRIC CO., West Genesee St., Auburn, N. Y.
GRADO LABORATORIES INC., 4614 7th Ave., Brooklyn 20, N. Y.
HEATHKIT, Heath Co., Benton Harbor, Mich.
LONDON-SCOTT—H. H. SCOTT INC., 111 Powder Mill Rd., Maynard, Mass.
PICKERING & CO. INC., Sunnyside Blvd., Plainview, N.Y.
RADIO CORPORATION OF AMERICA, Camden, N. J.
RECOTON CORP., 52-35 Barnett Ave., Long Island City 4, N. Y.
RONETTE SALES CORP. 190 Earle Ave., Lynbrook, N. Y.
SHURE BROTHERS INC., 222 Hartrey Ave., Evanston 18, Ill.
SONOTONE CORP., Elmsford, N. Y.
TANNOY (AMERICA) LTD., 38 Pearl St., New York 4, N. Y.
WEATHERS INDUSTRIES INC., 66 E. Glouchester Pike, Barrington, N. J.
WEBSTER ELECTRIC, 1900 Clark St., Racine, Wis.

STEREO THEN and now

A sweeping look at the evolution of stereophonics

By LOUIS E. GARNER, JR.

STEREOPHONY *is not new.* Only the current stereo boom is. The technique itself has been around for quite some time. Let's go back and see how stereo's birth—and evolution—took place.

But first, let's get our semantics straight. The name *stereophonics* is basically very old, having as its roots the ancient Greek words *stereo* (solid) and *phone* (sound). The word itself, then, is an adjective meaning, in essence, "having to do with solid (three-dimensional) sound."

While the name itself is ancient, practical stereophonic techniques had to await the introduction of mechanical means for transmitting and reproducing sounds. For centuries, it had been known that humans and other two-eared creatures used their pair of ears and their brain as an audio range-finder and automatic computer to identify the location and position of sound sources. This principle was recognized and used in some of the earliest experiments in the mechanical reproduction of sound.

Early stereo techniques

During the Paris Exposition in 1881, when the then new telephone was used to transmit programs from the stage of the Paris Opera, the audio engineers used a *pair* of telephone lines—one for each ear!

Dual-channel radio broadcasting techniques did not lag many decades behind the Paris telephone experiments. In the early 1920's, a few US stations conducted experimental two-channel broadcasts. Radio broadcasting was in its infancy then, and relatively few individuals owned a single receiver, much less the two sets necessary for listening to the broadcasts. So stereo broadcasting lay dormant for many years.

In the meantime, audio scientists and recording engineers recognized that simultaneous two-channel recordings were essential to realistic reproduction of sound. As early as 1931, A. D. Blumlein, a designer employed by Electrical & Musical Industries, Ltd., filed for and received British patents on a system for cutting (and reproducing) two-channel discs. A half-decade later, two employes of Bell Telephone Laboratories, A. C. Keller and I. S. Rafuse, developed a similar technique and applied for and were granted US patents.

These early demonstrations and inventions, while laying the groundwork for what was to follow, didn't excite too much popular interest and didn't, in themselves, cause much impact on the general public. Perhaps the first public demonstration of stereo techniques that did lead to positive action was conducted in 1933 by Bell engineers. A performance of the Philadelphia Symphony Orchestra at the Academy of Music in Philadelphia was picked up and electrically transmitted to Constitution Hall in Washington, D.C., over a three-channel system. Each channel included a microphone, amplifier, compensating network, attenuator, transmission line, power amplifier and speaker.

Later called a "stereophonic transmission system," the equipment and method used were discussed in a series of papers on *auditory perspective* published by the American Institute of Electrical Engineers (AIEE) in 1934.

The Bell demonstration did lead to positive results, for that master showman, Walt Disney, used multiple-channel audio techniques in his motion picture "Fantasia" a little over a half-decade later. "Fantasia" was the forerunner of the multiple-audio-channel motion pictures now standard in today's era of wide screens.

For a long while, two methods were used to add auditory perspective to mechanically reproduced sound. These were the *binaural* (literally, "two-eared") and *stereophonic* techniques. With similar goals, but different basic concepts, the two techniques were often confused and even experienced audio specialists would use the two terms interchangeably.

With the binaural method, an effort is made to duplicate, mechanically, human hearing processes. The pickup consists of two *closely spaced* microphones, positioned to simulate the pickup characteristics of human ears. Often, the microphones are mounted in an artificial head. Two audio channels are employed: One for the left, and a second for the right ear, with final reproduc-

Courtesy Bell Telephone Labs.

Early Bell stereo experiments (1933) included this New York demonstration where the orchestra was in a room two floors above the auditorium. Three microphones were spaced across the room in line with the conductor.

tion through tightly fitted earphones, each feeding the proper ear.

In effect, this method provides an electromechanical extension of the listener's ears to the program source.

The original stereophonic technique demonstrated by Bell required three (or more) independent channels. In theory, an *infinite* number of channels were needed for "perfect" results. The stereophonic method differs from the binaural technique in that *widely spaced* microphones usually are used, with final reproduction through loudspeakers.

With either system, the link between the pickup elements (microphones) and final reproducers (earphones or loudspeakers) may be made up of amplifiers and transmission lines, radio, transmitters and receivers, or recordings and playback gear.

Modern stereo systems

For some time, three channels were thought the *minimum* needed for good stereophonic reproduction. However, further tests and experiments showed that a two-channel stereophonic system (widely spaced pickup elements, coupled with loudspeaker reproduction) gave practical results comparable to those obtained from the theoretically perfect binaural system, with its mandatory earphone reproduction.

Thus, the two-channel stereophonic system has become today's standard, although three-, five- and even seven-channel systems may be used in theater work.

To gain widespread public acceptance, an economically practical, but technically adequate, recording and playback technique was needed. By its very nature, stereophony requires the simultaneous recording of two (or more) sources of program material. This, in itself, is not difficult if a suitable recording media is used. Magnetic tape, for example, may be converted to multiple-channel recording. All that is necessary is to use relatively narrow recording (and pickup) heads and to record one or more "channels" side by side across the width of the tape. As a result, commercially manufactured stereo tape recorders and prerecorded tapes have been available for a number of years.

At first, tape recorders were converted to stereo simply by adding another head, mounted to one side of the original unit. The tape used with such a modified machine had its two program channels "staggered" to correspond to the physical displacement of the two heads. With the introduction of multiple heads—one pickup "stacked" above the other in a single mounting—it became feasible to dispense with *staggered* tapes and use *stacked* tapes instead. With the latter, corresponding parts of the program material are recorded at parallel points on the tape.


PATENT SPECIFICATION

Application Date: Dec. 14, 1931. No. 34,857/31.

Complete Left: Nov. 10, 1932.

Complete Accepted: June 14, 1933.

394,325

PROVISIONAL SPECIFICATION.

Improvements in and relating to Sound-transmission, Sound-recording and Sound-reproducing Systems.

First patent on stereo disc recording was held by A. D. Blumlein. Application for the British patent was filed in 1931.

Today, all stereo tape machines are designed to use stacked tapes, although staggered tapes are still listed in the catalogs of some suppliers. *The two types are not interchangeable.*

In spite of its, in many ways, superior qualities, even monophonic tape recordings have never really caught on. There are several reasons for this. Tape playback machines are generally much more expensive than record players. Prerecorded tapes are more expensive than pressed discs handling the same amount of program material. Finally, and most important, threading a tape through rollers, guides and heads is much more difficult than simply dropping a disc in place on a turntable. *And no one has yet introduced a low-cost, foolproof, fully automatic tape changer.*

Thus, even though stereophonic techniques originated decades ago and stereo playback machines and prerecorded tapes have been available for a number of years, it was not until the introduction of a practical stereo disc system that the present boom began.

Stereo on disc

Stereo disc recording techniques are hardly new. First patents appeared in the 1930's as previously mentioned. Here in the US, as far back as 1952, Cook introduced a stereo disc having two independent bands—an outside band for one channel and an inside band for the second. These records were played by an odd-shaped pickup arm having two cartridges (and styli) mounted side by side. While the approach was ingenious, Cook's record was a commercial failure, for only half as much material could be placed on a single disc, the pickup arms were expensive and difficult to adjust, and none of the larger manufacturers seemed interested in adopting this design.

The beginnings of the present flood started in 1956 when US manufacturers heard that British Decca (London) had developed a *single-groove* stereo disc system. Not to be outdone, engineers at Westrex developed a single-groove disc recording system of their own.

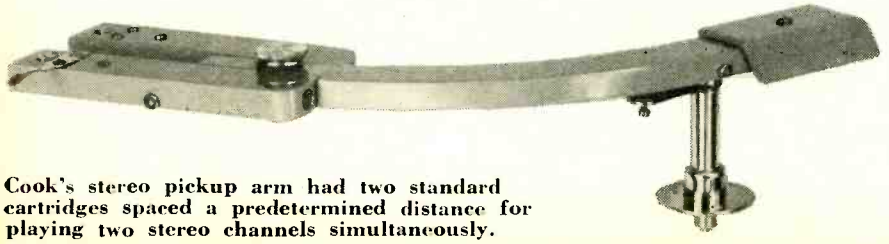
Technically, there was not much difference between the Westrex and London systems, at least as far as basic concepts were concerned.

In the London system, an up-and-down (vertical) movement of the stylus reproduces one channel, while a side-to-side (horizontal) movement reproduces the second. The Westrex system is, in essence, the British system rotated 45°—a V-shaped groove with walls slanting at a 45° angle is used. Variations in one wall represent the program material of one channel—variations in the other, the second. The resulting stylus movement is *both* up-and-down and sideways.

By October of 1957, Westrex was ready to demonstrate its system. After the demonstration at the Audio Engineering Society's convention in New York, engineers waxed enthusiastic and all major US record manufacturers formulated plans for entering stereo.

Had all gone according to normal procedure, chances are that interest in stereo would have developed slowly and logically. One manufacturer after another would have introduced stereo discs in limited quantities, with equipment manufacturers following suit with playback gear, carefully refining and developing each product before offering it to the general public. With the usual lag between initial invention and large-scale production, chances are stereo would not have achieved widespread public use until, say, 1960. However, there was a fly in the ointment.

The head of a small record manufacturing firm who heard the Westrex demonstration decided "this was for him." So Sidney Frey, the head of



Cook's stereo pickup arm had two standard cartridges spaced a predetermined distance for playing two stereo channels simultaneously.

Audio Fidelity, asked Westrex to cut a stereo-disc master using prerecorded tapes from his firm's inventory. On the surface, Audio Fidelity wanted these master discs only for experimental use. Westrex, of course, went along with Frey's request, but took the precaution of modifying the master to—so they thought—render the resulting disc unfit for commercial use. The dauntless Mr. Frey, however, took the Westrex master—noise, gaps and all, pressed commercial copies, and issued them to equipment manufacturers for tests.

In one fell swoop, Mr. Frey had opened the floodgates of stereo for, whether they wanted to or not, now that Audio Fidelity had led the way, no other manufacturer dared hesitate.

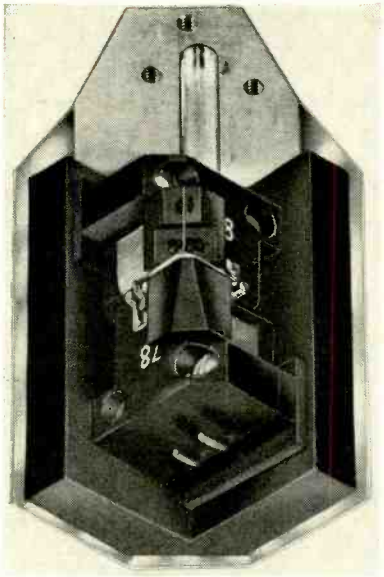
Actually, several practical stereo disc recording techniques came to the fore at about the same time—the British Decca (London), Westrex and, slightly later, systems developed by engineer Jerry Minter of Components Corp. and Dr. Peter Goldmark of CBS. For a while, there was some danger that the confusion of the 45-vs-33⅓-rpm discs would be repeated with stereo. However, remembering the loss of public confidence resulting from the earlier "battle of the speeds," record and equipment manufacturers got together in a hurry and the Westrex system was adopted as the industry standard.

Technical details of the Westrex method—popularly known as the 45/45 system because of the groove-wall angle—have been explained time and again and neeedn't be repeated here (see "How the Stereo Disc Works," RADIO-ELECTRONICS, July, 1958). Suffice, to say, however, that the current boom in stereo was made possible by a combination of factors: (1) the introduction of an industry-accepted single-groove disc recording method; (2) a stereo disc that was compatible with existing single-channel LP records (and playback equipment) (see "Compatibility and the Stereo Disc," RADIO-ELECTRONICS, August, 1958); (3) the audio industry's interest in a new "gimmick" to boost lagging sales, and (4) Audio Fidelity's effective scoop in releasing a stereo disc before industry, in general, was fully aware of what was happening. Thus, the gradual evolution of stereophony, starting in a sense, in the early 1880's, turned into such a rush in 1957 and 1958 that it took on the aspects of a minor technical revolution. But it wasn't a revolution after all!

Stereo via radio

Stereo broadcasting techniques have not advanced quite as rapidly, nor as far, as recording methods. True, early experiments were conducted in the '20's using two AM channels. However, stereo broadcasting hibernated for many years.

At present, no "standard" technique of stereo broadcasting has been approved by the FCC nor accepted by the broadcast industry as a whole. Stereo broadcasts, for the most part, are still made on an experimental basis by individual stations—generally cooperating or affiliated AM and FM stations. The AM station broadcasts one channel, the FM station the other.



The first Westrex stereo pickup was made from two standard 78-rpm phono cartridges. They were mounted at 90° to each other and coupled to a single stylus that followed the 45/45 stereo record groove.

Within the last year or so, two other broadcast techniques have come to the fore. TV networks have experimented with stereo, broadcasting one channel over the TV audio carrier and the second over a local network-affiliated AM station. Several major TV programs have successfully used this method.

Unfortunately, both the TV/AM and the FM/AM methods require the use of *two* broadcast station facilities—a relatively inefficient and, from a commercial viewpoint, uneconomical approach.

One of the newer techniques—that of multiplex FM—requires but a single broadcast station. (See "What is Compatible Stereo FM Multiplex?" on page 91 of this issue.) An FM station broadcasts one channel in conventional fashion. The second channel needed for the complete stereo program is broadcast over an ultrasonic "subcarrier" sent over the same rf carrier, then separated and detected by a special converter at the receiver. Thus, both channels are broadcast simultaneously over a single station carrier and are picked up by a single FM receiver. This method offers considerable promise for the future but, like the other stereo broadcast techniques, still has an experimental status. RCA and Philco have developed systems for AM stereo broadcasting that permit a single AM station to transmit both stereo channels. These, too, are experimental systems.

The evolutionary development of stereo "hardware"—that is, the electronic and electromechanical equipment used to reproduce stereo program material—has closely followed and paralleled the development of stereophonic techniques. Early experiments were made with crude telephones. Later, electronic (vacuum-tube) amplifiers were used. Today, stereo equipment, except for type of pickup used (phono cartridge or tape head) and provision for dual-channel operation, is essentially the same as that used in conventional audio (single-channel) work . . . with but one important exception.

CBS has developed an interesting "two-way" amplifier circuit which permits the electronic "hardware" of what is essentially a single amplifier to handle *both stereo channels simultaneously*, while still maintaining adequate separation between the two channels (see "2-Way Stereo Amplifier," RADIO-ELECTRONICS, December, 1958).

What to expect

Looking to the future, we can reasonably expect present trends to continue. Stereo has rushed forward so rapidly in the last few months that there will probably be a period of consolidation and refinement. Reasonable standards—particularly in the recording field—should be established. Not all program material can benefit from stereo reproduction.

We may expect changes, perhaps major ones, in several fields. In broadcasting techniques as more and more individuals acquire stereo gear and become interested in the reception of stereo programs. And, perhaps, in the tape recording industry as it feels an increasing pressure from the competition of (comparatively) low-cost discs.

In tape, RCA has done some handwriting on the wall with the introduction of a four-track 3¾-ips machine designed to use preloaded tape *cartridges* (or magazines). These cartridges can be slipped into place without fumbling, as easily as a disc can be placed on a turntable and, theoretically at least, should be no more costly than stereo discs handling the same amount of program material.

Stereophony has come a long way. Interest is at fever pitch—at least among audiophiles, record companies and equipment manufacturers. But stereo has not yet gained really widespread public acceptance. Whether "every home" will boast a stereo system in the future (as most can now boast a radio) is still a question for the crystal-ball experts. END

COLLECTOR'S ITEM

By Phyllis Barlow

I wish the term
"Pay TV"
Referred to bills
Owed to me.

If you use an adapter, the monophonic system you converted to stereo will be much easier to handle

ADAPTERS SIMPLIFY STEREO CONVERSION

By LARRY STECKLER
ASSOCIATE EDITOR

CONVERTED your monophonic system to stereo? Did it by adding the second channel—another preamp, amplifier and speaker system? Then by this time you know the disadvantages. You have two of everything to adjust. You have to move leads around to reverse channels or phase, play mono material or play one channel through both amplifiers. Time you started looking for a way out!

You won't have to look far. To cut down on the handling problem, try a stereo adapter. Several of these units are on the market. Their cost—and what they can do—varies considerably, so decide which one gives you what you want commensurate with what you can afford to spend before you make any choice.

With any of these units hooked up the control problem is greately simplified. Now you have but one volume control, and it regulates both amplifiers simultaneously and equally. You also get a balance control for matching the outputs so the output from both speakers is equal.

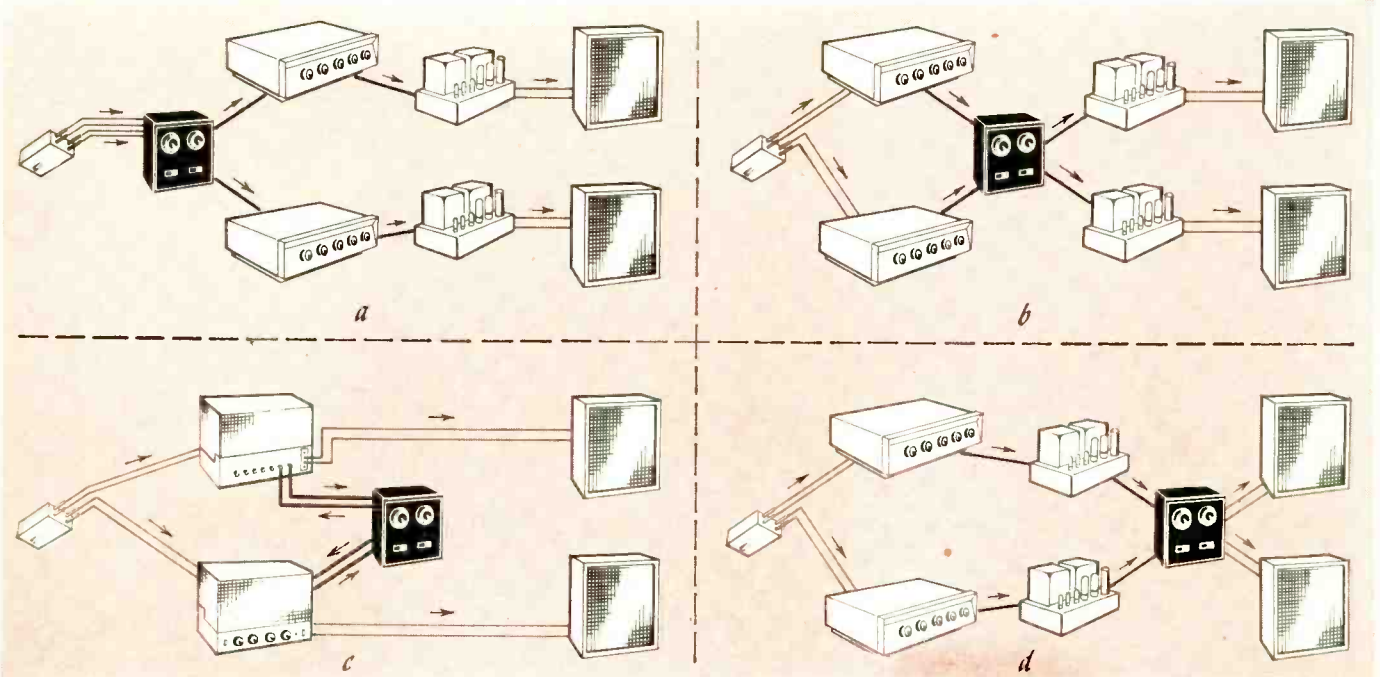
Some units provide for channel reversal, while others also include phase reversal. Best of all, some can be used as remote controls (attached by wire leads) that can be kept by the arm of your chair so you can adjust volume and balance from your favorite listening position.

Sounds wonderful, doesn't it? Well a little bad comes with the good. It bears an ugly name—insertion loss. Most adapters are passive units and resistances in these units can reduce the level of the signal passing through them—usually as much as 3 to 9 db. If the adapter you get cuts the signal level too much, you may have to keep your amplifiers' gain unreasonably high, introducing additional and unwanted distortion as well as lowering the signal-to-noise ratio. Be sure the adapter you get is suited to your amplifiers.

Adapters come in many forms. Some are adapters and nothing more. Others are remote-control units as well, and one incorporates a preamp that is used for the second channel. To draw the clearest possible picture of what these units are, how they work and how they are used, eight stereo adapters will be described.

Bogen model STA-1

Here is a unit that can be used in three ways, and with almost any hi-fi



The various stereo adapters can be used in different ways. A single adapter cannot be used in all the arrangements illustrated. They are limited to one or two of those shown. a—Between the cartridge and the preamps. (Construction details for such a unit are presented on page 42.) b—Between the preamps and the amplifiers. c—With combinations (preamp and amplifier in one unit). Tape-output jack connects to adapter input. Adapter output connects to tape-monitor jack. d—Between the amplifiers and the speakers.

amplifier (see Fig. 1). Of course, it is primarily intended for its manufacturer's equipment. Their latest monophonic line incorporates facilities for adding the stereo adapter. At the same time, the adapter can be used with older equipment — preamp–amplifier combinations if the units have tape monitor facilities, or between two separate amplifiers and two separate preamps.

When used with the newer amplifiers, the adapter simply connects to stereo adapter jacks on the back of each monophonic unit. A switch, accessible on some Bogen units only after removing the cover, puts the adapter into the circuit or takes it out as desired.

When used with older units (those that don't have stereo adapter jacks but do have tape monitor facilities) the amplifier's tape output jack (the one you would connect your tape recorder's RECORD amplifier to) is connected to the adapter's inputs. The adapter's outputs are connected to the amplifiers' tape monitor jacks. Now, when the tape monitor switch is flipped on, the signal source feeds into the preamp, out the tape output jack into the adapter, through the adapter and out to the tape monitor jack and on through the amplifying circuits of the preamp and amplifiers.

Of course, when the adapter is plugged into tape output and tape monitor jacks, there is no longer any jack on the amplifier that can be used for tape output. For this reason, two jacks, one for each channel, are on the adapter and are used as tape output jacks. As a last point, when the adapter is used in this way, there is no longer any tape monitor facility on either amplifier.

When used between pairs of separate preamps and amplifiers, the preamp outputs are connected to the adapter's inputs, and the adapter's outputs are connected to the amplifier's inputs.

The STA-1 provides four sets of controls—balance, volume, channel reversal and function. The first three are obvious. The function selector has two positions—MONAURAL and STEREO. In the STEREO position channel A feeds to the channel-A amplifier and speaker and channel B feeds to the channel-B amplifier and speaker. In the mono position a signal from either preamp feeds through the adapter to both amplifiers.

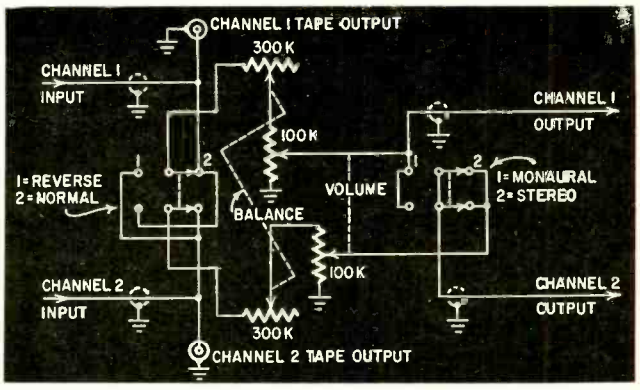


Fig. 1—Two switches and four potentiometers form the heart of the Bogen STA-1.

Dynakit DSC-1

Intended for use between preamplifiers and amplifiers, the DSC-1 is designed to complement its manufacturer's equipment (see Fig. 2). It can also be attached to the tape output and tape monitor jacks of preamp–amplifier combinations for stereo control of such devices.

An easy to assemble kit, it is less than a one-evening project. When finished, you have a passive control unit that offers volume, balance and blend controls. By flipping a switch, compensation is added and the volume control becomes a loudness control. Another switch is used to reverse channels while a third switches in a stereo tape recorder, if one in connected to the adapter.

The different feature of this unit is the BLEND control. At its full counterclockwise rotation it has no effect—it is turned off—and the two stereo channels are completely independent, giving you maximum channel separation. As you start to rotate the blend control clockwise, a switch clicks on and there is a slight mixing of the program material in the two channels. The further clockwise the control is rotated, the more the mixing increases and the less separation there is. At its full clockwise setting, another switch opens one of the input channels. Now a single

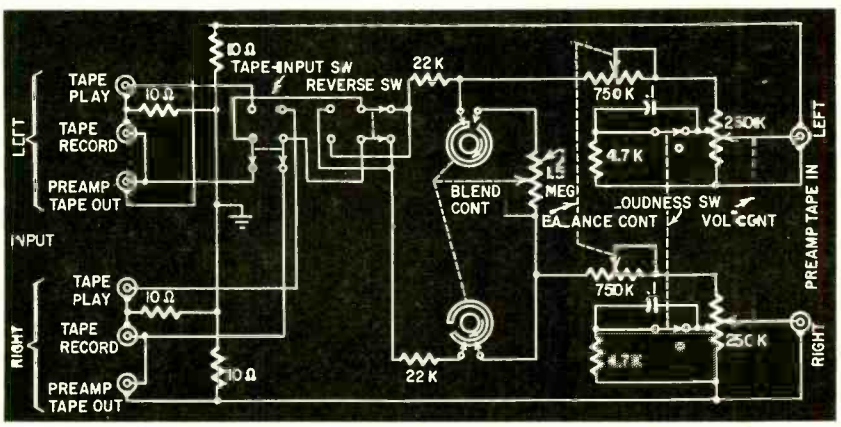
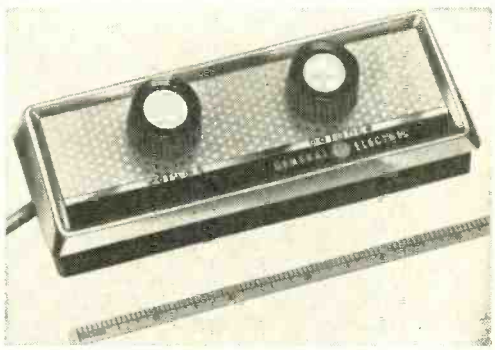


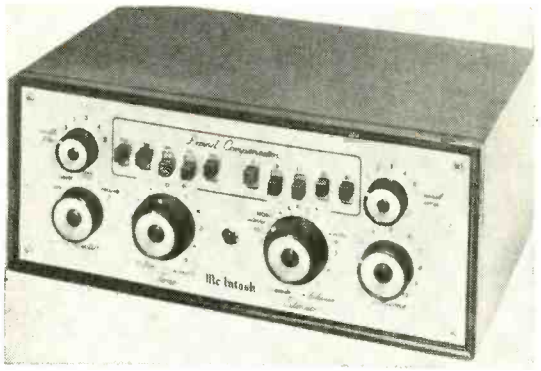
Fig. 2—The Dynakit stereo control features a blend control.

The Bogen STA-1.

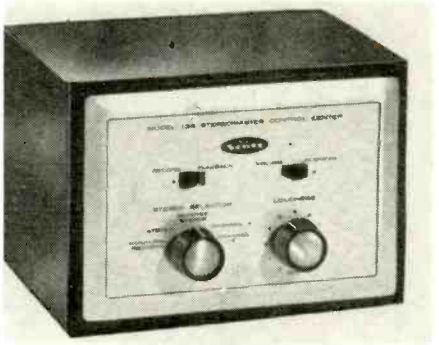
Dynakit's DSC-1 fully assembled.



General Electric makes this RG-1000 remote control.



The C-8S, McIntosh's combination of single-channel preamp and stereo *adapter*.



Scott's compact Stereomaster control center.

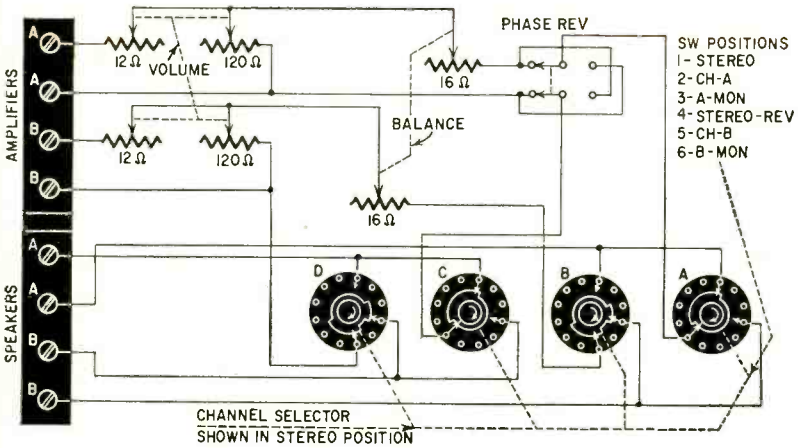


Fig. 3—Knight's adapter goes between the amplifiers and the speakers.

source can be played through both amplifiers. Flip the channel-reversal switch and the other input can be played through both channels.

What does the blend control do for you? It lets you fill the hole in the middle that appears when some stereo recordings are played or when phasing is incorrect—that unnatural separation intentional on some discs to accentuate the stereo effect. For best results, Dynakit recommends setting the blend control so there is no effect of completely separate sound sources, but instead a spread of sound that fills the space from speaker to speaker.

General Electric RG-1000

The unit (schematic not shown) plugs into the tape output jacks of the amplifiers and actually attenuates the signal at this point (just before it is applied to the volume and tone controls). For this reason, it cannot be used with amplifiers that have cathode-follower tape outputs. (There are only a few of these.) In such amplifiers this unit would have no effect on the signal in the amplifier.

A passive unit, this simple device is more a remote control than a stereo adapter. It supplies only balance and volume controls, but puts them on the end of a 30-foot cable so you can keep the controls by your chair.

The RG-1000 should be used only with paired amplifiers. Two dissimilar amplifiers might have different tape output levels and you would not be able to maintain equal control of the amplifiers. Of course, the unit can be used with stereo preamps too, and it is here that it truly becomes a remote-control device only. As with most of the other adapters, this one is primarily designed for use with this manufacturer's equipment.

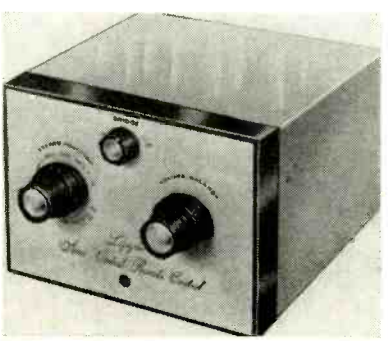
Knight-Kit 83 Y 778

Inserted between a pair of amplifiers (one two-channel stereo unit or two monophonic units) and their respective *speaker* systems, this compact unit provides remote stereo control (see Fig. 3). Because it is used in the low-impedance speaker output circuit—usually between 8 and 16 ohms—long connecting leads are feasible and the device can be kept by your chair or at some other convenient spot. The unit has a 12-ohm impedance. This passive unit comes in kit form and can be assembled in less than an evening.

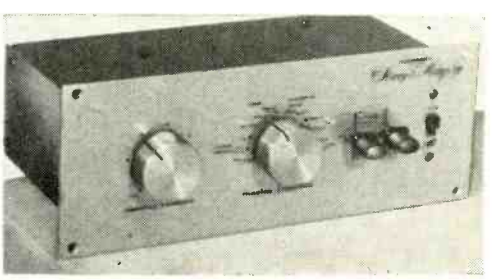
The unit has ganged volume controls, a balance control and a function selector. The function selector is a six-position rotary switch. In the STEREO position, there are two independent channels. In the A-CH (channel-A) position, only channel A is connected. This setting is used when balancing a stereo system. In the A-MON position, any signal from the channel-A amplifier is fed to both speaker systems. Set for STEREO REV, the channel-A amplifier plays through the channel-B speaker system and the channel-B amplifier plays through the channel-A speaker system. Set for B-CH (channel B), only channel B is connected. This position is used along with the A-CH setting when balancing the system. Last is the B-MON position. At this setting, any signal from the channel-B amplifier is fed to both speaker systems.

The unit has one limitation. It can handle no more than 20 watts of audio so the output of the amplifiers you use it with must be kept below this level.

The Knight-Kit adapter also acts as a remote-control unit.



Lafayette's adapter uses two tubes.



The Marantz stereo adapter comes with a horizontally or vertically marked front panel.

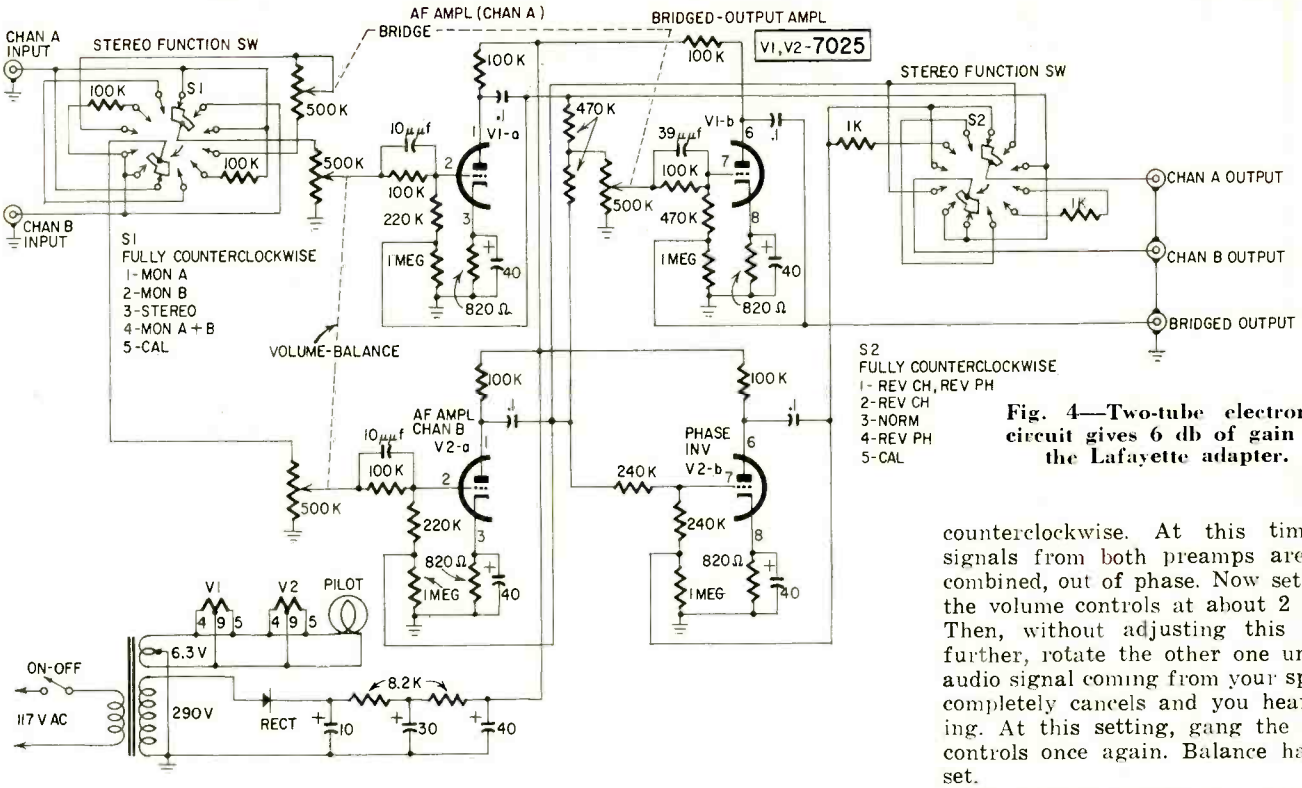


Fig. 4—Two-tube electronic circuit gives 6 db of gain in the Lafayette adapter.

More than 20-watts of audio will damage the components in the unit.

Insertion loss of the Knight unit differs from that of the others. Here, the loss is in output power. While this can cause trouble if you are using low-efficiency speakers, it will not force you to crank up your preamp and lead to hum, distortion, or poor signal–noise ratio. Another effect is that it reduces the damping of any speakers connected to this unit (except at the full-volume position).

Allied is also offering, under the Knight trademark, an assembled stereo adapter that follows the principles of the Knight-Kit unit just described. It is the model 750 stereo adapter. Differences are few and simple: the front-panel layout is not the same, and slide switches are used instead of a single rotary function selector.

Lafayette KT-315

This *electronic* unit, unlike the passive ones, provides 6 db of *gain* and acts as a remote stereo-control center (Fig. 4). It is inserted between the preamps and amplifiers of a stereo system. The unit has low-impedance output, obtained by using a lot of negative feedback in the output stage, and can be used 50 feet or more from the amplifiers it controls.

The VOLUME control is a clutch type unit which allows for individual or simultaneous control of the stereo channels and lets the dual pot also perform as a balance control. Two rotary switches, mounted concentrically, are used to select the unit's other functions. Each switch has five positions.

Switch S1 in the input circuit starts off in the MON A position. When set here, channel A plays through both amplifiers. MON B, the second position, feeds channel B through both amplifiers. Next is STEREO. Here both channels are completely separate — channel A plays through one amplifier and channel B through the other. Continuing around we come to MON A +B. This is used to play mono discs with a stereo cartridge. It parallels channels A and B so that effects of vertical movement, which, for example, might introduce rumble, are cancelled. Last is the CAL (calibrate) position. We will discuss that a little later.

Switch S2, another five-position rotary, is in the adapter's output. Its center position is labeled NORM—channel A plays through amplifier A and channel B through amplifier B. Going counter clockwise, we come to REV CH (reverse channel) and channel A plays through the channel-B amplifier while channel B plays through the channel-A amplifier. At the extreme counterclockwise position is REV CH, REV PH (reverse channel, reverse phase). As well as reversing channels as just described, the phase of one of the channels is electronically reversed.

Now let's return to the NORM setting and go clockwise. First is REV PH (reverse phase). The phase of only one channel is reversed here. Next is the CAL (calibrate) position.

With switches S1 at STEREO and S2 at CAL, you are ready to balance the stereo system. To do so a mono disc is played with the stereo cartridge. (To use a stereo disc for balancing, set both switches on CAL.) With the disc on the changer or turntable and everything hooked up and operating, the BRIDGE control on the adapter is rotated fully counterclockwise. At this time, the signals from both preamps are being combined, out of phase. Now set one of the volume controls at about 2 o'clock. Then, without adjusting this control further, rotate the other one until the audio signal coming from your speakers completely cancels and you hear nothing. At this setting, gang the volume controls once again. Balance has been set.

The BRIDGE control also serves another function. When selector switches are in the stereo position, it mixes the signal in the two channels, the amount of mixing depending on the control's setting. This eliminates the hole-in-the-middle effect.

For those who want to go a little further toward filling that hole, there is a BRIDGED OUTPUT jack. Here, a signal containing both the A and B channels is available. It can be fed to a third amplifier which drives a speaker placed between the channel-A and channel-B speakers.

Although KT-315 is a kit, a printed-circuit board simplifies construction of this two-tube control unit.

McIntosh C-8S

Here is something a little different. Built-in as part of a single-channel preamp is a stereo control unit. Its circuitry is shown in Fig. 5. When you add this preamp to a single-channel system, a separate stereo adapter is not needed.

Although specifically designed to complement this manufacturer's model C-8 preamp, the C-8S can be used with many other units. Instructions that come with the C-8S detail the modifications necessary before it can be used with a C-8. For other preamps, the arrangement is still simple. Just connect the existing preamp's output to the LEFT INPUT jack of the C8S and connect the existing amplifier's input to the unit's LEFT OUTPUT jack. Then connect the C-8S to the amplifier used for the right channel.

The unit is not recommended for use with preamp–amplifier combinations and requires an external power supply.

Three stereo controls are provided.

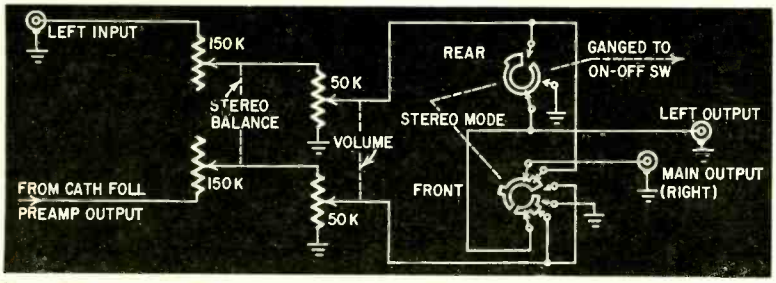


Fig. 5—This control circuitry is built into a single-channel preamp.

The STEREO BALANCE control lets you match the output of both channels. The VOLUME control is ganged and simultaneously varies the balanced output. The STEREO MODE control is a five-position rotary switch. It provides normal stereo, reverse stereo, left channel only, right channel only and mono settings.

Marantz model 6

This is a passive unit with a difference—it goes between the signal inputs and the preamps. All signal sources are connected to the adapter rather than to the preamps. Then the desired input is selected by adjusting the MASTER FUNCTION switch. The adapter's channel-A and channel-B outputs connect to the respective preamp's tape input jacks. Five pairs of inputs are provided—phono, tuner, tape, TV, extra. All can be used in either the stereo or mono modes. Mono programs can be played from either or both speakers, as desired.

Among the adapter's controls is a MASTER VOLUME control (a stepped attenuator) which simultaneously varies the output of both amplifiers. A switch for reversing channels whenever necessary is on the front panel. There is also a master ON–OFF switch. You connect the preamps to the adapter and your other components to the ac receptacles on the preamps. Then just flip the one switch on the adapter and all your equipment goes on or off together—no more running around with a dozen or so switches and always managing to forget at least one.

There is no balance control on this unit. Instead you must adjust the volume controls on the preamps to match the outputs of both channels. Once set, the balance is maintained and needs no further adjustment.

H. H. Scott model 135

This, like many of the other passive units, connects to tape jacks, between separate preamps and amplifiers or to this manufacturer's equipment per instructions that accompany the unit. (See Fig. 6) Although a simple unit many control features are offered. There is a ganged master volume control, and loudness compensation can be added if desired. A STEREO SELECTOR switch provides five modes of operation —MONAURAL RECORDS for playing mono discs with a stereo cartridge; stereo; REVERSE STEREO; CHANNEL A, this channel is played through both amplifiers; and CHANNEL B, again the channel is played through both amplifiers. A master power switch tops things off.

As an added feature, record and playback jacks that can be connected to a stereo tape recorder are offered. A switch on the adapter's front panel selects record or play back. These jacks are most convenient when recording stereo material on tape. For further details on this unit see "An Expand to Stereo Unit," in RADIO-ELECTRONICS, page 36, July, 1958.

So there you have it, a brief look at stereo adapters today. They can help solve your stereo conversion problem by cutting cost and making handling easy. END

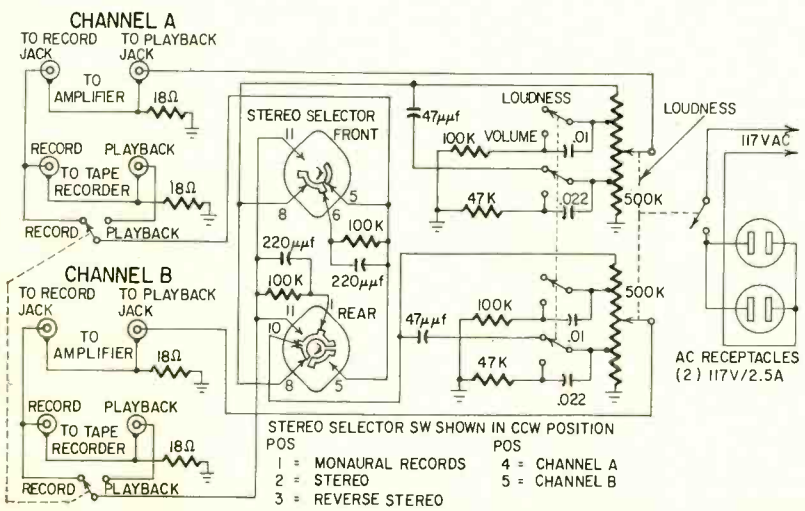


Fig. 6—Circuit of the H. H. Scott model 135.

NEXT MONTH

Sensitive Wide-Band Vtvm

How often have you been dubious of your measurements because of the frequency limitations of your voltmeter — or been unable to make them because it wasn't sensitive enough? Here is a laboratory type instrument that will make such measurements and make them accurately.

Remedies for Groove Jumping

The phono stylus that refuses to stay in the groove is occasionally troublesome to the hi-fi man, but gives far more agony to the record dealer who is forced to exchange records that "will not track." This article tells how to find out if the record or the equipment is at fault, and if the latter, what the service technician can do about it.

Free-Power Transistor Radio

Some new ideas in an ingenious, easily built little receiver that uses the broadcast station's own signal to furnish its operating voltages.

Reflex Enclosures, Part II
The ABC's of Mobile Radio, Part III

Due to the large number of stereo articles, it was necessary to hold these two articles over this month. They will appear in the April issue.

You can convert to stereo gradually, improving your mono system as you go along. Where should you start? Which components in your present system should be discarded? How much should you pay for conversion components?

Common-Sense Guide to STEREO

By DAVID LACHENBRUCH

WANT to go stereo—on your budget?

You can do it without economic pain if you proceed gradually. You'll see a dramatic improvement in your monophonic high-fidelity installation with each change you make, as you work toward the ultimate goal of full-toned, three-dimensional, solid sound.

If you don't have a monophonic hi-fi already, you can put one together now at a reasonable price, and go stereo later without wasting a single penny or a single watt.

While all component hi-fi systems are compatible with stereo, some are "more compatible" than others. There are so many approaches to stereo—so many variations and combinations of conversion components—that there can be no "standard method" of conversion which holds good in all cases.

And no two people see eye-to-eye—or hear ear-to-ear—on stereo systems and conversions. One man's stereophony may be another man's cacophony.

But there is still the fundamental fact that stereo requires two complete sound channels. Yet a stereo system need not, and should not, cost twice as much as an equivalent mono system.

Starting from scratch

A complete component stereo system today costs only about 25%–50% more than a monophonic hi-fi system of comparable rating and quality, and most of the additional cost is represented by the second speaker.

You can build a mono system now, using a stereo amplifier and stereo phono and a single speaker, at perhaps 10%–15% more than components designed solely for mono use. When you're ready to go stereo, you merely add the second speaker.

But if you already have a good mono hi-fi system, your problem is more complicated.

Begin at the beginning

Where should a gradual conversion job begin? In some cases, the answer will be obvious. If you have a component that stands out as the weak link in the chain—spoiling your hi-fi enjoyment—that's the natural one to replace first, with a stereo equivalent or one readily adaptable to stereo.

Ordinarily a good rule is to start at the program source, and the most widely used stereo program source today is the phonograph.

Stereo discs are plentiful and good. So if you're going to build a stereo system, why keep on buying monophonic records? Better to start a stereo disc library now—even before you have your 3-D system. Stereo records usually cost about a dollar more than their mono equivalents, and can be enjoyed monophonically until your system is complete.

But wait! Don't put your old mono pickup down on that new stereo disc!

Because of the difference in the groove characteristics, one playing with a mono needle will ruin a stereo record. But, monophonic records can be played with a stereo pickup.

To play stereo records, even monophonically, you'll have to have a stereo pickup, and to play them properly in stereo, a new record-playing mechanism may be required.

If your current turntable or changer isn't a good one, this is a good time to get rid of it and buy a new one engineered for stereo. However, your record-playing apparatus may be perfectly adequate for stereo. Here's how you can test it, and perhaps save the cost of a new turntable:

Buy your first stereo component—a stereo pickup cartridge (consulting the article and tables beginning on page 49 may help you decide which one is for you). You'll also have to insert a new set of leads in the pickup arm (either three- or four-wire) to accommodate the outputs of the new cartridge.

With the new cartridge installed, plug *one* of the phono output cables (either one) into your hi-fi system. Play a record—a monophonic one will do—and listen carefully for rumble. For the test, a disc recorded at a low level is good—a blank record, if you have one, is best.

If you hear rumble from your loudspeaker, the changer or turntable will have to be replaced for satisfactory stereo. But it needn't be replaced right away—when you parallel your phono input cables, the vertical component of stylus motion cancels out. When you finally go into stereo, the rumble again will be evident.

All new turntables and changers on the market are engineered for stereo—built for lower rumble and equipped with the proper pickup leads. And the best news is that they cost about the same as their old monophonic predecessors. Even equipped with a stereo cartridge, the cost of a changer generally is only 10%–20% more than the old mono equivalent.

With your ready-for-stereo phono feeding your present mono amplifier, you can begin playing stereo discs (you'll be hearing them monophonically) as well as standard LP's, using the same pickup. And chances are you'll notice an immediate improvement in the reproduction of your old records with the addition of the fresh cartridge and stylus.

supply generally make a stereo amplifier a considerably better buy than two monos.

A new type of stereo amplifier planned for production may make it unnecessary to consider keeping the old monophonic unit. The "two-way" amplifier (RADIO-ELECTRONICS, December, 1958, page 41) is nearly as simple as a monophonic amplifier, since it runs two channels through a single amplifier. It probably won't be priced more than 25% above an equivalent mono unit. You can't buy one yet, though, and the circuit is still untested in day-to-day use.

Stereo amplifiers are usually rated according to the sum of the power in both channels. Thus, a 28-watt amplifier has two 14-watt channels (sometimes it's also called a "dual 14-watt"). You can use it monophonically as a 28-watt amplifier.

The most popular stereo amplifier–preamps are 20-, 24-, 28-, 30- and 40-watt units and their prices range from $70 to $200 in prewired form, and currently from $45 to $70 as kits—although the variety of available kits will soon be wider. "Basic stereo amplifiers," without preamp or controls, vary from 20–60 watts in power, $75–$200 prewired and $35–$85 as kits.

system a little more cheaply—if you plan to use a separate preamplifier—is provided by the Heath Co. This company offers a mono preamp kit which is designed for easy conversion to stereo. The second-channel kit plugs into the first. The composite is a stereo unit with a complete set of stereo controls, including remote balance.

Other program sources

When you have complete equipment for playing stereo discs stereophonically, you've reached the first plateau. You'll certainly want to go on, and again at a pace dictated by your budget.

The next additions probably will be new program sources. You may already be using your stereo system for monophonic listening to radio or tape. Both sources may be converted to stereo easily and economically.

Low-cost head kits are available for converting monophonic tape decks for stereo playback.

If you have an FM or FM–AM tuner and live in an area where there are FM–AM stereocasts, all you have to do is buy a companion tuner to give yourself another stereo source. If you don't already have a good FM tuner, you might consider buying an FM–AM *stereo* tuner—one in which FM and AM sections can be used simultaneously.

right now by investing $50–$100 in a converter to use with a monophonic FM tuner. However, several multiplex systems are currently being tested by various FM stations—and they're incompatible with one another.

All current stereo multiplexing is classified "experimental" and may be terminated at any time. The FCC is expected to establish stereo broadcasting standards in a year or two. By then you'll be able to buy a stereo multiplex FM tuner for perhaps $20 more than a monophonic one. Until then, the purchase of a multiplex converter is recommended only to the most avid experimenters and those in the 50% tax bracket.

Cheap stereo

In this discussion, we haven't considered the $20 "bugs" and phono oscillators which will give you stereo using any radio's audio amplifier and speaker as the second channel. They provide true stereo, but not hi-fi stereo. There's nothing basically wrong with them—any more than there's anything wrong with a table radio, but they don't belong in a treatment of home stereo as the ultimate in high fidelity.

So why not improve your hi-fi while converting to stereo the easy step-at-a-time way? END

TABLE I—STEREO CONVERSIONS (Basic Disc System)*

If You Already Have—	You Can Add—	Approximate Price Range Wired	Kit
Record changer or Turntable and arm	Stereo pickup cartridge plus Pickup arm wiring†	—	$4.75–$70 $1–$5
Combination amplifier–preamp	Matching or similar unit plus Stereo adapter-control center	—	—
	Stereo adapter-control center	$13.50–$45	$10–$28
	or Combination mono amplifier–preamp and stereo control center	$110	—
Amplifier	Matching or similar unit plus Stereo preamp–control center	—	—
	Stereo preamp–control center	$90–$200	$40–$80
	or Combination mono amplifier-stereo preamp–control center	$50–$100	$60
Separate amplifier and preamp	Matching or similar amplifier plus Combination mono preamp–control center	—	—
	Combination mono preamp–control center	$60	$40
Single full-range speaker system	Matching full-range unit	wide	
	or 2 mid- and high-range units	wide	

*Some possible "minimum conversions" which can be made without discarding any presently used monophonic components. There are many other combinations. If it's advisable to discard any of your present components, see Table III. Price ranges are approximations and are subject to change as new components are introduced.
†Included with some stereo cartridges.

Has your amplifier ample fi?

Time passes . . . you've saved your pennies . . . and now you're ready to tackle the problem of the amplifier. Get plenty of sleep; be sure you're at the top of your physical and mental form—because what you do next will require considerable soul-searching and characteristic-comparing. You will have a bewildering array of choices.

The first to consider is whether it's best to keep or discard your old amplifier. It's a good idea to consider an all-new stereo amplifier if the answer to any of these questions is "no":

1. Are you completely satisfied with the monaural performance of your amplifier? By now you should have a good monophonic sound system and any deficiencies can be pinned on the amplifier. (If the present amplifier is good but underpowered, don't worry—you'll be adding more power.)

2. Is its sensitivity adequate for stereo equipment (6 mv for full power output for magnetic cartridges or 0.1 volt for ceramics, and 4 mv or less for tape heads)?

3. Can you obtain another amplifier with a closely comparable response

new ideas in STEREO SPEAKER SYSTEMS

By GEORGE L. AUGSPURGER *

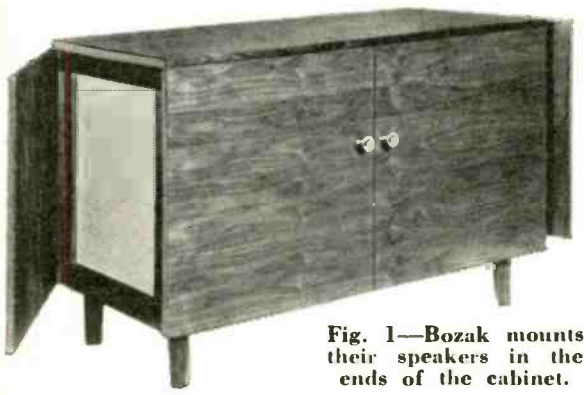


Fig. 1—Bozak mounts their speakers in the ends of the cabinet.

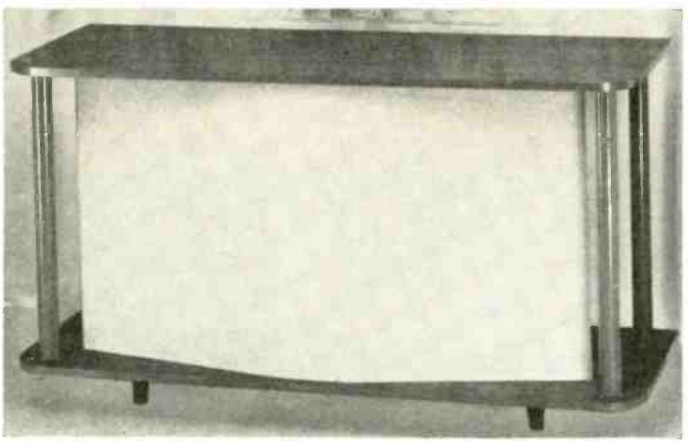


Fig. 2—Frazier uses two horn-loaded systems angled away from each other.

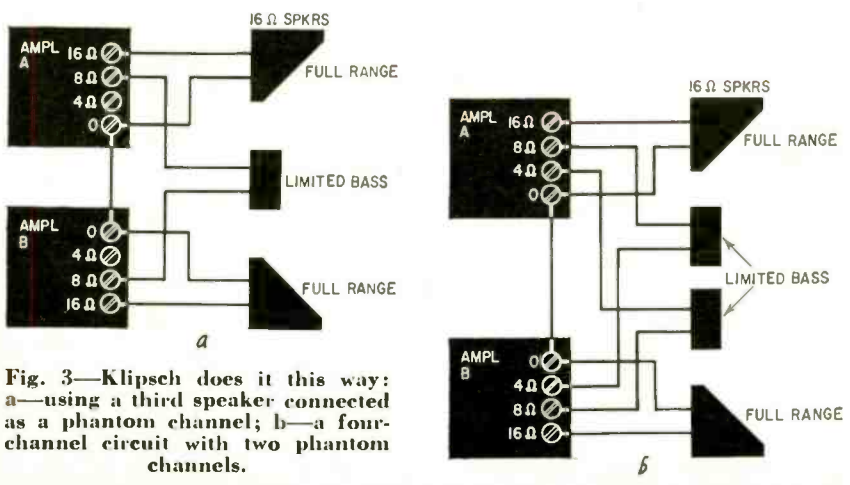


Fig. 3—Klipsch does it this way: a—using a third speaker connected as a phantom channel; b—a four-channel circuit with two phantom channels.

FOUR years ago Hollywood hailed stereophonic sound as the greatest invention since talking pictures. At the same time, the hi-fi industry had grave doubts that stereo would ever prove really popular for the home. An elaborate installation in a movie theater was a fine thing, but who would be willing to buy two complete sets of equipment just to listen to music?

Today, of course, the situation is turned inside out. People are buying stereo tape machines and phonographs faster than they can be made. But the patrons of movie palaces don't seem to care if the sound is seven-channel, one-channel, or just barely tolerable.

Naturally enough, the amazing consumer acceptance of two-channel stereophonic reproduction has resulted in a fantastic barrage of claims and counterclaims, and general confusion. And probably no components of the stereo system present a more bewildering choice than the speakers. Problems of utilizing existing equipment, finding space for another speaker system and achieving optimum room placement are encountered by every new stereophile.

Speaker manufacturers are aware of these difficulties, but their solutions have taken widely differing forms. It is the purpose of this article to examine several of the newer stereo systems and point out their functional differences.

Two full-range sources

First of all, it should be remembered that any two wide-range speakers in individual enclosures will give just as good stereo reproduction as if the cabinets are sandwiched together and labeled Stereo System. As a matter of fact, the listener has the obvious advantage of being able to adjust the position of the cabinets to give best results in a particular situation.

The big question with any two-

*James B. Lansing Sound, Inc.

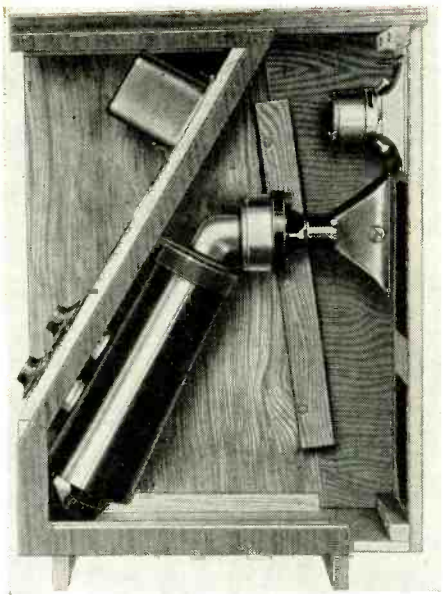


Fig. 4—Inside Electro-Voice Stereon.

channel arrangement, whether in a single cabinet or not, is, "How far apart?" If the sound sources are too close together, the full spatial effect is lost. If they are too far apart, the listener hears two separate performances.

The "hole in the middle"

Recently, some authorities have repudiated the whole notion of a hole in the middle between the two stereo speakers. "When everything is adjusted correctly," they say, "and the listener is seated properly with respect to the speakers, there is no consciousness whatever of separate sound sources. A curtain of sound seems to fill the space between the two speakers." And these people are perfectly right. *If* the two halves of the system are perfectly balanced, and *if* you find the exact spot where the sound blends properly, and *if* you don't move from that spot, the effect is similar to listening through a stereo headset.

The difficulty is that these are pretty big "if's." While the effective stereo area is big enough to accommodate a half-dozen persons, only one of them will hear the almost magical fusion of the two channels which is true stereo.

The best compromise between achieving as large an effective stereo listening area as possible, and at the same time maintaining sufficient spatial separation, seems to be to place the speakers so that the listener sees an angle of 30°–40° between them. Assuming that we will be about 9 feet from the speakers in an average room, the sound sources should then be 6 feet apart.

Bozak has achieved 6-foot separation in a cabinet only 4 feet wide by mounting the speakers in the ends of the enclosure facing outward (Fig. 1). The hinged doors which normally cover the grilles are opened to about 45° and serve as reflectors for the mid-range and highs. The exact angle of the doors can be adjusted to give best possible balance at a given listening position.

Jensen Manufacturing Co. provides adjustable directionality with a different arrangement. In the Stereo Director, the mid-range and high-frequency transducers are mounted on little turntables behind the grille cloth. They can be pointed in any direction without moving the cabinet.

Jensen does not achieve the full 6-foot separation of the Bozak design nor is it the only unit which uses relatively close spacing between sources. Both Pro-Plane and Frazier manufacture stereo speakers in which the distance between speakers is small, yet which achieve a reasonable stereophonic effect. Pro-Plane depends upon precise matching of components for maximum channel separation from a side-by-side arrangement. The Frazier enclosure houses two horn-loaded systems angled away from each other at 30° (Fig. 2). The angular separation helps get as much separation as possible from a small cabinet, and also increases the ratio of reflected to direct sound.

The opposite approach is taken by Paul Klipsch, who feels that one of the most dramatic accomplishments of stereophonic reproduction is the ability to surround the listener with sound. Klipsch recommends two full-range corner horn speaker systems (although they do not need to be identical) plus a third "fill" speaker in the center. If the middle speaker is fed a combination of the two stereo signals, the effect approaches that of three-channel reproduction. The listener does not notice any hole between the two main speaker systems.

Klipsch suggests that the third speaker be driven by simply connecting it across the two power amplifiers (Fig. 3-a). This connection results in only the *difference* signal between the two channels being heard from the center speaker. (If both channels are used simultaneously to play a mono source and are adjusted to the same gain, no sound will be heard from the third speaker.) Since the fill speaker is not required to reproduce low bass, it may be a small, inconspicuous unit. Klipsch & Assoc. makes a neutrally styled little system especially for this application.

The Klipsch approach can be expanded to provide two phantom channels by using the connection shown in Fig. 3-b.

Systems using combined bass

The problems of additional cost and finding space for a second full-range speaker system have been the most effective deterrents to stereo conversion for the man who already owns a fairly elaborate monophonic setup. Several companies have tried to get rid of both objections in one fell swoop by designing stereo hookups in which bass from both channels is reproduced by a single speaker. The stereo effect is then limited to the mid-range and highs.

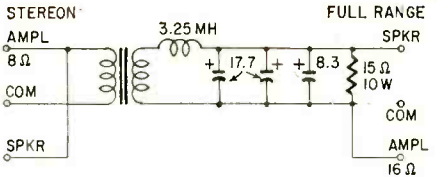


Fig. 5—Frequency mixing network in the Stereon.

The first of these stereo systems was marketed by Electro-Voice. The buyer employs his present speaker (or any good standard system if he is starting from scratch) for the main sound source. A second small unit called a Stereon (Fig. 4) is then used for the second system. A special Stereon network mixes frequencies below 300 cycles from both channels and feeds them to the bass driver of the larger system. The schematic of this network is shown in Fig. 5. The mid-bass and high-frequency transducers in the big system then reproduce frequencies above 300 cycles in one stereo channel, and the small Stereon unit reproduces the same range in the other channel.

If Electro-Voice components are used exclusively, it is possible to select a full-range system which employs the same mid-bass and high-frequency transducers as the Stereon. Thus, both halves of the installation are perfectly matched.

A somewhat similar abbreviated stereo arrangement is that engineered by University. This Trimensional system eliminates one more component by getting rid of the special mixing network. The trick here is a clever adaptation of a previous University design—the dual-voice-coil woofer. By connecting each coil to one of the stereo power amplifiers (through a built-in series inductance), the low frequencies from each channel are automatically combined in the single low-frequency speaker (Fig. 6).

University makes both a single-cabinet system and small limited-response systems similar in function to the Electro-Voice Stereon. The University tradename for these specialized units is Stereoflex. And to provide for all possible permutations and combinations, the company also manufactures a bass-combining network for customers who want a single-coil woofer.

The single-cabinet system built by University attempts to get maximum separation of sources in a compact cabinet by using reflecting surfaces, somewhat like the Bozak design (Figs. 7 and 8). The main difference is that the TMS-2 is a sort of small Bozak cabinet set backward against the wall. Sound is bounced off the reflecting surface, against the room wall and finally into the listening area.

There is actually quite a bit to be said for deliberately heightening the "spread" effect of multiple reflected-sound sources. For stereophonic reproduction especially, such an aggregate of more or less random sources helps dispel the awareness of sound coming

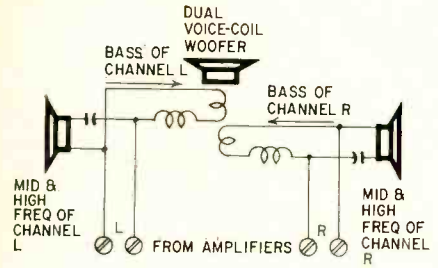


Fig. 6—Stereo connections to the University dual-voice-coil woofer.

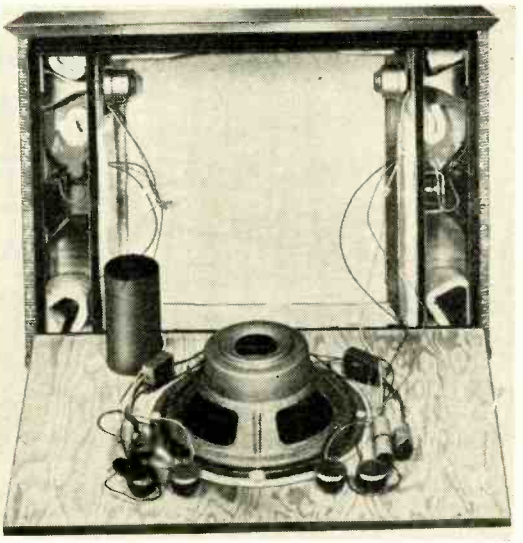


Fig. 8 — Inside view shows speaker arrangement used by University.

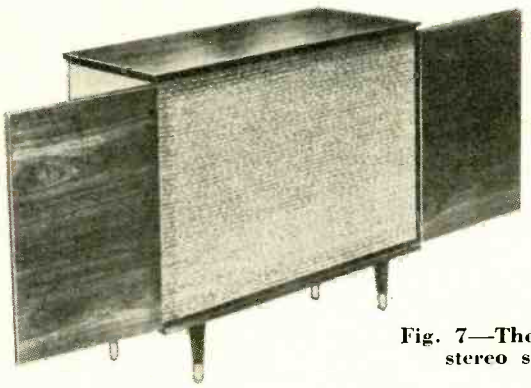


Fig. 7—The University TMS-2 stereo speaker system.

from two specific speaker systems.

The big difficulty with this arrangement is that maximum flexibility in a compact system has been achieved at the expense of accurate control over tonal response characteristics. The multiple reflected paths, varying diffraction and resonance effects depending on the positions of the doors, and unpredictable reflection characteristics of individual room walls, all combine to produce definite variations in the timbre of reproduced sound.

There is also the problem that adjustment of the reflectors must be made at the speakers—but the effect of this adjustment must be ascertained at the listening position.

Still another interesting variation of the combined-bass approach is the Stephens Stereodot designed by Bert Berlant (Fig. 9). Employing both combined bass and center fill, the Stereodot system consists of two small limited-bass units plus a special network. The Stereodot assembly is designed for use with any good full-range speaker system. The large speaker is placed in the middle, and the small Stereodot cabinets on each side.

When all connections have been made to the network, and stereophonic source material is turned on, the listener hears a full-range stereo performance covering considerable physical space, but without an audible hole in the center. Stephens states that the effective listening area is substantially larger than from a conventional stereo hookup, and that there is no loss of bass directionality even though frequencies below 400 cycles are combined and fed to the large system.

Nondirectional bass

It is an old classroom technique for a professor, when approaching a statement about which he is not too sure, to preface the assertion with, "It is a well-known fact that . . ." Almost every explanation of the theory behind the common-bass channel begins with "It is a well-known fact that the direction of frequencies below 300 cycles cannot be determined by the human ear." How true is all this talk about nondirectional bass frequencies?

In terms of absolutes under controlled conditions, it is quite valid. Listening to a source of sound in free space or an anechoic chamber, below about 300 cycles you no longer are able to tell the direction from which the sound is coming. However, if you or I try the same experiment in our living room with an audio oscillator and our present speaker system, we find that directional effects are clearly audible to below 150 cycles! The perplexing thing is that below about 500 cycles, while we *think* we can tell where the sound is coming from, we are just as apt to be wrong as not.

Why? In a room, as opposed to free-space conditions, strong standing waves are set up. If our head happens to be near a loop or a node at any given frequency, then just turning slightly is enough to change noticeably the intensity relationship between our two ears. Since this effect is due to room acoustics rather than the position of the sound source, it is not a true directional effect, but our ears can't tell the difference.

Consequently, though we can't pinpoint the source of low frequencies, an organ pedal note will nevertheless sound different if the speaker is moved.

Perhaps it will make the point clearer to suggest that if the common-bass system really gives an effect identical to two separate full-range systems, we should be able to demonstrate this experimentally.

However, if such an experiment is conducted, allowing a stereo program source to be instantly switched from separate full-range speakers to combined bass in one of the two speakers, it turns out that there is a noticeable difference. The question is does this difference really constitute a loss of the stereo effect and, if so, is it worth worrying about?

The answers to these questions must be determined by the critical listener. However, there are still other theoretical objections to a common-bass stereo speaker installation.

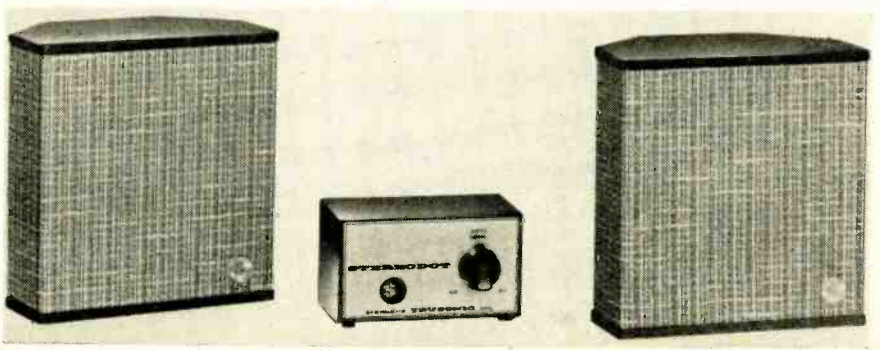


Fig. 9—Stevens Stereodot system is designed for use with any good full-range speaker system.

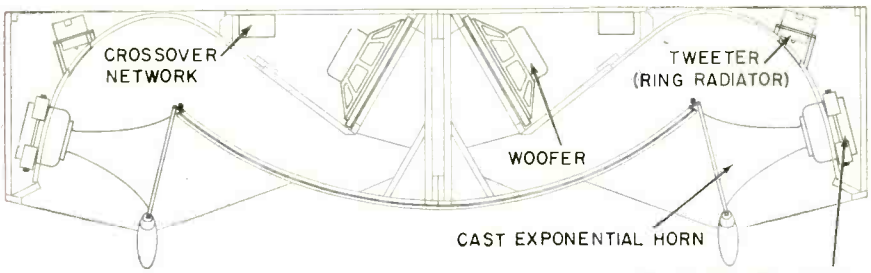


Fig. 10—Cross-section of the JBL/Ranger Paragon.

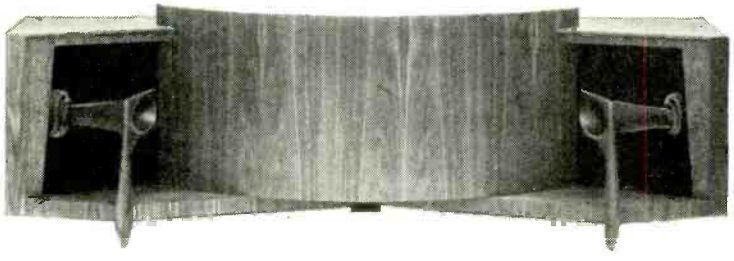


Fig. 11—Paragon, an integrated stereophonic reproducer.

One of the biggest advantages of stereo reproduction for the average listener is that sound reproduced from multiple sources some distance apart is much less dependent on room acoustics than reproduction from a point source. This is most noticeable in the low bass register. Separated sources at low frequencies tend to average out the peaks and dips introduced by standing waves in the listening room. Unless the main system is a very large corner horn or multiple-woofer arrangement, the "one-and-a-half" installation automatically throws away the best chance to iron out some of the discouraging acoustics of small rooms.

A third point which should be brought up is that there is nothing magical about 300 cycles. The loss of true directionality begins to occur *somewhere* around this point. Moreover, crossover networks don't switch speakers within a matter of a few cycles—at least an octave of noticeable overlap exists.

Taking into account both of these factors, Altec feels that a more realistic figure is 100–150 cycles. And once you're down this low, why not take advantage of the complete separation, suppression of adverse acoustical effects and precise matching of two separate full-range systems?

Acoustically integrated systems

Klipsch and Stevens derive an additional center channel from a two-channel source. Paul Klipsch suggests a possible four-channel connection for even more subtle transition between the end speakers. It is easy to see that if enough output taps were available, these center "phantom" speakers could be increased ad infinitum to give a completely "full" source of sound extending all the way from the extreme left-hand system to the right.

Col. Richard R. Ranger, well known for his work in the field of motion-picture sound recording, approached the problem of two-channel stereo reproduction from this continuous-source concept. Instead of electrically mixing a great many individual speakers, Ranger uses a combination of acoustic principles to achieve smooth integration between the two stereo channels.

Experimentation with directional speakers and various types of reflecting surfaces resulted in the arrangement of Fig. 10. Basically, the system requires two directional transducers covering the audio range from 300–500 cycles upward. These are faced into the ends of a convex surface. If the angular position of the speakers and the radius of curvature of the convex panel are just right, sound is projected outward from all points on the curved surface.

The type of low-frequency loading is not critical so long as the two sound sources are located at each end of the convex panel.

The relative intensity of the two speakers determines the apparent location of the sound source. With stereo program material, the "curtain of sound" spreads across the entire convex refractor.

The Ranger design is manufactured by James B. Lansing Sound, Inc. Fig. 10 is a cross-section of the JBL/Ranger Paragon shown in Fig. 11. This reproducer is almost 9 feet long, weighs about 800 pounds and uses twin sets of high-quality theater components. The compromise in this case has obviously been made with size and cost . . . not many of us can afford the $1,800 price tag of the Paragon even if we have room for it.

Very recently, JBL has introduced a second integrated stereo reproducer called the JBL/Ranger Metregon. This unit (Figs. 12 and 13) uses the same radial-refraction principle as the larger Paragon, but is housed in a cabinet only 6 feet wide. Both low- and high-frequency speakers face into the refractor panel. Consequently, almost any set of JBL speakers can be used in each half of the system. The Metregon is not only more flexible, but less expensive than the larger Paragon.

Some persons have complained that stereo is being thrust upon us without sufficient technical experimentation. They point to the wide variety of stereo speaker designs as an indication that we have not yet found *the* best approach to the reproduction of two-channel program material.

In reality, the opposite viewpoint is probably more valid. Different companies offer different products because they realize that the audiophile is sufficiently critical to demand an installation which meets the standards of his own taste, his own home, his own pocketbook. END

The Stereo section is continued on Page 80.

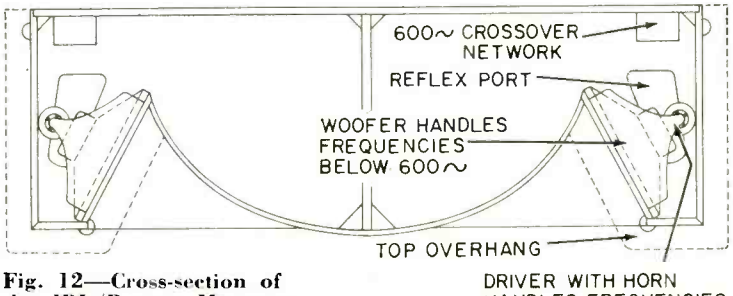


Fig. 12—Cross-section of the JBL/Ranger Metregon.

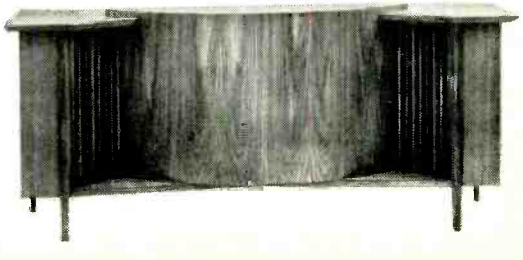
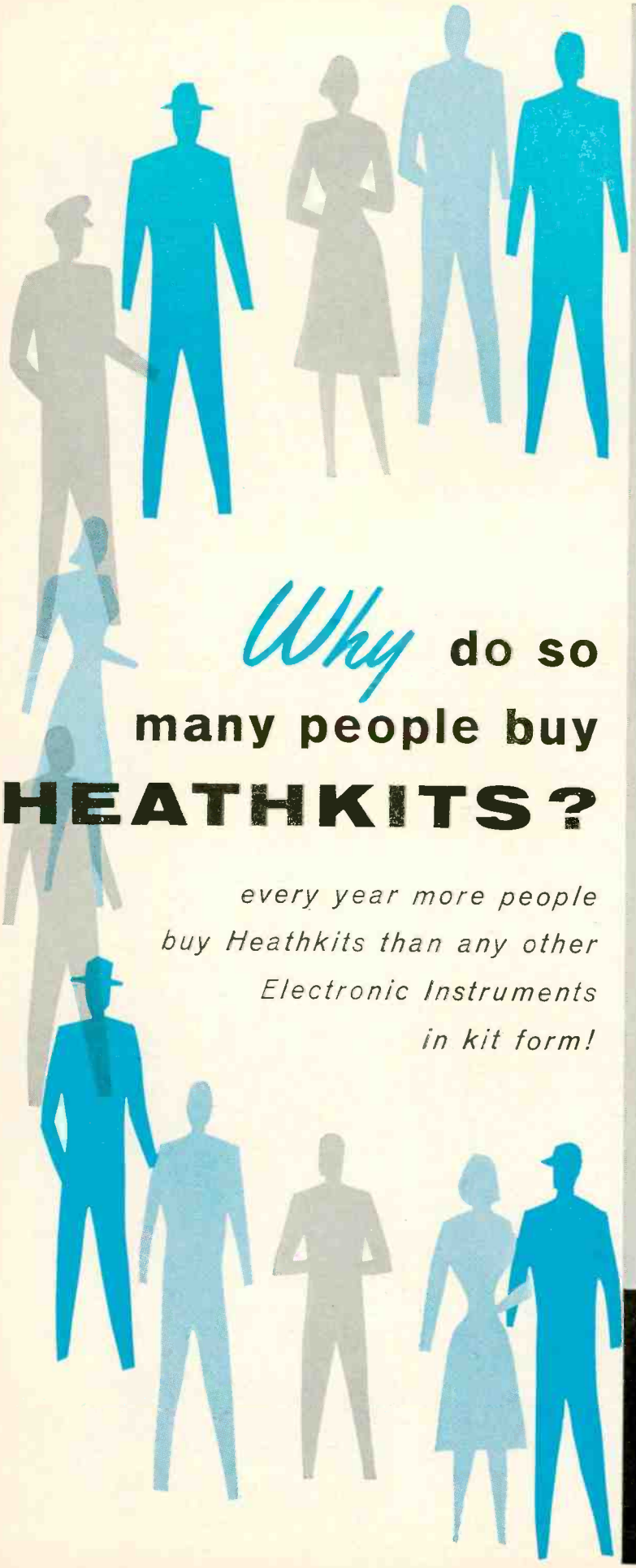


Fig. 13—The Metregon is another integrated stereophonic reproducer.



Why do so many people buy HEATHKITS?

every year more people buy Heathkits than any other Electronic Instruments in kit form!

Here are a few reasons why...

EASY TO BUILD

Heathkits are engineered for easy kit construction. You need no electronic or kit building experience whatsoever to successfully complete your own kit. Use of printed circuit boards and pre-wired, pre-aligned assemblies cut construction time. Manuals are carefully prepared, employing step-by-step instructions written in simple, non-technical language. Large pictorial diagrams and photographs show you exactly where each part goes.

LASTING QUALITY

Only top quality components go into Heathkits, assuring you of a finished product that is unsurpassed in performance, dependability and endurance. Rigid quality control standards are maintained at the Heath factory to see that each component lives up to its advertised specifications. Heathkits are conservatively rated. No performance claims are made that are not thoroughly proven and tested under the most stringent laboratory conditions.

ADVANCED ENGINEERING

Progress in electronics engineering never stands still at Heath. The latest developments in circuit design and components are exploited by Heath engineers, offering you superior performance at lower costs. New advances in all fields of electronics are carefully watched by Heath engineers to keep abreast of the rapidly growing industry. The modern, up-to-date styling of Heathkits make them a handsome addition to your home or workshop.

WORLD-WIDE REPUTATION

A pioneer in do-it-yourself electronics, Heath Company, over more than a decade, has established public confidence in its products both in the United States and abroad. Today, as the world's largest manufacturer of electronic kits, Heath stands as the leader in its field.

GREATER SAVINGS

Do-it-yourself Heathkits save you up to ½ the cost of equivalent ready-made equipment. Direct factory-to-you selling, eliminating middle-man profit, plus the tremendous Heath purchasing power mean even further savings to you. And the convenient Heath Time Payment Plan allows you to use and enjoy your Heathkit NOW, while you pay for it in easy installments.

HEATHKIT®

HEATH COMPANY
Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

TRANSISTOR PORTABLE RADIO KIT

HEATHKIT MODEL XR-1P **$29.95**

Fun for the whole family, this easy-to-build 6-transistor portable radio is ready to go wherever you go. The modern molded plastic case with pull-out carrying handle and fully enclosed back add beauty and convenience to this splendid kit. Six name-brand (Texas Instrument) transistors are used for good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides "big set" tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned making the radio ready for use as soon as kit is assembled. A built-in rod-type antenna assures good reception in all locations. Six standard flashlight batteries are used for power, providing extremely long battery life (between 500 and 1,000 hours) and they can be purchased anywhere. Stylish cabinet is two-tone blue molded plastic with gold inlay and measures 9" L. x 7" H. x 3¾" D. Shpg. Wt. 6 lbs.

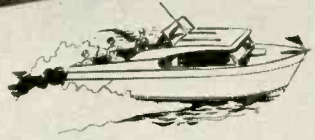
MODEL XR-1L: Identical to XR-1P except in handsome leather case instead of plastic case. Leather carrying strap included. Shpg. Wt. 7 lbs.

LEATHER CASE: Can be purchased separately if desired. Fits all XR-1P and earlier XR-1 chassis. No. 93-1. Shpg. Wt. 3 lbs. **$6.95.**

MODEL XR-1L **$34.95**

NAVIGATE BY PORTABLE RADIO

HEATHKIT MODEL DF-2 **$69.95**



2-BAND TRANSISTOR PORTABLE RADIO DIRECTION FINDER KIT

Enjoy the safety, convenience and entertainment of this self-contained, self-powered, six-transistor superheterodyne radio direction finder. It receives aeronautical and marine beacons as well as standard band broadcasts with startlingly clear tone reproduction over a long range. Covering the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc, the DF-2 is designed to take directional "fixes" on both aircraft and marine beacons as well as standard broadcast stations, while providing the entertainment of a high quality transistor portable radio. You are able to receive aircraft weather reports every thirty minutes and constant Coast Guard beacons on the 200 to 400 kc band. A dial light is provided for night operation. Power is supplied by six standard flashlight batteries which will last you up to one year under normal operation. Shpg. Wt. 9 lbs.

POWER CONVERTER KIT

MODEL PC-1 **$24.95**

Now you can operate your TV set, radio, razor, and other AC electrical equipment directly from your 12-volt boat or car battery. With the Heathkit Power Converter you can enjoy the convenience of home electricity whether boat cruising or on automobile trips. Two power transistors are employed for years of trouble-free, dependable service. No moving parts to wear out, no tubes to replace. Shpg. Wt. 8 lbs.

ELECTRONIC IGNITION ANALYZER KIT

MODEL IA-1 **$59.95**

Ideal for use on automobiles, boats, aircraft engines, etc., the IA-1 checks ignition systems with the engine in operation (400 to 5,000 RPM). Shows the condition of coil, condenser, points, plugs and ignition wiring. Shows complete engine cycle or just one cylinder at a time. Two test leads are supplied, each 10' long, which will enable you to reach either the breaker points or the spark plug wires. Shpg. Wt. 20 lbs.

ELECTRONIC TACHOMETER KIT

MODEL TI-1 **$25.95**

Useful on inboard and outboard boats, as well as in automobiles, the TI-1 operates directly from the spark impulse of the engine. Use on any spark ignited 2 or 4 cycle engine of any number of cylinders. Completely transistorized, it works with 6, 8, 12, 24 or 32 volt DC systems. Indicates revolutions-per-minute from 0 to 6,000. Calibration control provided for adjusting to engine type. Easy-to-build and easy-to-install. Shpg. Wt. 4 lbs.

PROFESSIONAL OSCILLOSCOPE KIT

Everything you could possibly want in an oscilloscope is found in the new Heathkit model OP-1. Featured are DC coupled amplifiers and also DC coupled CR tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the waveform may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustment. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Handsome cabinet features silver anodized front panel with red and black lettering and matching knobs. Shpg. Wt. 34 lbs.

HEATHKIT MODEL OP-1 **$179.95**

VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

Invaluable in experimental and design work, the PS-4 eliminates the need for building up a separate power supply for each new circuit tried. It provides a convenient source of variable regulated B+, variable bias voltage and filament voltage for labs and work shops. The PS-4 supplies regulated B+ output continuously variable from 0 to 400 volts DC at up to 100 ma, bias voltage variable from 0 to —100 volts DC at 1 ma, and filament voltage of 6.3 volts AC at 4 amps. Separate panel meters continuously monitors voltage and current output. Rugged, top-rated components used throughout for long, reliable service. Shpg. Wt. 16 lbs.

HEATHKIT MODEL PS-4 **$54.95**

Your best dollar value...

HEATHKIT®

HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

TEST OSCILLATOR KIT

Provides the test frequencies most often used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies (262 kc, 455 kc, 465 kc, 600 kc and 1400 kc) are quickly selected for troubleshooting or alignment of the IF frequency and high and low end of the broadcast band for proper tracking. Shpg. Wt. 4 lbs.

HEATHKIT MODEL TO-1 **$16.95**

HEATHKIT MODEL O-12 **$65.95**

"EXTRA DUTY" 5" OSCILLOSCOPE KIT

Laboratory quality at utility scope price makes this instrument an unusual value. The Heath patented sweep circuit functions from 10 CPS to better than 500 kc in five steps, giving you five times the usual sweep obtained in other scopes. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action are characteristic of this scope. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS-per-inch. Construction is simplified through the use of two etched metal circuit boards and precut, cabled wiring harness. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. An ideal scope for all service applications as well as in standard or color TV servicing. Shpg. Wt. 22 lbs.

MODEL SG-8 **$19.50**

RF SIGNAL GENERATOR KIT

A "must" for any beginning serviceman, this indispensable instrument is used for aligning tuned circuits quickly and tracing signals in faulty RF, IF and audio circuits. Covers 160 kc to 110 mc on fundamentals in five bands and from 110 mc to 220 mc on calibrated harmonics. Coils are prewound and calibrated. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

MODEL AG-9A **$34.50**

AUDIO SIGNAL GENERATOR KIT

This unique generator uses three rotary switches to select two significant figures and a multiplier to determine audio frequency, allowing return to the exact frequency previously measured when making multiple frequency measurements. Covers 10 CPS to 120 kc with less than .1 of 1% distortion between 20 and 20,000 CPS. Shpg. Wt. 10 lbs.

MODEL TS-4A **$49.50**

TV ALIGNMENT GENERATOR KIT

TV service technicians will appreciate the outstanding features found in this sweep generator. Provides essential facilities for aligning FM, monochrome TV or color TV sets. The all-electronic sweep circuit employs a trouble-free controllable inductor which varies frequency by magnetic means. An unusual buy at this low price. Shpg. Wt. 16 lbs.

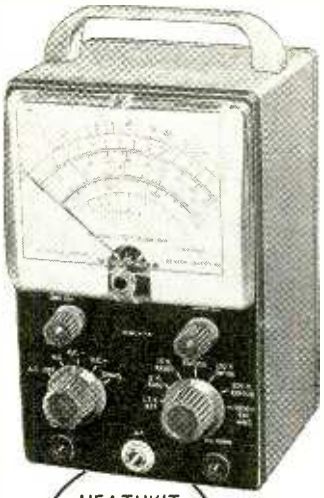
MODEL CD-1 **$59.95**

COLOR BAR AND DOT GENERATOR

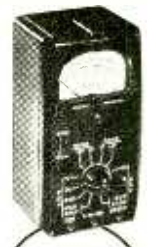
The CD-1 combines the two basic color servicing instruments, a color bar and white dot generator in one versatile and portable unit, which has crystal controlled accuracy and stability for steady lock-in patterns. (Requires no external sync leads.) Easy-to-build and easy-to-use. No other generator on the market offers so many features at such a great price saving. Shpg. Wt. 13 lbs.

ETCHED CIRCUIT VTVM KIT

Time proven for dependability, accuracy and overall quality, the V7-A is one of the wisest investments you can make for your electronic workshop or lab. Its multitude of uses will make it one of the most often used instruments in your possession. Use it to measure all operating voltages and potentials such as B+ and AC-DC, or straight AC power supplies, filament voltage, bias voltage, AVC voltage, line voltage, etc. Ideal for measurements in all types of AM, FM and TV circuits. Checks discriminator or detector operation, AVC or AGC performance, while the ohmmeter may be used to measure circuit continuity, circuit resistance, to test out individual components with resistance measurement, or to trace circuit wiring through cables or chassis openings. Front panel controls consist of rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit for high accuracy and an etched circuit board is employed for most of the circuitry. The circuit board not only simplifies assembly but permits levels of circuit stability not possible with ordinary conventional wiring methods. Shpg. Wt. 7 lbs.



HEATHKIT MODEL V7-A **$25.95**



HEATHKIT MODEL M-1 **$17.95**

HANDITESTER KIT

Ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop. The combination function range switch simplifies operation. Measures AC or DC voltage from 0 to 10, 30, 300, 1,000 and 5,000 volts. Direct current ranges are 0 to 10 ma and 0 to 100 ma. Ohmmeter ranges are 0 to 3,000 and 0 to 300,000. Top quality, precision components used throughout. Small and compact, take it with you wherever you go. Very popular with home experimenters and electricians. Test leads and 1½ volt size C battery are included with the kit. Shpg. Wt. 3 lbs.

HEATHKIT MODEL MM-1 **$29.95**

20,000 OHMS/VOLT VOM KIT

Portable and accurate, this kit features a 50 ua 4½" meter and 1% precision multiplier resistors for high accuracy. No external power required. Provides a total of 25 meter ranges on a two-color scale. Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1,500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000. Covers —10 db to +65 db. Housed in an attractive bakelite case with plastic carrying handle. Batteries and test leads included. Shpg. Wt. 6 lbs.

TUBE CHECKER KIT

Brand new in every respect, the TC-3 features outstanding performance and ease of operation. Sockets are provided for 4-pin, 5-pin, 6-pin, 7-pin, large, 7-pin miniature, 7-pin sub-miniature, octal, loctal, and 9-pin miniature tubes. Protection against obsolescence is provided by a blank socket to facilitate modification for checking newly added tube types. A 10-lever switch makes it possible to connect any element to any other element regardless of the pin numbers involved. A neon bulb indicator shows filament circuit continuity and leakage or shorts between elements. A specially designed spring loaded roll chart mechanism permits the roll chart to run freely throughout its entire length without binding. Thumb wheel drive knobs are provided on both sides of the panel to accommodate the left handed operator. Compact and small in size, the TC-3 is ideally suited for portable applications. Both the roll chart and the meter are illuminated to facilitate use in darkened areas. Shpg. Wt. 12 lbs.

HEATHKIT MODEL TC-3 **$39.95**

MODEL AV-3 **$29.95**

AUDIO VTVM KIT

This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of critical AC voltages. Features a large 4½" 200 ua meter with increased damping in the meter circuit for stability in low frequency tests. Measures AC from a low value of 1 millivolt to a maximum of 300 volts AC (RMS). Voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover —52 to +52 db. 1% precision multiplier resistors used for maximum accuracy. Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

MODEL BE-5 **$39.95**

LOW RIPPLE BATTERY ELIMINATOR KIT

Completely up to date the BE-5 will power all the newest transistor circuits requiring 0 to 12 volts DC, and the new hybrid automobile radios using both transistors and vacuum tubes. An extra low-ripple filter circuit is employed holding AC ripple down to less than .3%. Doubles as a battery charger or marine converter. Shpg. Wt. 21 lbs.

MODEL T-4 **$19.95**

VISUAL-AURAL SIGNAL TRACER KIT

New in every respect the T-4 features a built-in speaker and electron beam "eye" tube for signal indication, and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 5 lbs.

MODEL C-3 **$19.50**

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately as well as their operating characteristics with this fine instrument. All values are read directly on a calibrated scale. An electron beam "eye" tube indicates balance and leakage. A valuable addition to any service shop or lab. Shpg. Wt. 7 lbs.

MODEL CT-1 **$7.95**

IN-CIRCUIT CAPACI-TESTER KIT

This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mmf, not shunted by an excessive low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). Checks all bypass, blocking and coupling capacitors of the paper, mica or ceramic types. (Does not detect leakage nor check electrolytic condensers.) Electron beam "eye" tube is used for quick indication. A 5-position function switch is featured which controls the power to the instrument and selects the test being made. Easy to build and easy to use. Test leads included Shpg. Wt. 5 lbs.

"APACHE" HAM TRANSMITTER KIT

HEATHKIT MODEL TX-1
$234.95

- Built-in cooling fan
- Rotating Slide Rule Dial
- Compact, Stable, VFO
- Provision for SSB Adapter

This beautifully styled transmitter has just about everything you could ask for in transmitting facilities. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. A completely redesigned, compact and stable VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with full gear drive vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters (11 m with crystal control). This unit also has adjustable low-level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. A formed one-piece cabinet with convenient access hatch provides accessibility to tubes and crystal socket. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. A "spotting" push button is provided to allow tuning of the transmitter before switching on the final amplifier. This feature also enables the operator to "zero-beat" an incoming frequency without placing the transmitter on the air. Equip your ham shack now for top transmitting enjoyment with this outstanding unit. Shpg. Wt. 110 lbs.

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

New Styling...
New Features

HEATHKIT®

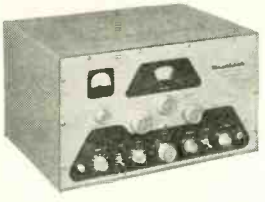
HEATH COMPANY
Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT MODEL SB-10
$89.95

SINGLE SIDEBAND ADAPTER KIT

Designed as a compatible plug-in adapter for the model TX-1 it can also be used with transmitters similar to the DX-100 or DX-100-B by making a few simple circuit modifications and still retain the normal AM and CW functions. Easy to operate and tune, the adapter employs the phasing method for generating a single sideband signal, allowing operation entirely on fundamental frequencies. The critical audio phase shift network is supplied, completely preassembled and wired in a sealed plug-in unit. Features include single-knob bandswitching for operation on 80, 40, 20, 15 and 10 meters, an easy-to-read panel meter, built-in electronic voice control with anti-trip circuit. Enjoy the advantages of SSB operation by adding this fine kit to your ham shack now. Shpg. Wt. 14 lbs.



MODEL DX-100-B
$189.50

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

DX-100-B PHONE & CW TRANSMITTER KIT

The same fine performance of the time proven DX-100 is retained in the DX-100-B with improvements in the crystal and loading circuits. The one-piece formed cabinet has convenient access hatch for changing crystals, etc. and the chassis is punched to accept sideband adapter modifications. Features a built-in VFO, modulator and power supply, complete shielding to minimize TVI, and a pi network output coupling to match impedances from 50 to 72 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW. Covers 160 through 10 meters. Single-knob bandswitching and illuminated VFO dial and meter face. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. Designed for easy assembly. Measures 11⅝" H. x 19½" W. x 16" D. Shpg. Wt. 107 lbs.

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

Operates on 80, 40, 20, 15, 11 and 10 meters, using a single 6146 tube in the final for 75 watt plate power input CW, or 60 watts phone. Single-knob bandswitching, pi network output, complete shielding, provision for three crystals and VFO. D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.

MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

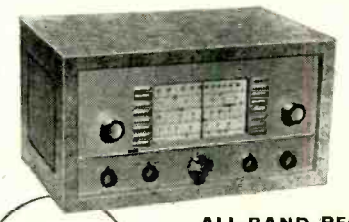
This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6DQ6A tube in the final for 50 watt plate power input, pi network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

"MOHAWK" HAM RECEIVER KIT

Designed for ham band operation and for maximum stability and accuracy, the Heathkit "Mohawk" receiver will let you enjoy ham activities to the utmost. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all the amateur frequencies from 160 through 10 meters on seven bands. An extra band is calibrated to cover 6 and 2 meters using a converter. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely pre-assembled, wired and aligned front end coil /bandswitch assembly assures ease of construction and top performance. Many more important features are provided in this outstanding receiver for dependable and effective amateur communications. Ruggedly constructed with well rated components throughout. Shpg. Wt. 66 lbs. Matching accessory speaker kit; optional extra. Model AK-5. $9.95. Shpg. Wt. 8 lbs.

- **Prewired and Aligned Coil/Bandswitch Assembly**
- **Crystal Controlled Oscillators for Drift-Free Reception**

HEATHKIT MODEL RX-1 **$274.95**

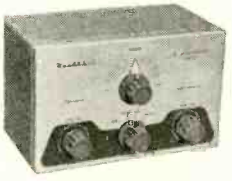


HEATHKIT MODEL AR-3 **$29.95**

(LESS CABINET)

ALL-BAND RECEIVER KIT

A fine receiver for the beginning ham or short wave listener. Frequency coverage is from 550 kc to 30 mc in four bands. Features include bandswitch, bandspread tuning, phone-standby-CW switch, antenna trimmer, noise limiter, RF and AF gain controls and headphone jack. Easy to build. Shpg. Wt. 12 lbs.



MODEL QF-1 **$9.95**

"Q" MULTIPLIER KIT

Use with any receiver with IF frequency between 450 and 460 kc to add additional selectivity for separating two signals or to reject one signal and eliminate heterodyne. A great help on crowded phone and CW bands. Not for use with AC-DC type receivers. Simple to connect with cable and plugs supplied. Shpg. Wt. 3 lbs.

"SENECA" VHF TRANSMITTER KIT

Brand new in every respect, the model VHF-1 "Seneca" is the latest addition to our line of ham transmitters. This self-contained 6 and 2 meter transmitter features built-in VFO, modulator, and dual power supply. A pair of 6146 tubes are employed in the push-pull final amplifier stage and features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Slightly less in the 2 meter band to prolong amplifier tube life. Panel controls allow VFO or crystal control, phone or CW operation on both amateur bands. Four switch-selected crystal positions. Complete RF shielding to minimize TVI. Spotting push-button provided. The VFO slide rule type dial features edge-lighting and vernier tuning. An ideal transmitter for the ham who wants to extend operation into the VHF region. Shpg. Wt. 56 lbs.

HEATHKIT MODEL VHF-1 **$159.95**

MODEL CA-1 **$13.95**

"AUTOMATIC" CONELRAD ALARM KIT

This easy-to-build device gives instant warning and cuts AC power to your transmitter when a monitored station goes "off-the-air". Use with any radio receiver having an AVC circuit. A sensitivity control adjusts to various AVC levels. Incorporates a heavy duty six-ampere relay and manual "reset" button to reactivate the transmitter. Complete instructions provided for connection to receiver. Shpg. Wt. 4 lbs.

MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

Check the match of your antenna transmission system by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1. Handles a peak power of well over 1 kilowatt and may be left in antenna feed line. No external power required. 160 through 6 meters. For 50 or 75 ohm lines. Shpg. Wt. 3 lbs.

MODEL B-1 **$8.95**

BALUN COIL KIT

Unbalanced coax lines can be matched to balance lines of either 75 or 300 ohms by using this balun coil kit. Use without adjustment from 80 through 10 meters at power up to 200 watts. May be located any distance from transmitter or antenna. Protective cover included. Shpg. Wt. 4 lbs.

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

This unique device lets you switch from receiver to transmitter merely by talking into your microphone. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 5 lbs.

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

Far below the cost of crystals to obtain the same frequency coverage this VFO covers 160, 80, 40, 20, 15, 11 and 10 meters with three basic oscillator frequencies. Better than 10 volts RF output on fundamentals. Requires only 250 volts DC at 15 to 20 ma, and 6.3 VAC at 0.45 a. Illuminated dial reads direct. Shpg. Wt. 7 lbs.

Beautifully Styled With Plenty of Room For The Most Complete Stereo System

MODEL SE-1 (center unit) **$149.95** Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39.95** each Shpg. Wt. 42 lbs.

STEREO EQUIPMENT CABINET KIT

This superbly styled cabinet ensemble is designed to hold your complete home stereo hi-fi system, consisting of a "stereo equipment center" flanked by two individual "stereo wing speaker enclosures". The unit has room for all the components required for stereo sound. Although designed to hold Heathkit stereo components, it is not frozen to this arrangement. The kit is supplied with mounting panels precut to accommodate Heathkits, but interchangeable blank panels are also furnished so you can mount any equipment you may already have. The precut panels accommodate the Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2), and record changer (RP-3). Record changer chassis pulls out easily for convenient loading and unloading. Adequate space is provided for record storage and a pair of matching Heathkit power amplifiers (from 12 to 70 watts). The stereo wing speaker enclosures are open backed, cloth grilled cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. The matched grain sliding tape deck access door on top pops-up flush when closed. Entire top features a shaped edge. Hardware and trim of brushed-brass and gold finish. Rich toned grille cloth is flecked in gold and black. No woodworking experience required. All parts precut and predrilled for easy assembly. Maximum overall dimensions (all 3 pieces): 82¾" W. x 36½" H. x 20" D. Center Cabinet: 47½" W. x 36½" H. x 20" D.

HEATHKIT MODEL CE-1 **$43.95** each

CHAIRSIDE ENCLOSURE KIT

Combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit in the space provided. Changer compartment measures 17¾" L. x 16" W. x 9⅜" D. Adequate space is provided in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. Good ventilation is achieved through properly placed slots in the bottom and back of the enclosure. Overall dimensions are 18" W. x 24"H x 35½" D. All parts are precut and predrilled for easy assembly. The Contemporary cabinet is available in either mahogany or birch, and the Traditional cabinet is available in mahogany suitable for the finish of your choice. Beautiful hardware supplied. Shpg. Wt. 46 lbs.

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HEATHKIT MODEL RP-3 **$64.95**

HIGH FIDELITY RECORD CHANGER KIT

Every outstanding feature you could ask for in a record changer is provided in the Heathkit RP-3, the most advanced changer on the market today. The unique turntable pause during the change cycle saves wear and tear on your records by eliminating the grinding action caused by records dropping on a moving turntable or disk. Record groove and stylus wear are practically eliminated through proper weight distribution and low pivot point friction of the tone arm. Clean mechanical simplicity and precision parts give you turntable performance with the automatic convenience of a record changer. Flutter and wow, a major problem with automatic changers, is held to less than 0.18% RMS. An automatic speed selector position allows intermixing 33⅓ and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33⅓, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

Assemble it in Just One Evening

The popularity of this modestly priced speaker system attests to its high fidelity performance. The SS-2 provides an ideal basic speaker for your home hi-fi system. Flexibility of design allows it to be used as a table top model or as an attractive consolette with optional legs. May also be used as a supplementary speaker in more advanced systems or as replacement speaker for TV sets, etc. The specially designed tweeter horn rotates 90 degrees allowing you to use the speaker in an upright position if desired, as in the Heathkit stereo wing speaker enclosures. Total frequency range is from 50 to 12,000 cycles-per-second. An 8" mid-range woofer covers from 50 to 1,600 CPS while a compression-type tweeter with flared horn covers 1,600 to 12,000 CPS. Both speakers are by Jensen. A variable balance control allows level adjustment of the high frequency speaker. Power rating is 25 watts. Constructed of ½" veneer-surfaced plywood suitable for light or dark finish. All wood parts are precut and predrilled for simple, quick assembly. An added feature of the SS-2 is that, although an outstanding performer in its own right, it may be combined with the SS-1B "range extending" speaker system later to extend the frequency range at the high and low ends of the audio range. Build in just one evening for many years of listening enjoyment. Shpg. Wt. 26 lbs.

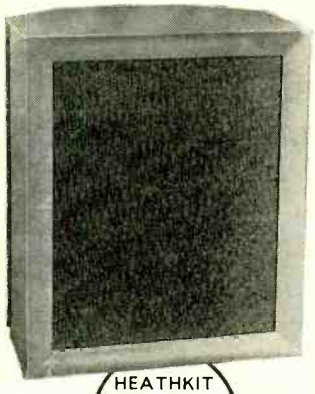
ATTRACTIVE BRASS TIP ACCESSORY LEGS convert SS-2 into handsome consolette. 14" legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26. **$4.95.**

OPTIONAL LEGS
NO. 91-26 **$4.95**

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**

Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.



Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Designed exclusively for use with the SS-2, the SS-1B employs a 15" woofer and a super tweeter horn to extend the range of the SS-2 to an overall response of ±5 db from 35 to 16,000 CPS. When used together the two units form an integrated four-speaker system and are designed to combine into a single piece of attractive furniture. Impedance of the SS-1B is 16 ohms and power rating 35 watts. A control is provided to limit the output of the super tweeter. Constructed of beautiful ¾" veneer-surfaced plywood suitable for light or dark finish of your choice. All parts are precut and predrilled for simple assembly. No woodworking experience required. All hardware included. Shpg. Wt. 80 lbs.

"LEGATO" HI-FI SPEAKER SYSTEM KIT

It is difficult to describe in words the performance of this magnificent speaker system. You may never find absolute perfection in reproduced sound, but the Legato comes as close to achieving it as anything yet devised. Perfect balance, precise phasing, and adequate driver design combine to produce the superb quality of reproduction inherent in this instrument. The crisp, clear high frequencies and rich full bass engulf you in a sea of life-like tone. Two 15" Altec Lansing low frequency drivers cover frequencies from 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. The unique crossover network is built-in making electronic crossovers unnecessary. The legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for light or dark finishes of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

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Easy to use...

HEATHKIT

HEATH COMPANY
Benton Harbor 20, Michigan

High Fidelity AM and FM reception in a Single Set

HEATHKIT MODEL PT-1 **$89.95**

Professional Stereo-Monaural AM-FM Tuner Kit

Enjoy stereophonic broadcasts as well as outstanding individual AM and FM radio reception with this deluxe 16-tube AM-FM-stereophonic tuner combination. Features include three etched circuit boards for high stability and ease of construction, prewired and prealigned FM front end, built-in AM rod antenna, tuning meter, FM-AFC (automatic frequency control) with on-off switch, and flywheel tuning. A multiplex jack is also provided. AM and FM circuits are tuned individually making it ideal for stereo applications since both AM and FM can be used at the same time. A switch selected tuning meter functions on either AM or FM. Cathode follower outputs with individual level controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. Anywhere from 1 to 4 limiters or IF's assure smooth, non-flutter reception on weak or strong stations alike. The silicon diode power supply is conservatively rated and is fuse-protected assuring long service life. Flywheel tuning combined with new edge-lighted slide-rule dial provide effortless tuning. Use of three printed circuit boards greatly simplifies construction. Vinyl-clad steel cover is black with inlaid gold design. Shpg. Wt. 20 lbs.

MODEL FM-3A **$26.95**

HIGH FIDELITY FM TUNER KIT

The Heathkit FM-3A Tuner will provide you with years of inexpensive hi-fi enjoyment. Features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures neglible drift after initial warmup. Employs a high gain cascode IF amplifier and has AGC. Power supply is built-in. IF and ratio transformers are prealigned as is the front end tuning unit. Two outputs provided, one fixed, one variable, with extra stage of amplification. Shpg. Wt. 8 lbs.

MODEL BC-1A **$26.95**

HIGH FIDELITY AM TUNER KIT

The BC-1A incorporates many features not usually expected in an AM circuit particularly in this low price range. It features a special detector using crystal diodes and broad band-width IF circuits for low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Covers the complete broadcast band from 550 to 1600 kc. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs and built-in power supply. Shpg. Wt. 9 lbs.

MODEL W-6 **$109.95**

"HEAVY DUTY" 70 WATT HI FI AMPLIFIER KIT

Designed for "rugged duty" called for by advanced hi-fi systems and P.A. networks. Silicon diode rectifiers assure long life and heavy duty transformer provides excellent power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohm or 70 volt output and the correct feedback resistance. Shpg. Wt. 52 lbs.

MODEL W-5 **$59.75**

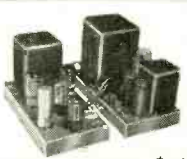
25 WATT HI FI AMPLIFIER KIT

Enjoy the distortion-free high fidelity sound from one of the most outstanding hi-fi amplifiers available today. Features include a specially designed Peerless output transformer and KT66 tubes. Frequency response is ±1 db from 5 to 160,000 CPS at 1 watt and within 2 db 20 to 20,000 CPS at full 25 watts output. Hum and noise are 99 db below 25 watts. Shpg. Wt. 31 lbs.

MODEL W-4AM **$39.75**

SINGLE CHASSIS 20 WATT HI FI AMPLIFIER KIT

A true Williamson-type high fidelity circuit, the W-4AM features 5881 push-pull output tubes and a special Chicago-Standard output transformer to guarantee you full fidelity at minimum cost. Harmonic distortion is 1.5% and IM distortion is below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps for 4, 8 or 16 ohm speakers. Shpg. Wt. 28 lbs.



MODEL W-3AM **$49.75**

DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT

Another famous Williamson-type high fidelity circuit, the W-3AM features the famous Acrosound TO-300 "ultralinear" output transformer and 5881 tubes. The power supply and main amplifier are on separate chassis for installation flexibility. Harmonic distortion is less than 1% and IM distortion is less than 1.2% at 20 watts. Shpg. Wt. 29 lbs.

HEATHKIT MODEL SP-2 (STEREO) **$56.95**

MODEL SP-1 (MONAURAL) **$37.95** Shpg. Wt. 13 lbs.

MODEL C-SP-1 (CONVERTS SP-1 TO SP-2) **$21.95** Shpg. Wt. 5 lbs.

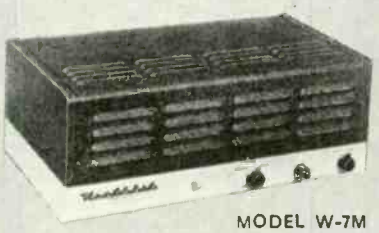
Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

This unique kit allows you to purchase it in the monaural model if desired and then add the second or stereo channel later. The SP-2 features 12 separate inputs, six on each channel, with input level controls. Six dual concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch. A separate on-off switch is provided. The function switch provides settings for stereo, 2-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. NARTB equalization and RIAA, LP, 78 record compensation are provided. A remote balance control is included. Printed circuit boards for easy assembly. Built-in power supply. Shpg. Wt. 15 lbs.

HEATHKIT MODEL WA-P2 **$19.75**

"MASTER CONTROL" PREAMPLIFIER KIT

Control your hi-fi system with this compact unit. Features 5 switch-selected inputs to accommodate a record changer, tape recorder, AM tuner, FM tuner, TV receiver, microphone, etc., each with level control. Provision also for a tape recorder output. Equalization for records through separate turnover and rolloff switches for LP, RIAA, AES and early 78's. Shpg. Wt. 7 lbs.



MODEL W-7M **$54.95**

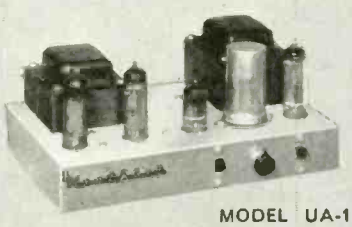
"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

Enjoy this high fidelity power amplifier at less than a dollar per watt. Full audio output and maximum damping is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Features famous "bas-bal" circuit, EL-34 output tubes and special 70 volt output. Shpg. Wt. 28 lbs.

MODEL XO-1 **$18.95**

ELECTRONIC CROSSOVER KIT

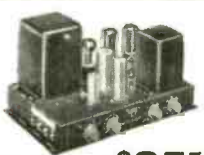
This unique instrument separates high and low frequencies and feeds them through 2 amplifiers into separate speakers. Located ahead of the main amplifier, it virtually eliminates IM distortion and matching problems. Note: Not for use with Heathkit Legato speaker system. Shpg. Wt. 6 lbs.



MODEL UA-1 **$21.95**

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

The versatility and economy of this fine kit make it a truly "universal" hi-fi amplifier. An ideal basic amplifier for any hi-fi system or a perfect addition to gear your present hi-fi system to stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range. Shpg. Wt. 13 lbs.



MODEL A-9C **$35.50**

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

Designed for home installation as well as for PA requirements, the A9-C combines a preamplifier, main amplifier and power supply all on one chassis. Four switch-selected inputs are provided as well as separate bass and treble tone controls offering 15 db boost and cut. Detachable front plate allows for custom installation. Shpg. Wt. 23 lbs.

MODEL SW-1 **$24.95**

SPEEDWINDER KIT

A real timesaver, the SW-1 leaves your tape recorder free for operation while rewinding tape at the rate of 1200 feet in 40 seconds. Prevents unnecessary wear to the tape and recorder. Handles up to 10½" tape reels. Handles 800' reels of 8 and 16 millimeter film as well. Automatic shutoff prevents whipping at end of rewind. Shpg. Wt. 12 lbs.

NO. 401-6 **$7.50**

12" UTILITY SPEAKER KIT

Replace inferior speakers in radio or TV sets to obtain better tone quality or set up an auxiliary speaker for testing purposes with this convenient, high quality speaker. The speaker will handle up to 12 watts with a frequency response of ±5 db from 50 to 9,000 CPS. Speaker impedance is 8 ohms and has a 6.8 oz. magnet. An outstanding dollar value. Shpg. Wt. 7 lbs.

MODEL TK-1 **$9.95**

COMPLETE TOOL SET

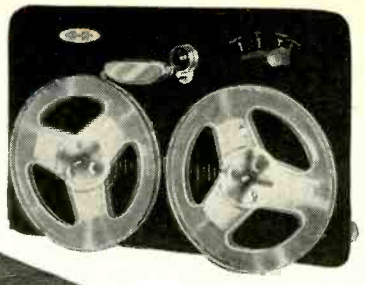
These basic tools are all you need to build any Heathkit. The pliers, diagonal side cutters, 2 screwdrivers, and soldering iron are all of top quality case hardened steel for hard duty and long life. Pliers and side cutters are equipped with insulated rubber handles for safety. A good example of just how easy Heathkit building really is. Shpg. Wt. 3 lbs.

HIGH FIDELITY TAPE RECORDER KIT

The model TR-1A tape deck and preamplifier combination provides all the facilities you need for top quality monaural recording/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. Both units may be mounted together or separately affording high flexibility in every application. Features include NARTB playback equalization —separate recording and playback gain controls —cathode follower output and provision for mike or line input. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. A filament balance control allows adjustment for minimum hum level. Complete instructions provided for easy assembly. Overall dimensions of tape deck and preamp is 15½" W. x 13½" H. x 8" D. Shpg. Wt. 24 lbs.

HEATHKIT TR-1A **$99.95**

Includes tape deck assembly, preamplifier and roll of tape.



HEATHKIT TE-1 **$39.95**

Tape preamplifier sold separately if desired. Shpg. Wt. 10 lbs.

Many more Heathkits to choose from

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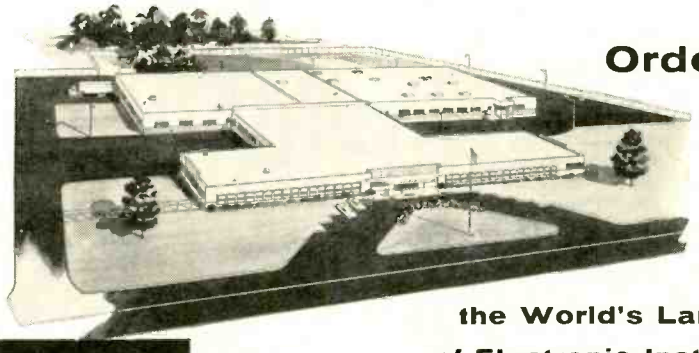
"BOOKSHELF" 12 WATT AMPLIFIER KIT

Here are a few of the reasons why this attractive amplifier is such a tremendous dollar value. You get rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern styling". The many features include full range frequency response 20 to 20,000 CPS ±1 db with less than 2% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs: mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control—and it's easy-to-build. Complete instructions and pictorial diagrams show where ever part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Cabinet measures 12½" W. x 8 3/16" D. x 4⅜" H. Output transformer has taps at 4, 8 and 16 ohms to match the speaker of your choice. An ideal unit to convert your present hi-fi system to stereo sound. Shpg. Wt. 15 lbs.

An Amplifier, Preamplifier all in one!

HEATHKIT EA-2

$28.95



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STEREO Glossary

By ERIC LESLIE

THIS glossary is intended to be a compilation of stereo terms. As such, it does not list terms that are not peculiar to stereo, but are used generally in audio or electronics. For example, *main carrier* is listed, but not *carrier*. Where terms like *channel* have a special stereo meaning as well as a general one, the stereo definition is given. For a complete audio glossary, see "High-Fidelity Dictionary," by Bukstein, RADIO-ELECTRONICS, February to July, 1955.

45/45. System of disc recording in which the signals originating at the two microphones of a stereo setup are impressed on the sides of a groove that is so cut that the two sides are at an angle of 90° from each other, and both are 45° from the surface of the record.

A, B. Terms used to refer to one or the other of the two stereo channels, to the microphones, speakers or other equipment associated with those channels or signals. The A channel is usually the left; the B channel the right one.

A + B, A — B. The sum and difference signals of the two channels. The A + B signal combines the signals of both channels (microphones) in phase: the A — B signal combines them out of phase. By combining in suitable circuitry, it is possible to add A + B and A — B, obtaining 2A, the signal from one microphone, and to subtract A — B from A + B, obtaining 2B, the signal from the other microphone or channel. (See **sum.**)

adapter, stereo. A device which, used with two sets of monophonic equipment, makes them act together as a single stereo system. (Also called stereo control unit.) May include a ganged or concentric volume control, balance control, and switching equipment to permit channel reversal, single-speaker phase reversal and operation as a monophonic as well as a stereophonic system.

amplifier, two-way. An amplifier in which both right and left channels are amplified simultaneously with the same tubes. This is accomplished by using push-pull circuitry, but feeding one signal to the input grids in parallel instead of push-pull. Two output transformers are used in a "matrixing" circuit to separate the parallel and push-pull signals.

ASRA (Automatic Stereophonic Recording Amplifier). An instrument developed by Columbia Broadcasting System for stereo recording. It features controlled compression of the vertical component of the stereo recording signal, with automatic means for decreasing or increasing the amount of compression as may be required by the recording conditions.

balance. The maintenance of equal average volume from both speaker systems of a stereo installation.

balance control. A control for preserving the balance between the two channels of a stereo installation, usually a potentiometer so connected as to increase the volume on one channel while decreasing the volume of the other.

binaural. The word originally used for a two-channel sound system. Superseded by *stereo*, it is now most often used to describe a stereo system using headphones.

carrier, main. The high-frequency alternating current, or electromagnetic wave in space, that, in FM multiplexing and other systems, carries part of the stereo information directly and the other part on a *subcarrier*. In some systems the main carrier carries one stereo channel, the subcarrier the other. In others (Crosby), the main carrier carries the sum of the two channels, the subcarrier the difference. Still other ways of dividing the signal between main and subcarrier have been proposed.

cartridge, phonograph pickup. The unit which translates mechanical motion of its stylus in the record groove to an electrical signal. In stereo, it has two electrical outputs so arranged that the direction of stylus motion that produces maximum output from one is 90° from that producing maximum output from the other.

cartridge, tape. A device which makes it possible to play tapes without threading the machine manually for each play. It is a flat container with two tape reels and means for stopping the player when the tape is completely unwound from one reel onto the other. (Now more commonly called "tape magazine.")

channel. One of the two signals which compose ordinary stereo reproduction. The sound picked up by one of two (left or right—A or B) microphones, amplified and made again into sound through its own (left or right) speaker system. Also, the equipment or circuitry associated with one of the two signals, as "right-channel amplifier."

channel reversal. Shifting the outputs of a stereo system so the channel formerly heard from the left speaker now comes from the right, and vice versa. (Called reverse stereo on some control units.)

compatibility. Any agreement between two systems, so that equipment designed for one can be used for the other. In stereo, often refers to multiplex broadcasting that can be received equally well as straight FM broadcasts on monophonic equipment or as stereo programs on equipment designed for stereo reception, or to the playability of either monophonic or stereophonic records with a 45/45 pickup.

compliance (of the stylus and armature of a pickup). The reciprocal of stiffness—the ease with which the stylus responds to an outside force, such as the variations in the conformation of the record groove. Absence of mechanical opposition, friction or inertia. (In a stereo pickup, vertical compliance is as important as lateral; in monophonic pickups, vertical compliance is often made small to reduce rumble.)

concentric controls. In stereo, controls with which the volume or tone of one channel is regulated by a large knob and that of the other with a smaller knob mounted on it and operating through a shaft concentric with (inside of) the other. It is usually possible to lock the two shafts so that, once adjusted, they can be operated as a single unit.

controls.

balance. The control that maintains both channels at the same volume, or favors one at the expense of the other. (See **balance control.**)

concentric. (See **concentric controls.**)

master volume. A volume control that changes the level of both channels together.

Cook system. An early stereo disc recording technique in which the two channels were recorded simultaneously with two cutters on different portions (bands) of a record as concentric spirals. The playback equipment consisted of two pickups mounted side by side so that each played at the correct spot on its own band.

Crosby system. Proposed compatible multiplex FM stereo broadcast technique in which the right and left signals are combined in phase (sum signal) and transmitted on the main carrier, and combined out-of-phase (difference signal) and transmitted on the subcarrier. The two signals are so combined (matrixed) in the receiving apparatus as to restore the right and left channels.

crosstalk. That portion of the signal which, properly belonging to one channel, is heard on the other in reproduction. Usually expressed in decibels under the proper channel level. More common in stereo records, it is heard occasionally on stereo tapes.

difference (signal, channel). Combination of right and left channels out of phase (so they subtract from each other, leaving an arithmetical difference). Used in multiplexing, in two-way amplifiers, in the Minter recording system, etc. The *sum* and difference signals can be combined in reproduction equipment to result in right and left channels. (See **sum.**)

dual element. The two-element transducing unit in the pickup which produces the two stereo channel signals.

function switch. In adapters or control units, the switch which determines whether the system plays as a monophonic or stereophonic unit; may parallel the speakers; cut out one or the other, switch amplifiers from one speaker to the other, reverse channels; etc.

groove. The furrow engraved on the record surface by the cutter. In stereo discs, its cross-section is that of a right-angled triangle, with each side at a 45° angle to the surface of the record. The stereo information is cut on both sides of this groove.

head (magnetic recording or playback). A magnetic tape head in two parts, for recording both channels of a stereo program simultaneously on a single tape or for playing back previously recorded signals. In present recording, *stacked* heads (one directly above the other) are used. Earlier techniques used *staggered* heads, separated on the machine, so that right and left portions recorded simultaneously were not oppo-

site each other on the tape.

hole in the middle. Term applied to an exaggerated stereo effect in which all the sound appears to come from two areas near the speakers and little or none comes from a point midway between them. Also, the central point from which little or no sound is heard. (Hole-in-the-middle may result from poor placement, adjustment or phasing of reproduction equipment, or from recordings in which the stereo effect has been exaggerated, intentionally or otherwise.)

isolation (channel). Degree by which one channel may be made independent from the other; the amount by which crosstalk between channels is reduced. (See **crosstalk.**)

lateral. Refers to sidewise motion of the cutter or pickup stylus, or to the groove or signal produced by such motion. Stereo recordings (either 45/45 or lateral–vertical system combine lateral and vertical motion of cutter or playback stylus; present-day monophonic recordings are purely lateral, with no vertical component.

lateral–vertical recording. A technique of making stereo phonograph records in which one signal is recorded laterally, in the manner of monophonic records, and the other vertically, as in hill-and-dale transcriptions or the old Edison records. The two signals are at right angles to each other, as in 45/45 recordings, but with the difference that one is cut at right angles to the surface of the record, the other parallel to it.

magazine, tape. A container holding a reel of tape, for playing without manual machine threading, a tape cartridge. (See **cartridge, tape.**)

master control. Usually applied to the control that varies volume on both stereo channels simultaneously.

matrix. Circuitry designed to combine two or more signals to produce signals differing in number or kind or both from those that enter it. In stereo, usually applied to a network designed to convert the sum and difference signals of the two channels to straight channel signals. The matrix adds the signals (A + B) and (A — B) in the one case and subtracts them in the other, resulting in 2A and 2B.

Minter system. A proposed stereo recording technique in which the two program channels are combined additively and recorded with a monophonic cutter. A 25-kc note is also recorded, and this note is frequency-modulated by the two channels combined subtractively. The sum and difference signals are matrixed to produce the right and left channels.

monaural. See **monophonic.** (Monaural is the older term, still used occasionally.)

monophonic. Pertaining to a single sound source, or reproduction simulating that from a single sound source (such as when the output of several microphones is mixed at the input of an amplifier, or the output from both channels of a stereo amplifier is fed to a single speaker).

MS system. (German *Mitte-Seite*, or middle-side system). A technique of stereo pickup in which two directional microphones are placed close together and at right angles to each other so oriented that one picks up sound from directly ahead with maximum intensity, the other one from the two sides.

multiplex stereo. A system of broadcasting both channels of a stereo program on a single carrier, commonly done by modulating an ultrasonic *subcarrier*, either with the signals of one of the stereo channels, or by a *difference signal*, composed of the two channels combined out of phase, or subtractively. Other types of signal combination are used in some proposed systems.

phase. The position or condition with reference to each other of any two things undergoing periodical or cyclic variations. Two similar alternating currents are in phase when their positive and negative peaks occur at the same time; 180° out of phase when the positive peak of one coincides with the negative peak of the other. Two speakers are in phase when a signal applied simultaneously to them causes their cones or diaphragms to move forward or backward together; out of phase if it causes one to move forward and the other back.

phasing. Causing two systems or circuits to

STEREO

operate in phase, or at some desired difference from the in-phase condition (as for example 180° out of phase, for matrixing, etc.).

phase splitter. As used in adapters and stereo multiplex systems, a circuit with two outputs, one of which puts out a signal in phase with the input, the other out of phase with it. In multiplex systems it is used for changing the phase of a channel for additive or subtractive combination with the other; in control units, to correct for anything that may have put one of the channels out of its proper phase.

pseudo-stereo. Modification of a monophonic sound source to produce an effect resembling stereo. The crudest method is to separate the program frequency-wise into two "channels," one mostly highs and one mostly lows, and feeding one of these channels to the right, the other to the left speaker. More sophisticated methods include delaying the signal so that sounds are heard from the "second channel" a fraction of a second later than those of the main signal. Up to the present, no system of pseudo-stereo has gained wide popularity.

ping-pong effect. Exaggerated stereo—reproduction in which all or the bulk of the sound appears to be coming from one or the other of the speakers, with little or nothing between. (So called from early demonstration tapes and discs which featured sounds of a table-tennis game, with the two players very close to their respective microphones.) May be due to improper placement or adjustment of receiving equipment—more often to faulty recording techniques.

quasi-stereo. Called also **near-** or **semi-stereo** (or by manufacturers of such systems, simply "**stereo**"). Systems in which, instead of having a full speaker system for each channel, one channel may have only middle- and high-frequency speakers, or systems in which the lows may come from a centrally placed woofer, fed with lows from both channels, with the right and left speakers handling only the middles and highs for their respective channels.

recording, stereo. The process of impressing signals from two channels on a tape or disc in such a way that the channels are heard separately on playback, giving a directional, three-dimensional, effect. See **lateral-vertical and 45/45 recording.**

separation (channel). The degree to which material intended for the right speaker is kept out of the left one, and vice versa. Isolation.

spacing (microphone or speaker). The distance between microphones or speakers in stereo recording or reproduction. Microphone spacing may vary from a few inches (as in the MS system or in so-called "binaural" recording where microphones are strapped to the sides of a dummy head) to many feet. Speaker spacing is limited by the listening room, but preference seems to favor a spacing roughly half as great as the distance between them and the listener.

stereo(phony). Method of recording (or transmitting) and reproducing sound so as to give a sense of directionality, so that the listener can distinguish, for example, between performers at the left, center and right of an orchestra. This is accomplished by picking up the sound with at least two microphones, recording or transmitting each of these signals or *channels* separately, and reproducing through two or more speakers spaced somewhat similarly to the microphones.

Stereosonic system. A recording technique in which two closely spaced directional microphones are used, with their maximum directions of reception at an angle of 45° from each other. Thus, one picks up sound largely from the right, the other from the left.

subcarrier. A frequency impressed on a carrier by the same means as is used to impress the other program material carried, but which itself is modulated by other intelligence. By using a subcarrier, a single transmitter may broadcast two programs or both channels of a stereo program.

sum (signal, channel). The signal or channel which combines the signals from the two microphones in phase (A + B). By transmitting a sum and a difference (A − B) signal, then combining them in and out of phase, it is possible to re-create the two original signals: (A + B) + (A − B) = 2A; (A + B) − (A−B) = 2B. The sum-and-difference technique is used in the Crosby compatible FM multiplex, the Minter stereo recording system, in two-way amplifiers, etc.

switch, channel-reversing. A switch that reverses the positions of the two speakers with respect to the channels, so that, when thrown, the channel previously heard from the right speaker is heard from the left, and vice versa.

switch, phasing. A switch that reverses the terminals of a single (right or left) speaker system in a stereo setup so that the two sets of speakers can be brought into phase with each other.

tape (stereo). Magnetic recording tape with two recording strips (tracks) for recording both channels of a stereo program simultaneously.

tape, four-track. A tape with four recording strips, so that it may be played in both directions for streo recordings, in the same manner as a two-track tape for monophonic recordings, thus permitting twice as much material to be recorded as on a two-track tape. Tracks 1 and 3 are used for one channel, 2 and 4 for the other.

three-channel stereo. A system of stereo recording or reproduction which uses three spaced microphones for recording and three sound reproducers for playback. Three-channel pickup for recording is common, the third channel being used for editing or blending; three-channel reproduction in the home is unknown except for special setups.

translator (matrix). Device or circuit for converting 45/45 signals to lateral–vertical, or sum-and-difference to left–right signals.

vertical. The signal—in 45/45° recording—that is produced by a sound arriving simultaneously and 180° out of phase at the two microphones. It causes the cutting stylus to move vertically.

compliance. (See **compliance.**)

signal, component or channel. (See **lateral–vertical recording.**)

Westrex system. The accepted 45/45 system of disc recording, as developed by Westrex, Inc.

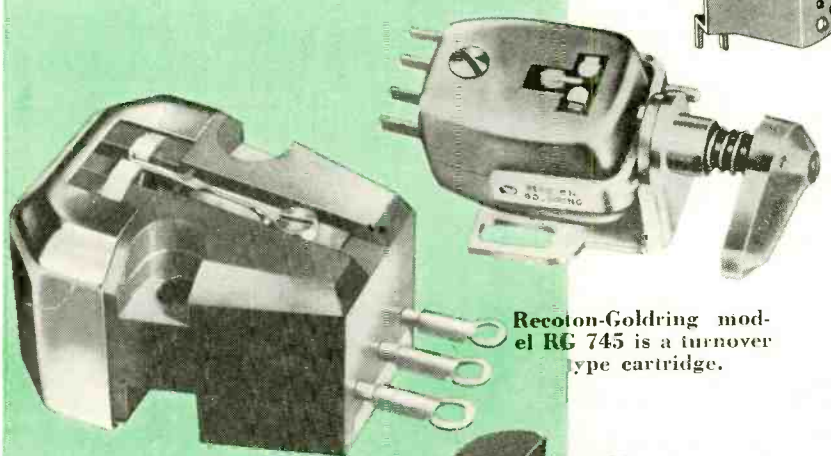
END

Dynaco–B&O Stereodyne, Recoton-Goldring model 745, Shure Custom Dynetic, Tannoy Vari-Twin and the Weathers C501

more STEREO cartridges

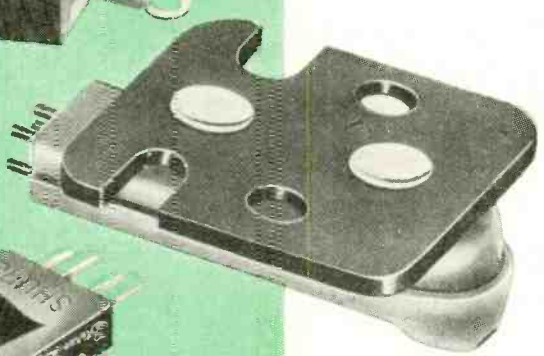
By JULIAN D. HIRSCH

Photo of Dynaco–B&O Stereodyne. Drawing (below) is exploded view.



Recoton-Goldring model RG 745 is a turnover type cartridge.

Tannoy's Vari-Twin. Version sold in U.S. will have four output terminals.



The Shure M7D Custom Dynetic moving-magnet type cartridge.

The C501 is Weathers ceramic stereo cartridge.

A NUMBER of new stereo cartridges have been announced since the last article of this series ("Stereo Phono Cartridges", RADIO-ELECTRONICS, November, 1958). Five are described here.

Dynaco–B&O Stereodyne

The Stereodyne, manufactured in Denmark by Bang & Olufsen and distributed in this country by Dynaco, is a variable-reluctance cartridge of unorthodox design.

It contains four fixed coils, completely encapsulated, surrounded by a cylindrical shield which eliminates hum pickup from external fields. Each coil has an iron core which acts as a pole piece. The four pole pieces extend from the body of the cartridge, forming the outline of a square. The magnet is at the rear of the cylindrical cartridge.

The stylus assembly, which can be easily replaced by the user, is on a plastic cup containing four holes which slip over the pole pieces. An X-shaped iron armature is mounted in the cup. The stylus arm, a light hollow tube, passes through the center of the X and into a hole in the bottom of the cup. The space surrounding the armature is packed with a silicone damping jelly (exploded view is at left.)

The four coils are wired in two push-pull pairs. A stylus displacement corresponding to modulation of either channel of a stereo record changes the magnetic flux through the corresponding pair of coils, since the ends of one arm of the X-shaped armature move toward one pole and away from the other. The other arm of the X merely rotates slightly on its axis without changing flux distribution in the second pair.

Because the stylus arm extends along the axis of the cartridge cylinder, the entire cartridge is mounted at an angle to the record surface. A removable plastic cone protects the stylus arm, which is supported at the armature end.

In accordance with the growing practice of isolating the two channels in stereo cartridges, the Dynaco–B&O Stereodyne has four output connections. The output terminal configuration is unlike any of the other cartridges we have described. The two upper terminals are for one channel, and the lower pair, with narrower spacing, are for the other.

Frequency response of the Sterodyne

STEREO

is rated flat within 2 db from 30 to 15,000 cycles, without peaks. Output is 7 mv per channel at a stylus velocity of 5 cm/sec. Weight: 10 grams.

Stylus compliance is 5×10^{-6} cm/dyne. Because of the completely symmetrical design, compliance is the same in all directions. The stylus is a diamond with a tip radius of 0.7 mil. The moving mass is less than 3 milligrams. Tracking forces of 2 to 4 grams are recommended. The mounting is standard, and fits conventional pickup arms.

Channel separation is in excess of 22 db. The pickup's design prevents any magnetic attraction to a steel turntable and eliminates hum pickup.

The Dynaco–B&O Stereodyne costs $29.95; a replacement, $14.95.

Recoton-Goldring model 745

The model 745 is a stereo version of the popular Recoton-Goldring model 666 cartridge. It is a turnover variable-reluctance pickup, with a stereo cartridge and a monophonic cartridge mounted back to back. Two models are available, with identical stereo sections. On the reverse side of the RG 745-3SD is a 3-mil sapphire stylus for playing 78-rpm records. The RG 745-1SD has a 1-mil sapphire on its reverse side, providing a standby monophonic cartridge.

The stereo side of the Recoton-Goldring model 745 is similar in basic design to other variable-reluctance cartridges. The internal connections of the coils and the design of the pole pieces are such that stylus motion at a 45° angle to the record surface develops a voltage in one or the other of the coils.

The model 745 is equipped with Mu-metal shields to reduce hum pickup from external fields. Its mounting bracket allows the cartridge to be rotated by a lever extending from the front of the arm. It may be mounted in any arm having standard ½-inch mounting centers. Weight, including mounting bracket, is less than 1 ounce (28 grams). The two channel outputs are brought out to four in-line terminals.

Frequency response of the stereo section ranges from 20 to 15,000 cps, ±2db. The output is 6 mv per channel. The stylus is a 0.7-mil diamond. Its compliance is 4×10^{-6} cm/dyne, and a tracking force of 3 to 5 grams is recommended. Channel separation is better than 20 db.

Recoton-Goldring's 745 costs $29.95. Styli for both sections replaceable by user.

Tannoy Vari-Twin

The British-made Tannoy Vari-Twin is a variable-reluctance cartridge with its coils and magnetic structure enclosed in a plastic molding. A Mu-metal shield reduces hum pickup.

The Vari-Twin is available with a choice of two diamond styli. A 0.5-mil stylus is recommended for stereo playback only, and the optional 0.75-mil stylus may be used for either stereo or mono records. Recommended tracking force is 3 to 4 grams.

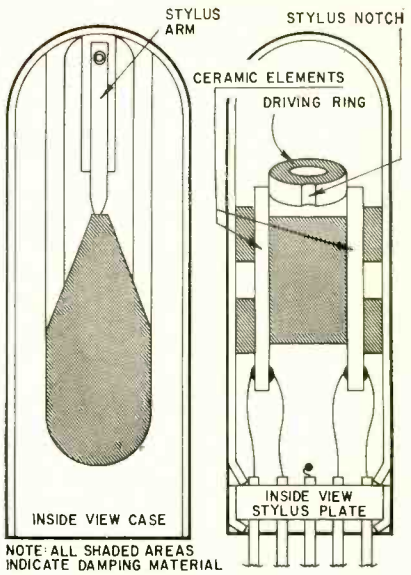


Fig. 1—Unusual coupling system between stylus and ceramic elements of Weathers C501.

The performance specifications for this cartridge are unusual in two respects. They refer to the test records used (E.M.I. TT 10801 and 10802) and in the case of channel separation, figures are given for a number of frequencies. The specification states that the channel separation on the test records is not defined precisely by their manufacturer. Nor will true and meaningful channel-separation data on many of the better American cartridges be available until better test records are made (see "Test Records for Stereo" on page 90).

Frequency response of the Tannoy Vari-Twin is 30 to 15,000 cycles within 1.5 db. Channel separation is stated to be 27 db at 4,000 cycles and 10 db at 10,000 cycles. These figures represent the extremes of channel separation between 30 and 10,00 cycles.

The output of the Tannoy cartridge is 7 mv per channel. It has ½-inch mounting centers and will fit any standard pickup arm. The user can replace the stylus assembly.

The photo shows three output terminals, but all cartridges for the American market will have four output terminals and fully isolated channel outputs.

Shure stereo Custom Dynetic

Shure's model M7D Custom Dynetic, latest addition to their line of stereo cartridges, is a moving magnet type, like the higher priced M3D. The M7D stylus is easily replaced without tools. The entire stylus assembly, including the small rectangular magnet, may be slipped out of the cartridge with the fingernail.

The body of the M7D is molded plastic and should be immune to damage under usual conditions of use. Somewhat lighter than most other magnetic cartridges (6.8 grams), it will mount in any standard arm. Terminal arrangement differs from any

other thus far announced.

Frequency response is rated as 20 to 15,000 cycles. Output is 5 mv per channel. Stylus compliance is 3.5 × 10^{-6} cm/dyne in both vertical and lateral planes. The diamond stylus has a 0.7-mil radius, and tracking forces from 4 to 7 grams are recommended. The price is $24.

Channel separation is rated at more than 20 db at 1,000 cycles. The M7D has a negligible external magnetic field and is not attracted to steel turntables.

Weathers C501

The Weathers C501, a ceramic stereo cartridge, represents a radical departure from precedent, both in its design and in the fact that its manufacturer has heretofore been associated with a very high quality capacitance pickup.

The design of the Weathers ceramic cartridge is simple, yet basically unlike any other cartridge in its approach to the difficult problem of reproducing a stereo record. The two ceramic elements are mounted parallel to each other and are heavily damped along most of their length. They are coupled by a small rubber ring. A notch on the circumference of this ring engages the stylus arm. The stylus assembly is on a separate metal plate, which clips onto the cartridge body (see Fig. 1).

A purely lateral stylus motion deflects both elements in the same direction. Their outputs are added in the external circuitry to produce a monophonic signal, identical in both channels. A vertical stylus motion deforms the driving ring, causing it to expand laterally and deflect the elements in opposite directions. Stylus motion at a 45° angle produces a composite output in the same manner as other types of stereo pickups.

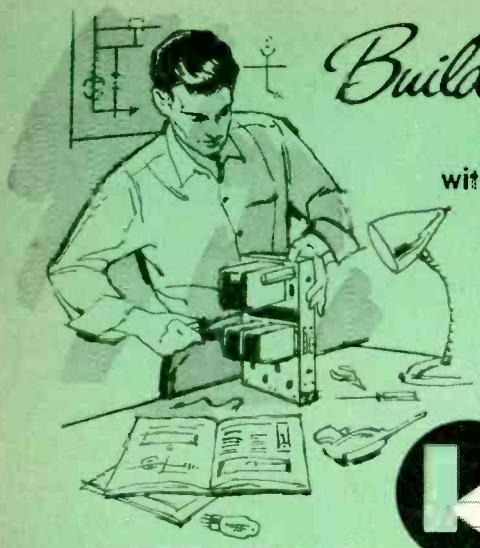
Weathers claims a frequency response flat from 15 to 30,000 cycles. The high compliance and low moving mass make it possible to use a 2-gram tracking force, yet the cartridge is rugged enough for operation in record changers.

The channel separation is stated to be 25 db, which is unusually high for a ceramic cartridge. The output is 15 mv at a stylus velocity of 5 cm/sec.

The 0.7-mil stylus is available in either sapphire or diamond. Since it is nearly all contained within the cartridge case, it is well protected against damage. The stylus assembly is replaceable by the user without tools.

Although the photograph shows a rectangular four-terminal output configuration, production units are equipped with five in-line terminals. Each element has its own pair of terminals, and a fifth terminal in the center is connected to the cartridge case. This arrangement allows greater flexibility in grounding the system to eliminate electrostatic hum pickup. Being ceramic, the Weathers is inherently free from magnetically induced hum.

The Weathers ceramic stereo cartridge costs $17.50 with a diamond stylus and $9.75 with a sapphire. END



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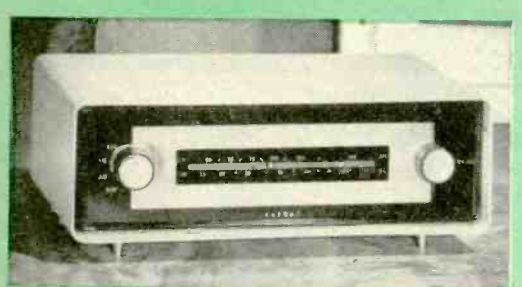

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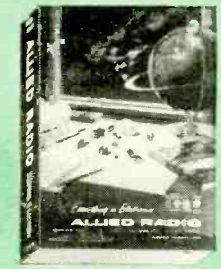

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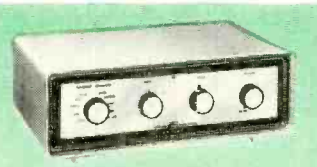

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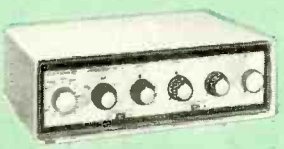

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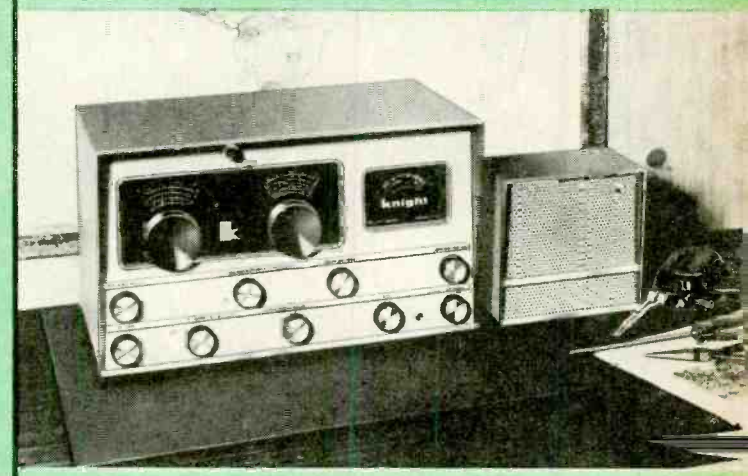

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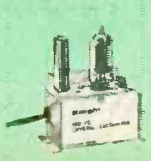

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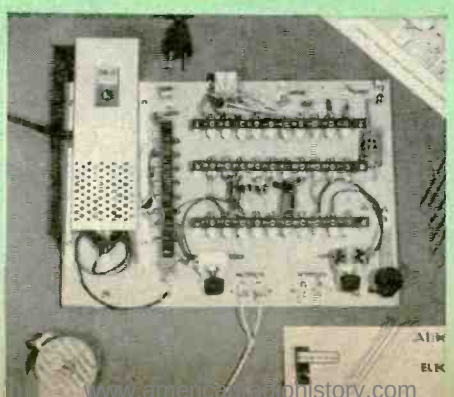

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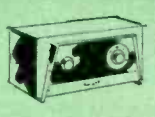

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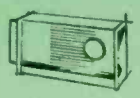

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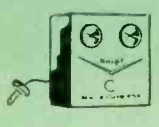

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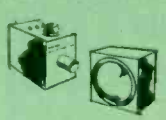

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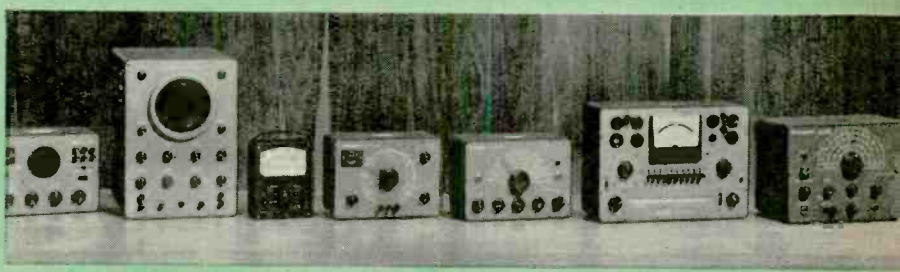

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TEST RECORDS for STEREO

By CHESTER SANTON
Station WQXR, New York City

RECORDS used to test stereo equipment reflect the patterns of current progress in the art. Users of records designed to test monophonic playback gear are occasionally disappointed when they encounter test records for evaluating stereo equipment. The discovery that some of today's test records for stereo go only to 10,000 cycles is sobering, but no cause for alarm in light of progress so far.

In November, 1957, a few weeks after unveiling its 45/45 stereo disc system, Westrex made a test record embodying that concept available. About 3,000 copies of this first Westrex test record were purchased by segments of the audio industry that were devoted to testing products used in playing the 45/45 stereo record. This first disc is now being superseded by the Westrex 1-C Stereo Disk Test Record.

The 1-C offers the following: Side A has five bands. The first one is designed to test the left channel with tones ranging from 50 to 10,000 cycles. RIAA 1,000 cycles is recorded at 0.5 cm/sec. Band 2 feeds identical information to the right channel. Band 3 contains 100 cycles in the left channel at 0.36 cm/sec. The same tone is repeated for the right channel in band 4. The last band is quiet groove for detecting rumble.

The other side of the record contains seven lateral cuts. Band 6 goes from 50 to 10,000 cycles, RIAA 1 cm/sec rms. Band 7 contains a 3,000-cycle tone recorded at 4.5 cm/sec; band 8 offers a solitary 1,000-cycle tone recorded at 5 cm/sec. Band 9 is a quiet groove. Band 10 sweeps from 15 to 300 cycles at constant velocity (0.22 cm/sec) with markers at 20, 25, 30, 40, 45, 50, 60, 70, 80, 100, 150, 200, 250 cycles. Band 11 repeats, at a level 6 db lower, the material on the previous band and band 12 offers the sweep of band 10—but 12 db down.

At first glance, a 10,000-cycle ceiling on these records may appear arbitrary to those accustomed to dizzier heights. However, stereo tape fans are already familiar with such a ceiling on 7.5-ips test tapes of conservative design (Ampex test tape No. 5563 cited in May, 1958, New Discs and Tapes column).

For the past few years, two high-quality playback channels have given impressive results with stereo tapes that are reasonably flat and low in distortion between 50 and 10,000 cycles. For stereo discs, channel separation is a more serious problem above 10,000 cycles than it is below. At present, frequency-response problems are diminishing. Channel separation above 10,000 cycles, always a factor, is emerging as the next hurdle in stereo disc development.

London Records has released its first test record for stereo frequency checks (London PS-131). This 12-inch disc easily reaches a heartening 12,000 cycles, using a frequency curve stated to be within ±½ db of the RIAA characteristic. Side 1 *(left channel only)* consists of 12 bands. The first seven, starting at the top take us from 12,000 to 1,000 cycles with the intermediate bands devoted to 10,000, 8,000, 6,000, 4,000 and 2,000 cycles. The remaining bands offer 500, 250, 125, 60 and 40 cycles. The 1,000-cycle signal is recorded at 1 cm/sec and cross-talk at that frequency is claimed to be better than 20 db. The other side of the record contains the same information for the right hand channel.

The time allotted to each test tone on the record is a feature that will be welcomed by anyone who has seen a signal conk out while the meter needle was still searching for a place to rest. Each tone is approximately 45 seconds in duration. This test record corroborates the progress evident in terms of musical response on London's regular stereo releases.

For the past few months, the Custom Record Department of RCA Victor has been allocating to the trade on a priority basis a series of test records for stereo. Perhaps the most interesting item for future experiment is their record No. 12-5-71, a 12-inch 78-rpm microgroove disc that covers a range from 1,000 to 20,000 cycles. Frequencies above 10,000 cycles run in 1,000-cycle steps, up through 20,000 cycles.

Three significant features set apart this 45/45 test record. The speed is not that usually used in test records today. Perhaps more important, the recording curve does not conform to the RIAA characteristic. The disc is recorded at a *constant velocity* of approximately 3.8 cm/sec.

The speed, though a vital factor in providing such upper-end response, is apt to rekindle an old argument. That argument, still unresolved, deals with the use of 78-rpm speed in early monophonic test records. Until more information on this recording curve is available, many will question this record's usefulness.

If RCA, under the stress of stereo, has abandoned the RIAA curve which it originally sponsored, an interesting theory suggests itself. Further study may reveal that, above 10,000 cycles, a stereo recording curve other than RIAA might be advantageous.

In recent months, Components Corp. of Denville, N. J., has been offering experimenters a quick check on balance and separation between channels in their test record No. 58–45/45, a 7-inch LP selling for only a dollar. A single test frequency is used throughout—1,000 cycles. Standard level on the first three bands is 5 cm/sec. Band 1 has test tones in parallel—one in each channel. Bands 2 and 3 have tone in right and left channels, respectively.

In the course of your travels through the ever-lengthening stereo disc catalogs, you may come upon items that will tend to undermine your confidence in even the most carefully tested rig. A few of the earlier stereo discs had a disconcerting trait that showed up in some of the concerto recordings. As the tones of a solo instrument went up in frequency, the instrument itself would appear to sidle toward the center of the area separating the two speakers of identical design. Then, as the soloist returned to the middle frequencies, the instrument returned to its former position until the next high passage (climb in frequency) in the music. The problem was solved in subsequent releases and the few "restless" records may in time become collector's items.

One stereo record of recent vintage illustrates in a very straightforward manner the present stability of the sound source in each channel. The RCA Victor record of the *Requiem Mass* of Tomás de Victoria (LSC-2254) offers two dissimilar choirs, each occupying its own half of the area between speakers. At no time do the two choirs sing in unison. On a properly balanced setup, the invisible line that divides them is not crossed by either choir. The newer models of stereo cutters obviously provide better channel separation.

Although recent activity in the stereo tape field has been minimal, one new test tape has made its appearance since our last roundup. NCB Technicor Laboratories, Box 491, Ithaca, N. Y., provides two tapes for alignment inspection and equalization. The 7.5-ips reel is $9.95; the 15-ips is $11.95. All signals are original master recordings from oscillators that are custom-equalized to compensate for differences of blank tape stock. A graphic level chart produced by the individual tape accompanies each reel, which is packed in a metal can. Tones of 7,500 and 10,000 cycles are provided for azimuth alignment and the 12 preannounced signals (at a level of −10-db, NARTB curve) strike an old refrain, 50 to 10,000 cycles.

Once you try test records for stereo and discover differences of 6 to 8 db in channel separation among stereo pickups, you'll understand why some observers have been saying, "It's earlier than you think." END

The Madison Fielding MX-100 multiplex converter.

What is compatible STEREO FM MULTIPLEX?

This first article of a series on FM multiplex shows how and why it can make stereo broadcasts compatible

By NORMAN H. CROWHURST

MULTIPLEX originated as a way to send a number of messages over the same pair of telephone wires without interference between them. The system is called carrier telephony. One message is sent as is; the others are used to modulate carriers of successively higher frequency. Provided there is no distortion in transmission, the individual carriers can be demodulated at the receiving end, separated and delivered to the appropriate circuits, without any interference between them.

Applying multiplex to FM radio is not exactly new. For some time a relatively few stations have been using a multiplexed channel to carry background music. The regular FM channel carries not only the audio recovered by a normal FM receiver but a supersonic "carrier" frequency, which we shall call a "subcarrier" to avoid confusion with the transmitted carrier (Fig. 1).

This subcarrier frequency is modulated with the extra channel. The modulation can be either AM or FM at this point, regardless of the main transmission being FM. For both the background music system and the multiplex stereo, the subcarrier is frequency-modulated by the extra program channel.

The extra channel requires a multiplex adapter to recover it. The regular receiver may reproduce the subcarrier but, being ultrasonic, it is inaudible. However, the regular de-emphasis will tend to eliminate it from the audio output. To recover the subcarrier's program content, the subcarrier is picked off after the regular detector and before de-emphasis (Fig. 2) and fed into the multiplex adapter.

Multiplex reception can be explained by going over the circuit of a typical multiplex adapter (see Fig. 3). First, the subcarrier is separated from the audio by simple frequency-selective filters. The high-pass filters eliminate the main-channel audio from the subcarrier. The low-pass filters are a precautionary measure against any "splash" getting through from an adjacent FM channel, which is normally inaudible but could affect the subchannel modulation.

Then the subcarrier has to be demodulated in just the same way as a regular FM carrier. This requires a limiter to eliminate any AM component —making sure the subcarrier is of absolutely constant *amplitude*—and then a detector. Although a ratio detector or discriminator could be used, the subcarrier poses one problem—linearity.

With a regular FM carrier, the deviation, a maximum of 75 kc, is only a very small fraction (less than one-thousandth) of the carrier frequency, which is in the region of 100 mc. For the multiplex subcarrier, the carrier frequency is probably 50 kc, with a deviation of several kc at least. For the Crosby system (as developed by Murray Crosby) it is ±25 kc, which means the frequency deviates between 25 kc (50–25) and 75 (50+25). It would be practically impossible to get linear detection over this range with conventional detectors.

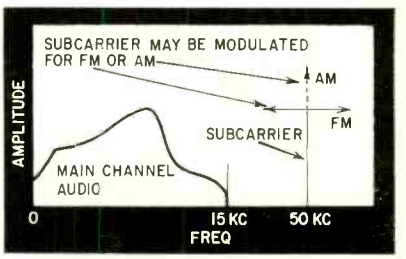

Fig. 1—The composite program spectrum used to modulate the main FM carrier of a multiplex system.

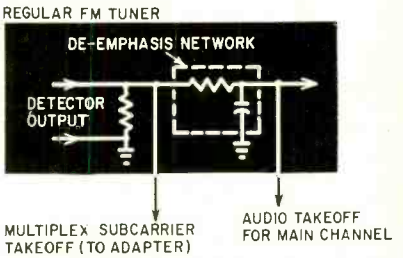

Fig. 2—Essential takeoff points for the main and multiplex subcarrier in a regular FM tuner.

Stereo, as we have it on records, is an accomplished fact. Stereo broadcasting, on the other hand, is the fastest-moving subject in the stereo picture. Even after this article was set in print, a number of new systems were proposed. These included the RCA AM-only technique, Philco's proposed combination of phase and amplitude modulation on AM stations, the Calbest sum-and-difference system, one announced by Fordham University, and others. This article covers the Crosby technique, one of the better known systems. An article by Don Lewis of the Halstead organization (October, 1957, page 89) described another system. As information becomes available, articles on the systems mentioned above--and newer ones--will be published.

A detector that will work is borrowed from computer techniques—the counter. It shapes each cycle of the incoming frequency into a pulse and then uses an integrator circuit (a charging capacitor) to give an instantaneous voltage output proportional to frequency.

The Madison Fielding unit uses a refinement of this method. The subcarrier, after limiting, trig-

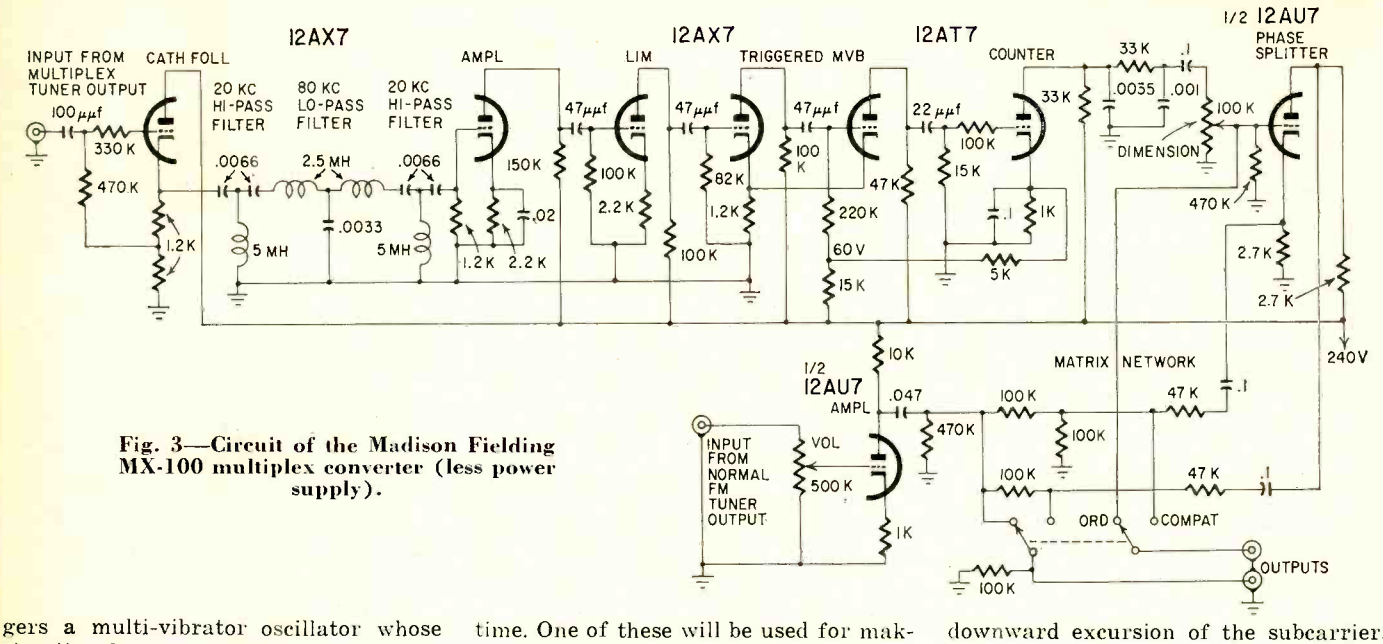

Fig. 3—Circuit of the Madison Fielding MX-100 multiplex converter (less power supply).

gers a multi-vibrator oscillator whose circuit values are chosen so each oscillation "waits" for the triggering cycle of subcarrier. The output from this oscillator then goes to the counter circuit.

One of these counter circuits, with properly chosen values, has a distortion of less than 1%. It should be pointed out that low distortion is just as important in both channels, whether these are "regular" left and right or the compatible variety.

Compatibility—what is it?

Now we come to this compatible part. To understand what compatible stereo multiplex is, first we'll have to explain how ordinary stereo multiplex is "uncompatible." The simplest way of using multiplex for stereo would be to transmit one channel, say the left, in the ordinary way, and multiplex the right one on to the subcarrier. But this would mean a regular (nonmultiplex) FM receiver would recover, not a balanced, monophonic program, but only the left half of a stereo program.

Without going into the question of whether anyone would know the difference, the fact remains that monophonic records are made by mixing multiple channels that were taped in the first place as two- or three-channel stereo tracks. If we listen to only one channel of a stereo transmission, we do not get the full balance of a normal monophonic record. So this method of using multiplex for stereo is not compatible for the user who does not have a stereo system.

Compatible stereo uses a different channel arrangement, so anyone using a monophonic FM receiver will still get good sound, and not just half of the stereo. For the 45/45 disc, this is done by a vector resolution of the angle of cut. For compatible multiplex, electrical matrixing is necessary.

Matrixing is merely a way of making two different mixes of the original left and right channels at the same time. One of these will be used for making monophonic records—what you get by using a lateral pickup to play a stereo record. The other will be an out-of-phase mix, equivalent to using a vertical pickup on a stereo record. Different "mixes" have been proposed. The sum-and-difference technique described here is that of the Crosby method, possibly the best known of the experimental systems.

The first mix contains the "sum" of the left and right channels and can be called the monophonic component of the matrix. The second contains the "difference" between the left and right (Fig. 4). When this difference is restored by rematrixing to obtain the original left and right, we have stereo again. So we can say that the difference component is really the stereo component of the matrix.

The demodulated multiplex difference or "stereo" channel from the counter detector is fed to a phase inverter. At the same time, the regular audio, which is the monophonic component, is taken from the tuner's de-emphasized ouput and mixed with the phase-inverted outputs to produce left and right channels again.

The Crosby FM multiplex compatible stereo system uses a 50-kc subcarrier with ±25-kc deviation from the "stereo" channel. The "mono" channel occupies its usual audio-frequency range, which is arbitrarily considered to be 0–15 kc but which presumably could be stretched to 20 kc and still have a 5-kc margin below the maximum downward excursion of the subcarrier.

Balancing the matrix

Stereo balance is a somewhat different problem with a compatible matrixed system than with a straight left–right system. At first sight, it seems more complicated, but it is actually easier to use. The multiplex output—the "stereo" channel—has a control which can be called a difference, stereo or dimension control. Crosby and Madison-Fielding both use the last term; others may call it the stereo control.

Anyway, turning the dimension control to zero leaves us with only the sum or monophonic input. In this position, the system's two main amplifiers have their inputs virtually paralleled, to play monophonicly. Set this way, it is easy to adjust their gain individually until the apparent sound source is midway between the two speakers (Fig. 5-a). After this, the main amplifiers' gain controls need no further attention. Stereo balance, between left and right, is set once and for all.

Now you use the dimension control to get the desired stereo effect. It is quite an interesting control. It has the effect of spreading out the apparent sound source, a good reason for giving it the name of dimension control.

Let's see how the controls function. The main tuner volume control adjusts the gain of the mono channel—it does not affect the subcarrier. So the adapter's volume control must also be adjusted to change the level and maintain true stereo. If the main control is

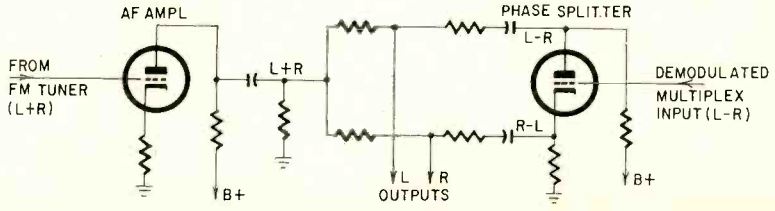

Fig. 4—How the basic matrixing circuit retrieves left and right channels from the sum and difference signals.

SENCORE FS-3 FUSE-SAFE METER

Cut down on costly call backs caused by blowing fuse resistors

Time-Saver of the MONTH!

by Herb Bowden*

Nearly all TV Manufacturers now produce TV receivers with fuse resistors in the power supply section. Technicians have learned that this component can be a real source of trouble unless the circuit is serviced properly. Many times, the fuse resistor is replaced and, apparently, the receiver is functioning normally. In a few days, the service technician makes an expensive call back, only to find the fuse resistor open again. The Sencore FS 3 Fuse-Safe meter is designed to test the power supply circuit to determine whether or not it is safe to replace the fuse resisitor. It can also be used in much the same manner to test circuits using fuses. It has a third function of serving as a wattmeter at 115 volts.

Fig. 3—Model FS 3 is designed to aid in checking fuse-resistor circuits.

WHY A FUSE RESISTOR IS USED

Let us see why a fuse resistor is used. The circuit shown in Fig 1 is a typical TV power supply as used in an Admiral 16AG1 portable. Fuse resistor R501 serves a dual purpose. It protects the selenium rectifiers from inrushing currents when the set is first turned on and at the same time, acts as a B-plus fuse. This lowers production cost, and, therefore, it is usually found in portable TV receivers and radios only.

HOW A FUSE RESISTOR IS DIFFERENT

The fuse resistor is unlike a fuse or conventional resistor to service. It is neither as stable as a heavy wire-wound resistor nor does it fuse like an ordinary fuse. For example, the AC current being drawn through the fuse resistor in figure 1 is approximately one ampere. This fuse resistor should not draw over 1.2 amperes and is usually operated below this level. If 1.5 amperes were drawn through the fuse resistor, it would open but perhaps not for days. If three amperes of current were drawn through the fuse resistor (which is approximately three times the rated amount), it would still take 60 seconds to open. Of course, the problem with the long delay when you have only a ten percent overload is that you are safely back at your service shop when the fuse resistor opens. This means another trip . . . no charge. The $8.95 cost of the FS 3 will soon pay for itself as these costly call-backs are prevented.

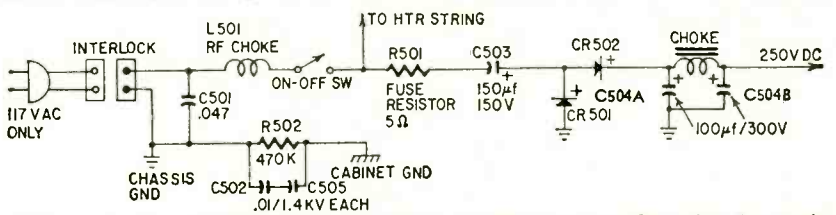

Fig. 1—Power supply of Admiral 16AG1 is typical of TV power supplies using fuse resistors.

WHAT CAUSES THE FUSE RESISTOR TO OPEN

A number of faults in the circuit shown in figure 1 will cause the fuse resistor to open. Here are some.

1. **Filter capacitors C503, C504A or C504B becoming leaky. The picture may appear normal but the fuse resistor will blow after several hours of continuous use.**
2. **Capacitors C504A or C504B increasing in capacitance. Current drawn through the fuse resistor is proportionate to the capacity value.**
3. **High AC line voltage.**
4. **Any B plus short in the receiver. This is one condition that may show up in the picture or sound before the fuse resistor blows.**
5. **A defective fuse resistor. Fuse resistors have been known to give a great deal of trouble under normal operating conditions, often when the circuit is operating properly. However, you can't be sure that it is only the fuse resistor unless the circuit is checked first.**

HOW TO TEST THE FUSE RESISTOR CIRCUIT WITH THE FS-3 CHECKER

The FS 3 Fuse Safe tester is especially designed to simplify the checking of fuse resistor circuits. Note that the FS 3 checks the operating current in the circuit and not the fuse resistor itself. The operating currents that pass through the fuse resistor are primarily AC, but can be mixed with DC and pulsating DC. The moving iron meter used in the FS 3 is constructed so that it will read either AC, DC, Pulsating DC or combinations of all three at the same time. To test the fuse resistor circuit, merely connect the test leads to the terminals that held the fuse resistor and read the meter. Be sure to remove the fuse resistor if it hasn't already burned out. Set the switches to the 2 AMP and TEST LEADS settings. A separate scale is used for each fuse resistor. See Figure 2. The scale is divided into a green area and a red area. If the reading is in the red area, there is more work to do to the circuit. If it is in the green area, it is safe to replace the fuse resistor. A 5 ohm, 10 watt resistor in built in the unit to protect the TV circuit during test time. The FS 3 can be left in the circuit at all times during repair, if the pointer is not pinned.

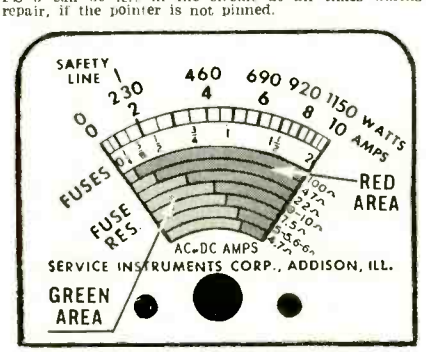

Fig. 2—FS 3 Meter Scale

OTHER FUSE SAFE CHECKS

The Fuse Safe meter can be used in the same manner as above for checking circuits with fuses to see whether or not it is safe to replace the fuse. A 2 ampere current scale for either AC or DC should be used for circuits that are normally used throughout the receiver, except for line fuses. If the meter indicates above the rating of the fuse, the circuits should be repaired or a higher value fuse used. This is especially handy in horizontal output circuits where the change of a damper tube, or the drive voltage on the output tube will lower the current and stop call backs on these intermittent fuse blowing sets.

To check line fuses or to use the FS 3 as a wattmeter, switch to PWR CORD and to the 10 ampere range. Plug in the line cord and then plug the unit into the AC receptical. Read either amperes or wattage directly from the two top scales.

WHY IT IS NECESSARY TO HAVE A SPECIAL METER TO CHECK THESE CIRCUITS

The FS 3 checker is the only service type tester available that will check the fuse resistor circuits accurately. This is because it is necessary to have a meter that will check AC, DC and pulsating DC at the same time. More than this, most service type meters do not read AC current at all. A DC Ammeter will read near zero in this circuit. The most important reason for the use of the FS 3 is that it is the only meter that interprets the current rating of a fuse resistor for you. The TV schematics do not list the optimum ratings of the fuse resistors. They are not rated in power dissipation so that one can derive the operating current. More than this, there is little coordination between the physical size of the fuse resistor and the maximum current point. Here is a table of the maximum operating currents as determined by an investigation throughout the industry. The FS 3 red and green scales were determined from these values.

Fuse Resistor (ohms)	Maximum Operating AC (amps)
4.7	1.3
5	1.2
5.6	1.2
6	1.2
7.5	1.0
9	0.85
10	0.85
22	0.6
47	0.35
100	0.2

HOW TO DETERMINE VALUE OF FUSE RESISTOR TO USE IN THE RECEIVER

Most fuse resistors are marked with part numbers only. The schematic will generally show the value of the fuse resistor but is time consuming to look up and often is not available. If a fuse resistor burns out, merely connect the Fuse Safe checker in place of it and note the scale where the reading is about 10 per cent off the red area into the green. Install this value fuse resistor and it will protect the circuit and will not burn out due to overload. Naturally, the TV circuit should be operating properly before using the FS 3 for this check.

WHERE TO BUY THE FS-3

The FS 3 can be purchased from nearly every parts distributor in America and Canada. Just ask for the Sencore Fuse Safe that sells for $8.95 dealer net.

*President SENCORE
121 Official Road Addison, Ill.

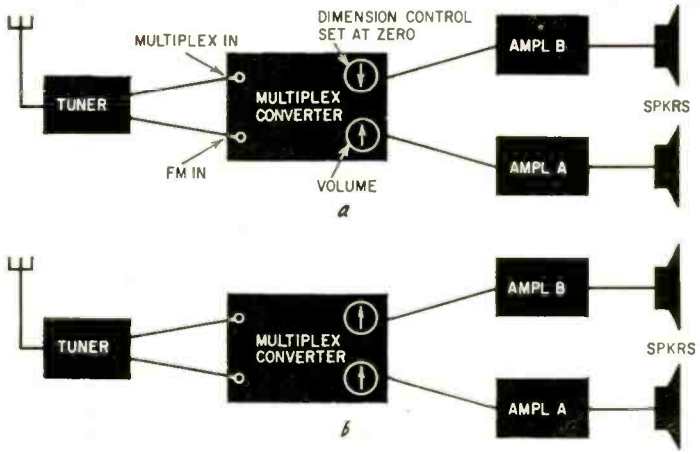

Fig. 5—The simple sequence for obtaining correct balance with compatible multiplex stereo: a—adjust the volume controls on the amplifiers so the sound comes from between the speakers; b—adjust dimension control to give stereo effect to suit program and listening room.

turned down by itself, the stereo component will get too big and the spread will be too wide, and vice versa.

Slight misadjustment between the volume and dimension controls will not throw the stereo out of balance, left against right. This has been set, once and for all, by the main amplifier gain controls. Rather it will alter the degree of stereo effect or the apparent sense of "dimension." But won't this cause distortion?

Before answering this question, it should be pointed out that the same question applies equally well to any system in which matrixing is used—for the Crosby system for FM radio and also relative to 45/45 records. Any inaccuracy in the angle at which a pickup is mounted or in its sensitivity to stylus motion will result in the same kind of difference from complete left-right separation.

How much separation?

This makes it apparent that inaccurate matrixing is equivalent to lack of separation between left and right channels. In particular, if the dimension control is slightly below its correct setting, this is equivalent to a normal "leakage" between left and right channels. If the difference is set to nine-tenths of what it should be (1 db low), this is equivalent to a separation between left and right of 20 db (one-tenth breakthrough).

If the difference channel is 1 db high (about 10%), this will be equivalent to about the same separation except that the "breakthrough" between channels (left and right) is in opposite phase.

But how important is this breakthrough? A lot of stress has been placed on separation—but how important is it? As far as separation *for its own sake* is concerned, some 10 or 12 db is plenty. This can be shown by playing monophonic material over two speaker systems, spaced as for stereo, and adjusting the levels out of balance.

When the two are at exactly the same level, the sound appears to be halfway between (assuming you have your phasing correct). When it is between 3 and 6 db louder in one speaker, the sound from that speaker predominates and one gets the impression, unless you put your ear close to it, the other is not working. This is the effect of difference in intensity only.

A similar effect occurs with relatively small time difference, as demonstrated by Haas' experiments*. These established that the apparent sound source is the one that gets its sound to the listener first.

So 10 to 12 db separation should be adequate. Why then the insistence on much bigger values of separation? The full answer to this question is beyond the scope of the present article, but we can say here that lack of separation is often likely to be accompanied by one or more relatively severe forms of distortion that are audible. It is not simple transfer of program from left to right channel or vice versa that is likely to spoil reproduction, so much as the appearance of distortion components of the left channel program in the right channel output and vice versa.

So it seems, in any stereo system, we have two kinds of separation to worry about: the system separation, and the operating separation. If the system *cannot provide* better than, say 20 db separation, we are likely to be in trouble. The probability is that a good proportion of this one-tenth breakthrough is not just transfer of program from left to right and vice versa, but it contains distortion components; and a 10% distortion component is not good! As a guarantee against this, separation much better than 20 db should be possible with the system.

But in practical operation, so long as we know the *nature* of the breakthrough does not produce distortion, a separation of 10–12 db is plenty. Lack of *perfect* adjustment between the main channel volume and the dimension control will result in a little breakthrough,

*Langford-Smith, *Radiotron Designers Handbook*, Fourth Edition, page 867.

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STEREO

in one phase or other, without any attendant distortion. Consequently, this is quite acceptable. In fact a little adjustment of this kind may actually improve the stereo illusion for a particular room or program or combination of the two.

If both the main-audio and difference-channel outputs have, say, less than 1% distortion, and no cross-modulation distortion between them, the left and right channels will each have an overall distortion of less than 1%. Even if the dimension control is 10% off its correct setting, the program in each (left and right) output, will still have less than 1% distortion.

But getting back to the FM multiplex system as a whole, the compatible version is about the most compatible thing in stereo. A regular FM receiver, without adapter, can receive the mono channel and ignore the stereo, and its quality will be as good as any mono disc. With a stereo adapter and amplifier–loudspeaker system, it will give good stereo that has the advantage of being adaptable to program or listening conditions. And it can readily be tied in with a stereo system using discs or tape as a source material. In fact many tuners and preamps are already providing for it.

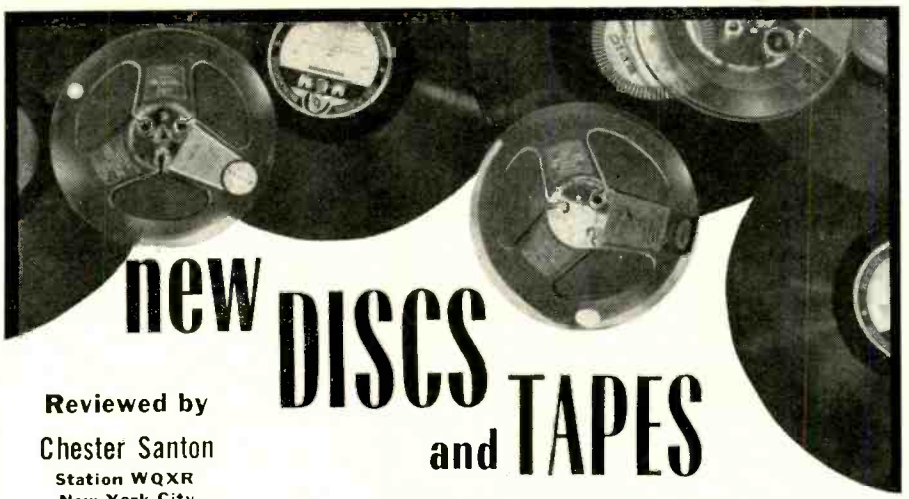
This article has aimed at explaining what compatible FM multiplex is. There is still quite a bit more to know: How well does it work? Does it sacrifice anything in quality (as compared with straight FM) to get stereo? And how do you go about signal tracing it? These and related questions will be taken up in a further article in a forthcoming issue. END

TWO MORE STEREO SYSTEMS

Stereo broadcasting continues to challenge the electronics industry's inventors—and two new experimental systems have now been added to the half-dozen previously proposed (News Briefs, RADIO-ELECTRONICS, January and February, 1959).

Motorola Inc. and station WGN-TV, Chicago, jointly presented a demonstration of a proposed stereophonic TV system, using present TV standards but adding a multiplex sound subcarrier. The compatible stereo–mono system has a matrixing stage to direct sounds to the proper audio-amplification channels. The subcarrier bandwidth is 5 kilocycles.

Calbest Electronics Co., Los Angeles, announced the development of a compatible stereo FM system which uses a "narrow-band" multiplex subcarrier, making possible two subcarriers, in addition to the main carrier, on a single FM channel (the second for such subsidiary uses as monophonic music beamed to stores and factories). The Calbest technique employs a sum-and-difference method, with a crossover at 3,500 cycles, the output of both channels being identical at frequencies above this point.



new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

ONE year ago, this column carried a brief account of the first public appearance (Dec. 13, 1957) of a stereo disc intended for commercial release. Several records employing the Westrex 45/45 system were played back during that demonstration with a lab stereo pickup more than twice as bulky and expensive as the home pickups in use today.

As I recall the event, the highlight of the evening was a laboratory disc furnished by Westrex. Reproduced by speakers at least 15 feet apart, this stereo record re-created the depth and dimension of a scene from "South Pacific" as Juanita Hall, a chorus and orchestra were heard in *Bali Hai*. In the weeks that followed, pressings of this disc (dated 10/21/57) were distributed for test purposes to the phonograph industry. I have used my copy only on state occasions such as the inauguration of a stereo pickup or other component.

In terms of low distortion content, this early example of disc stereo stands up well even in the company of today's stereo records. *Bali Hai*, 3¾ minutes in duration, occupies a band ⅞ inch wide at the outer edge of a 12-inch record. Upon measuring a recent light-music recording made with a Westrex cutter (Mercury SR-60013 reviewed below), I detected better range in an outer-edge selection that ran for 3¼ minutes yet occupied a band only ½ inch wide.

The progress of the stereo disc is evident in other ways. I have listened recently to the better-than-average Westminster recording of the Tchaikovsky *Nutcracker Ballet* (Rodzinski and the Philharmonic Symphony of London) in three different versions, monophonic disc, stereo disc and two-track 7.5-ips stereo tape. The tape is far ahead in the bass end and is followed by mono and stereo discs in that order. The highs tell a different story. There the mono disc is superior by a clear margin. Next is the tape (played back flat) with the stereo disc a close runnerup.

Commercial stereo discs, after a poor start one year ago, have almost caught up with stereo tapes and mono discs in technical specifications.

GRIEG: *Peer Gynt—Incidental Music*
Oivin Fjeldstad conducting London Symphony Orchestra
London FFSS Stereo Record CS-6049

This disc will not be greeted with cheers in all quarters. For the past year, we have been told by recording engineers (who have records to prove their point) that low bass frequencies could not be transferred to a stereo disc. Now along comes London with the penetrating extreme lows of the bass drum formerly heard only on the better monophonic records. These lows occur in the section entitled *In the Hall of the Mountain King*. Separation is easy and reveals details in the music scarcely noticed in the past. Fjeldstad, known to a few record collectors as conductor of the Oslo Philharmonic, displays an authentic Scandanavian approach to this descriptive music.

The Queen's Birthday Salute
Royal Artillery Band
Vanguard Stereo Record VSD-2011

The stereo and monophonic versions of this release offer interesting comparison. A wider frequency range is present in the single-channel disc but the greater impact comes from the stereo job. Two channels make the listener a participant in the ceremony that took place in Hyde Park, London, on the occasion of the 31st birthday of Queen Elizabeth II. In stereo, squadrons of cavalry sweep across one wall of your room. In the mono version, their deep clatter is stationary. The climax of the ceremony and the record is a 21-gun salute. Bass frequencies of greater depth boom forth on the monophonic version, but stereo lets you follow the sound waves of the cannon as they travel from right to left until they hit the walls of buildings at the edge of the park. Stereo is my choice hands down because my pickup easily covers the bass in this remarkable Vanguard record.

Skin and Bones
Carl Stevens Orchestra
Mercury Stereo Record SR-60013

The title here refers to the predominant use of percussion and trombones in this carefree approach to popular music. Although skins are featured, there is nothing hidebound in these Carl Stevens arrangements of standard tunes. Ultra close, multiple miking gives you all the presence a good system can deliver. The exceptional response is partly explained by the brevity of the record. Some classical stereo discs crowd 20 or more minutes on one side. The symptoms of such crowding are reduced level and dynamic range. This release spreads 13 minutes over side 1; side 2 offers 14 minutes of music. On both sides, the final band is as good as the first.

Music Boxes and Chiming Clocks from Alec Templeton Collection
RCA Victor Stereo Record LSP-1867

Some of the first examples of bona fide high-fidelity recordings used music boxes to demonstrate successful handling of transients. This disc proves that it is possible to preserve steep wavefronts of clean configuration in a twin-channel groove. Mr. Templeton's amazing collection of antique music boxes and clocks, recorded at his home, includes mechanisms as small as a cigarette case. Others have an 8-foot height and organlike tone. The most startling sonorities on the record issue from a timepiece delicately referred to as a "Grandmother clock." The larger instruments derive the greatest benefit from the added depth that is the result of stereo.

WAGNER: *Die Walküre, Act 1*
Hans Knappertsbusch conducting Vienna Philharmonic Orchestra
London FFSS Stereo Records (2) OSA-1204

London has increased its already commanding lead in disc stereo with the release of this stirring opera based on German legend. Every technical sign points to this as the outstanding operatic item of the stereo disc's first year. The sumptuous sound captured on this recording may help to turn the tide toward discs when more playback equipment of expensive design comes into stereo use. The range and power of the orchestra, the realism and depth of the voices of

STEREO

Kirsten Flagstad, Set Svanholm and Arnold Van Mill are fully evident only on the finest speaker systems.

Deep River
The Robert Shaw Chorale
RCA Victor Stereo Record LSC-2247

Spirituals sung with precision and compassion by the Shaw Chorale are a new experience in stereo. Deep, rich detail is discovered by the ear that probes this music with the aid of two good audio channels.

Cinerama South Seas Adventure
Alex North conducting Cinerama Symphony Orchestra
Audio Fidelity Stereodisc AFSD-5899

In 1952, the seven sound channels of the Cinerama motion-picture process anticipated much of the current interest in stereo. Now, for the first time, portions of a Cinerama sound track are available on a stereo disc. The experiment will hold greatest interest for those who have seen the film. Others may find the record more mystifying than entertaining. Not having seen the picture, I was unable to make head or tail of the episodes, and the record jacket offered very little help. The 97-piece Cinerama Orchestra heard throughout the travelogue provides more convincing evidence of multichannel sound than do the scenes recorded on location.

Organ Concert
Austin Lovelace
Concert-Disc (Stereo) CS-32

Pedal notes of surprisingly firm bass are an outstanding feature of organ release. Yet they come through without muddying the rest of the tonal spectrum. The organ played by Austin Lovelace at the First Methodist Church in Evanston, Ill., was rebuilt in 1954. It now includes some of the features found to be desirable in older organs for the performance of music from the Baroque era. Several modern works share the program with selections by Bach, Peeters and Pachelbel. Mike placement takes full advantage of the reverberant acoustics yet maintains smoothness throughout the frequency range.

RESPIGHI: *Feste Romane*
RACHMANINOFF: *Symphonic Dances*
Sir Eugene Goosens conducting London Symphony Orchestra
Everest Stereo Records (2) SDBR-3004

Outstanding engineering in the design of recording equipment used by Everest continues to pay handsome dividends in the stereo sound of the finished product. In this two-record album, adequate precautions have been taken to accommodate the wide groove cut necessary for good results on stereo discs. The *Feste Romane*, with its shattering fortissimos, is spread over two record sides. Monophonic recordings of this music, with the exception of a Westminster Lab Record, place the work on one side of a disc. The seldom-recorded *Symphonic Dances* offer attractive Rachmaninoff melodies in pleasantly spirited form.

RAVEL: *Daphnis and Chloe (Complete Ballet)*
Manuel Rosenthal conducting Orchestra du Théâtre National de l'Opera de Paris
Westminster Stereo Records (2) WST-204

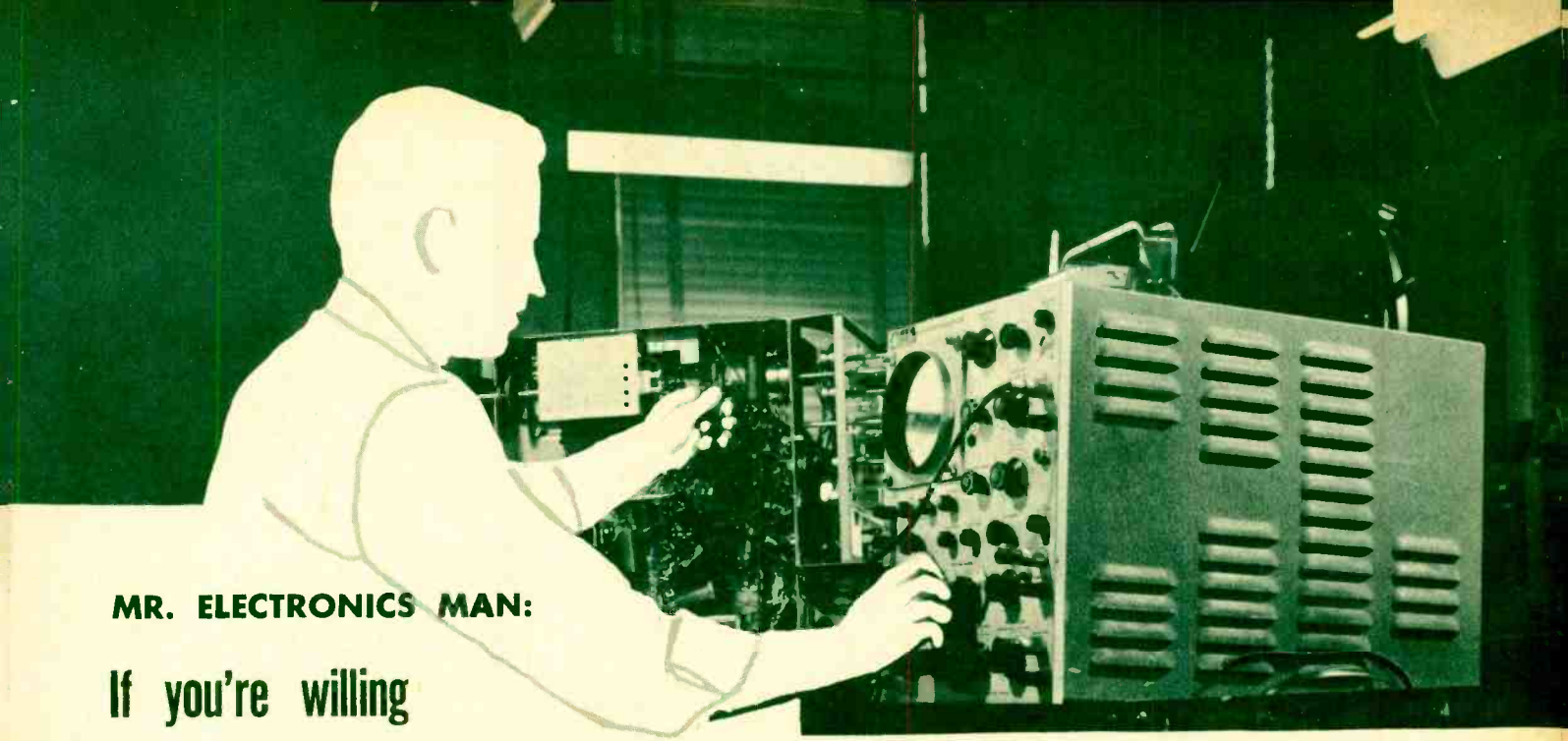
Those awaiting a top-notch performance of this ideal-for-stereo ballet score are advised to wait while the stereo catalog is undergoing major expansion. Although plenty of know-how and skill is revealed by the French engineers responsible for the sound on this two-record album, other conductors could top this performance.

STRAVINSKY: *Firebird Suite*
Pierre Monteux conducting Paris Conservatoire Orchestra
RCA Victor Stereo Tape BCS-88
(7-inch; playing time, 20 min. $6.95)

The groaning and grumbling of the lower strings at the beginning of this tape will sound like the sweetest music to the man sampling a new investment in good woofers. Throughout this poised performance, the lows are more impressive than the highs, a relationship that is found in quite a number of tapes on the market today.

Mike Todd's Broadway
Everest Stereo Record SDBR-1011

This album is a tribute to a master showman. Mike Todd's last production, "Around the World in 80 Days," set a new standard in motion-



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picture audio quality with its excellent stereo sound. It is fitting that these tunes representing his hit shows have now received the benefit of the latest stereo disc techniques.

Cootie Williams in Stereo
RCA Victor Stereo Tape BPS-173
(7-inch; playing time, 21 min. $6.95)

The latest RCA stereo tape recalls the days when Cootie Williams played in the Duke Ellington band. The familiar growling trumpet that was a distinctive part of that aggregation during the '30's now fronts a new band in this stereo release. The style is relaxed. The tunes range from Artie Shaw's *Summit Ridge Drive* to Ellington's *Caravan*. The sound here is clearer than that found on RCA pop stereo tapes one year ago.

Other Worlds Other Sounds
Esquivel and His Orchestra
RCA Victor Stereo Tape CPS-171
(7-inch; playing time, 24 min. $8.95)

Esquivel is a Mexican bandleader and arranger with a flair for putting stereo to his own use in popular music. In this novel album he leads a 26-piece orchestra, plays the piano and directs the Randy Van Horn vocal group in old favorites such as *Begin the Beguine, Night and Day, Poinciana*, etc. A beguine tempo is furnished in all selections by a rhythm section made up of two guitars, tympani, bongos, conga drum and organ. The listener is kept very busy following the arrangements while the sound is juggled from one channel to another.

Rossini Overtures
René Leibowitz conducting Pasdeloup Orchestra, Paris
Urania Stereo Record USD-1014

Enjoyable, nonfrantic performances of four well known Rossini overtures. Distant miking preserves the illusion of a concert hall and makes easier the separation of instrumental choirs. Unfortunately, this spacious perspective is gained at a price. A pre-echo problem is more apparent when added gain is required to bring up the music to normal volume. Yet the stereo illusion is more effective in this item than in a companion Urania release of Handel's *Water Music* (USD-1023) because the orchestra is deployed in a more conventional seating arrangement.

GRIEG: *Concerto in A Minor*
RACHMANINOFF: *Rhapsody on a Theme of Paganini*
Leonard Pennario, piano
Erich Leinsdorf conducting Los Angeles Philharmonic Orchestra
Capitol Stereo Record SP-8441

Signal level is below normal in these sensitive performances of two highly popular compositions for piano and orchestra. Even stereo systems low in background noise will find this disc difficult to reproduce. Surface noise becomes a problem when the gain is increased in playback. The monophonic version is the safer bet.

Landmarks of a Distinguished Career
Stokowski and Symphony Orchestra
Capitol Stereo Record SP-8399

Released at the same time as the disc above, a slightly better level is maintained in these specialties associated with the career of Stokowski on records. The Debussy *Clair de Lune* and *Afternoon of a Faun* share honors with Sibelius' *Swan of Tuonela* for cleanest sound. Distortion rises steeply at the end of side 2.

Serenata
Antonio Janigro conducting I Solisti de Zagreb
Vanguard Stereolab Record VSD-2013

A delicious record and a highly instructive one when this agile string group is heard in both stereo and mono versions. A listening comparison on top-flight equipment reveals differences in frequency range that can be described in the following manner. Divide the total frequency range of the mono version into eight equal parts. The segments comprising the top treble and the lowest bass are missing in the stereo version. However, heard by itself on a subsequent occasion, the stereo version offers the illusion of good frequency range because of the basic advantage stereo enjoys in presence. The monophonic disc has the better range but the stereo unlocks the conversation voiced by the string orchestra.

Ports of Pleasure
Les Baxter Orchestra and Chorus
Capitol Stereo Record ST-868

Mood albums are twice as moody in stereo.

STEREO

Witness this imaginary Oriental travelogue by Les Baxter. The seating of the orchestra is unorthodox, in keeping perhaps with the mysteries of the East conveyed by these Baxter compositions. Strings carry the main burden with exotic percussion bursting into bloom all over the sound stage.

Sauter-Finegan Memories of Goodman and Miller
Sauter-Finegan Orchestra
RCA Victor Stereo Record LSP-1634

Stereo is reviving interest in the type of sound featured by full-voiced dance bands of the '30's and '40's. As every middle-aged cat knows, Bill Finegan used to arrange for Glenn Miller and Eddie Sauter for Benny Goodman. In this unusually clean recording, they dust off the old arrangements and reminisce in style with their own fine band. The clarinetist in the Goodman material is heard at far left in some tunes, slightly left of center in others. A very minor mystery in an otherwise terrific album.

BRAHMS: *Symphony No. 1 in C Minor*
Jascha Horenstein conducting Symphony Orchestra of Southwest German Radio
Stereovox ST-PL 10.690

A substantial performance is buttressed by the added solidity that stereo imparts to a real piece of music. The banks of strings in the second movement, heard in three dimensional sound, call attention in a new way to Brahms' mastery of the symphony orchestra.

Cook's Tour of Stereo
Cook Vector-Stereo Record 2004 SD

Emory Cook is recutting the stereo records in his catalog, using the new Cook Vector-Stereo cutter. This cutter employs the technique set forth by Dr. Goldmark of CBS Laboratories at the 1958 IRE convention. Due to reduction of the energy in the vertical component, this copy of Cook's *Tour of Stereo* sounds better than the early stereo pressing of the same material. Because there is little or no compression in the new copy, sound is relatively open and full. Improved range offers presence similar to that found on monophonic discs by Cook. The musical samples of his catalog benefit more from the new cutter than do the familiar sound effects used to transport the listener on this tour.

Monophonic Recordings

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

Hi Fi Highlights from Bizet's Carmen
Raymond Saint-Paul conducting Chorus and Orchestra
Harmony HL-7127

Here is an excellent buy in Columbia's $1.98 Harmony series. Recorded in Paris with soloists from l'Opéra-Comique, these highlights provide an enjoyable introduction to the most popular French opera of all time. The young singers reflect the tradition of the opera house that first produced *Carmen* in 1875. The sound is fresh and the miking is exemplary. Apparently neither the artists nor engineers were told that their efforts would end up on a bargain-price disc.

DELIBES: *Sylvia (Complete Ballet)*
Anatole Fistoulari conducting London Symphony Orchestra
Mercury OL 2-106

Don't throw away your expensive monophonic pickup while albums such as this are being issued. The singularly bump-free response attained here is ideal for dual-channel playback with a good monophonic cartridge. Anatole Fistoulari, in his first recording for Mercury, brings wide experience to this first modern recording of the complete ballet. Highly recommended.

TCHAIKOVSKY: *Symphony No. 5 in E Minor*
Pierre Monteux conducting Boston Symphony Orchestra
RCA Victor LM-2239

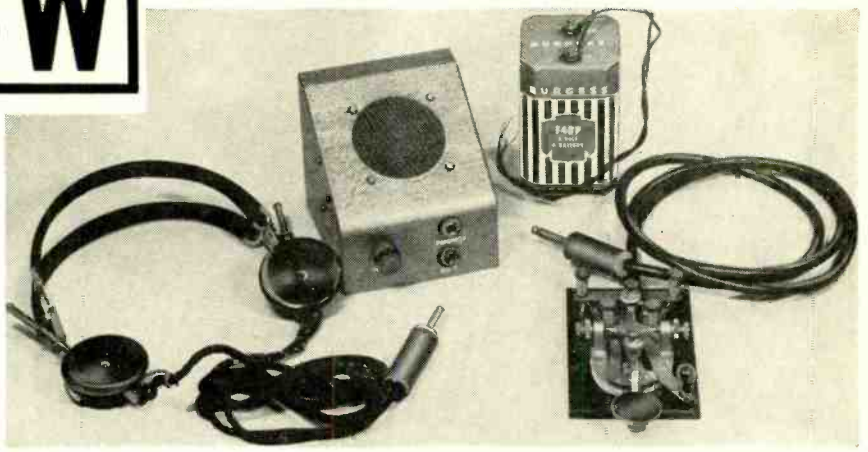
The level is on the low side in this one. Nevertheless, the recording merits wide attention because this version is not available in stereo. With the possible exception of the unique performance by the Leningrad Philharmonic on Decca—this is the *Fifth* to own. Never one to rush this orchestra in an effort to play to the balcony, Pierre Monteux preserves the full sonority of the orchestra in this lush symphony.

END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

TRANSISTOR CW TONE GENERATOR

Use a battery for keying or couple the unit to a transmitter's rf output —you have a combination code practice oscillator and CW monitor



The finished oscillator in its small meter case.

By BILL O. HAMLIN, W1MCA

HERE is a versatile transistor CW monitor or code-practice oscillator which can be used by the beginner, novice or full-fledged ham. In fact, the beginner may learn the code with this device and later connect it to a transmitter after getting his ticket.

It is arranged so that versatility does not end with usage as it provides for a number of different connections or hookups. It is powered by a battery or rf and the variable output tone can be heard from either its built-in speaker or a pair of phones plugged into the phone jack.

The unit is connected to a battery for code practice, through a keying relay to a battery for monitoring transmitter output, or to the transmitter's rf output, so when the transmitter is keyed the characters are repeated by the audio tone of the monitor. The latter also checks transmitter operation, as failure of rf output cuts off the monitor.

Power required to operate the oscillator and get a good output from the speaker is very small, in the order of 3 volts at 50 ma or 150 mw. Any size transmitter will provide this power. Just set C1 for proper operation. Higher power and higher impedance circuits require less capacitance for C1.

With the value shown for C1, 5–15 $\mu\mu$f, full capacitance provides the right monitor power for a 50–100-watt transmitter output into a 52-ohm line with C1 connected directly to this line. For higher impedance and higher powers proceed cautiously. The dc voltage across the monitor's rectifier circuit should not exceed 15 volts under any conditions. Higher voltages may damage components.

For best rf-powered operation the instrument's case is grounded. Of course, the transmitter's rf signal is coupled to the tone generator's RF INPUT jack. If the transmitter uses a coaxial transmission line, attach the rf pickup to the coaxial line on the antenna side of the low-pass filter to prevent TVI. A gimmick wire works fine for coupling from an open wire line to the monitor. Sometimes the monitor can be operated from the receiver's antenna input by eliminating capacitor C1 in the monitor proper and placing it across the receiver's antenna-relay contacts, if one is used. This type of hookup is not always entirely satisfactory because it is affected by receiver tuning and factors peculiar to the individual layout.

The well known Hartley oscillator is used (see Fig. 1). Its frequency is determined primarily by T and C3, but is also affected by the other components.

Capacitor C2 is needed as an audio bypass in rf power operation. Its value is fairly critical as it not only changes frequency but also turn-off time when the key is opened. Too small a value increases the oscillator frequency; too large a value causes monitor oscillation to hang over, after the radio transmitter is turned off.

Switch S is purely for convenience. It disables the oscillator during radiotelephone operation. Under battery operation, open the key or disconnect the battery to turn off the oscillator.

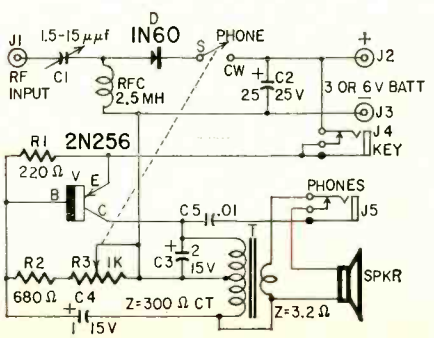
There is no volume control in this circuit because it automatically works out right for comfortable listening. An L-pad attenuator could be used to control speaker volume if necessary.

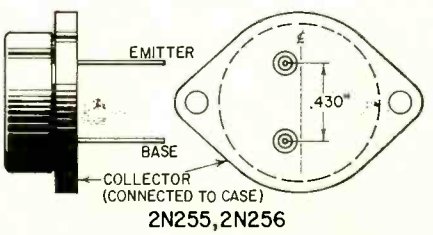
Construction hints

The transistor CW tone generator is built into a 2-inch meter case. The 2-inch wide shelf becomes the front panel with the open side of the box downward. A 2½-inch 3.2-ohm speaker is used with a miniature output transformer.

Capacitors C2, C3 and C4 are miniature low-voltage electrolytics. Be sure that they are polarized according to the schematic or they will be damaged. The transistor can be either a 2N255 or

(*Continued on page 108*)





R1—220 ohms, ½ watt
R2—680 ohms, ½ watt
R3—miniature pot, 1,000 ohms, with spst switch S
C1—1.5-15-$\mu\mu$f trimmer
C2—25 μf, 25 volts miniature electrolytic
C3—2 μf, 15 volts, miniature electrolytic
C4—1 μf, 15 volts, miniature electrolytic
C5—.01 μf, disc ceramic
D—1N60
J1, 2, 3—tip jacks
J4, 5—phone jacks, 3-conductor, closed
RFC—1-2.5mh choke
S—spst on R3
T—output transformer: primary 300 ohms, ct; secondary, 3.2 ohms (Argonne AR-121 or equivalent)
V—2N256
Case, 4½ x 4 x 4 inches cut for 2-inch meter
Speaker, 3.2 ohms, 2½ inches
Miscellaneous hardware

Fig. 1—Circuit of the 1-transistor unit.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77—VACUUM TUBE VOLTMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, No explanation necessary!

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

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBEES** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only ..... **$42.50 NET**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

Model 80 — ALLMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

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

THE *ONLY* 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES *ALL* THE FOLLOWING FEATURES:

- **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- **CAPACITY RANGES** permit you to accurately measure *all* condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

SPECIFICATIONS:

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

FEATURES:

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure *unchanging* accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only **$42.50**

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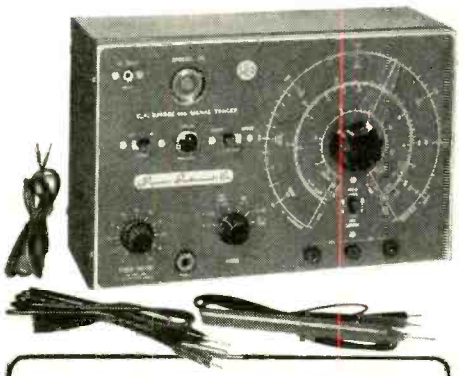
For the first time ever: ONE TESTER PROVIDES ALL THE SERVICES LISTED BELOW!

SUPERIOR'S NEW MODEL 76

ALL PURPOSE BRIDGE



Model 76 BRIDGE . . . Total Price $26.95—Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months if satisfactory. Otherwise return, no explanation necessary!

IT'S A CONDENSER BRIDGE

with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A RESISTANCE BRIDGE

with a range of 100 ohms to 5 megohms

IT'S A SIGNAL TRACER

which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A TV ANTENNA TESTER

The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

SPECIFICATIONS:

CAPACITY BRIDGE SECTION

4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

SIGNAL TRACER SECTION

With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

RESISTANCE BRIDGE SECTION

2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

TV ANTENNA TESTER SECTION

Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

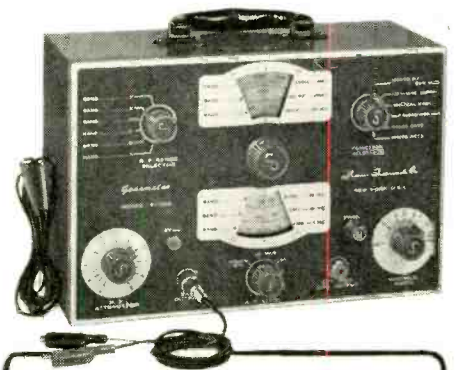
Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

$26.95 NET

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



Model TV-50A GENOMETER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

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

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

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

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

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SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50 NET

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Model 83—C.R.T. TUBE TESTER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

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

- Model 83 is *not* simply a rehoshed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.

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

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

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

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See following page for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

Model 82A — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button —

THAT'S ALL!

Read emission quality direct on "BAD-GOOD" meter scale.

Specifications

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only..... **$36.50 NET**

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

MOSS ELECTRONIC, INC.
Dept. D-584 3849 Tenth Ave., New York 34, N.Y.

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

Name .....

Address .....

City ..... Zone..... State.....

All prices net, F.O.B., N. Y. C.

- ☐ Model 77 ..... Total Price $42.50
  $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 80 ..... Total Price $42.50
  $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 76 ..... Total Price $26.95
  $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TV-50A ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TW-11 ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 83 ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 82A ..... Total Price $36.50
  $6.50 within 10 days. Balance $6.00 monthly for 5 months.

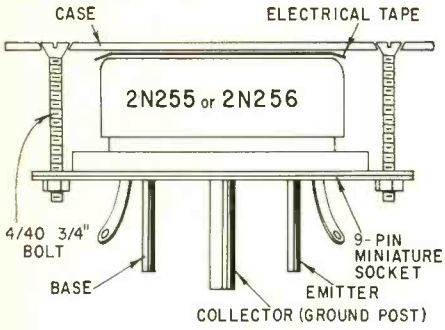


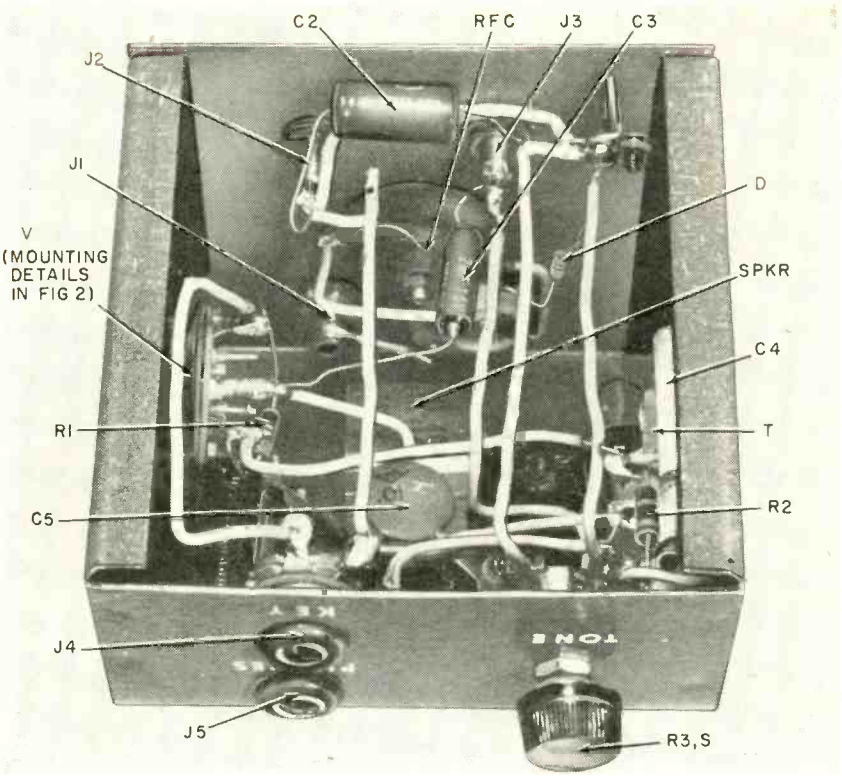
Fig. 2—Detailed diagram shows how the transistor is mounted in the oscillator's case.

(*Continued from page* 103)

2N256. Both have the same characteristics, but the 2N256 withstands peaks up to 30 volts while the 2N255 is rated for 15-volt peaks. The transistor has and automobile style case and mounts on the side of the box. (Fig. 2).

A 9-pin miniature socket slips over the transistor leads and holds the transistor in place. If the socket does not have a center ground post to make contact with the transistor case and collector, another method can easily be devised.

Both key and phone jacks are closed-circuit types mounted on the front panel with rubber grommet insulators. A tight fitting ½-inch hole will hold the jacks securely without a nut. END



This internal view shows the parts layout used by the author.

Replace a lot of selenium rectifiers? Use one silicon unit for all ratings up to 500 ma—it takes up less room and does a better job

WHY SILICON RECTIFIERS?

By DAVID DUNCAN

The small silicon rectifier in foreground replaces any other rectifier in photo. Unit is rated at 130 volts, 500 ma.

LET'S review some of the case histories that turn up practically every day in a busy service organization, because these bread-and-butter operations are now much simpler and more profitable, thanks to a new device—the silicon rectifier.

The first of these typical service experiences even has a typical smell, the fine aroma of a selenium rectifier in process of giving up the ghost. Mr. Burnup phones to tell you that his TV receiver "begins to smell queer after it has been on for a while, and the picture keeps rolling." You put your supply of selenium replacements in your tool box, after telling Burnup to leave the set off. When you reach the set, you see that it was turned off as you came up the drive—the chassis is still hot. You give Mr. Burnup a straight look and get a fishy one back. OK, got to be a new rectifier anyway, but the old one might have shorted and taken the filter capacitor with it.

When you get inside the set, you find that Mr. Burnup gave you the wrong model number. This one takes a 400-ma rectifier, and in your tool box are 65-, 150-, 200-, and 300-ma units. You ran out of 400-ma units that morning.

Should you ask the customer to wait till the next day, when you'll have the missing unit? Should you hop in your car and drive the 15 miles to the distributor, then come back and fix the set? You get customer ill-will one way, lose your profit the other.

One rectifier for all sets

All you have to do to avoid this situation is to stock a single rectifier with a current rating large enough to take care of all ratings you are likely to encounter. Of course it has to be small enough and inexpensive enough to be a practical replacement.

Silicon rectifiers meet these specifications. Like selenium, silicon is a semiconductor material and the basic rectifying action is very similar in both. However, it has a higher current capacity per unit of area, a lower voltage drop and greatly improved aging characteristics.

One silicon rectifier, like that in the photo above, rated at 500 ma (750 ma in heat-sink operation), is the right size and price to make a convenient replacement for any one of the 10 or 15 selenium units that cover the range from 65 ma on up. Stocking one kind of rectifier unit, instead of 10 or 15, whacks inventory down to size, besides insuring that a certain type has not run out just before a customer needs a new one.

A variety of mounting accessories for the silicon units makes it easy to substitute them in almost any chassis. There are single-, double- and four-unit, bridge type, clip-in holders, if you want a plug-in arrangement and there is no holder in the chassis. If the chassis already has a holder of the right size, naturally you have a 2-minute replacement job.

Another way to mount the units is by screwing them into the chassis, since their ends are threaded. This provides a heat sink that raises the current rating to 750 ma. A third way is to use the standard grid-cap type connector or caps with leads, for soldering directly into the circuit.

Low-voltage troubles

Here is another old familiar—the TV picture that's shrunk from the sides of the tube. The low B-voltage that causes this condition often comes from either an aging selenium rectifier or low line voltage. You can end both of these troubles by replacing the selenium rectifier with a silicon unit. The voltage drop in the silicon unit is only about 1 volt with normal loads, so it delivers between 15% and 20% more voltage to the load than a new selenium unit.

This higher voltage also takes care of a couple of other troubles that turn up on your log book time after time. Picture brightness in a TV set gets low as B-voltage drops. It happens gradually, so by the time the customer is dissatisfied, it's pretty far down. When you install a silicon unit to bring it

Ac Line	B Voltage Selenium	B Voltage Silicon	Current Selenium (ma)	Current Silicon (ma)	Beam Current Selenium (μa)	Beam Current Silicon (μa)	Light Output* Selenium (ft. candles)	Light Output* Silicon (ft. candles)
90	200	220	140	165	200	290	9	15
95	212	230	150	175	240	325	11.5	17.5
100	220	240	170	190	320	380	15	20.5
105	230	250	175	200	390	430	18.5	23
110	240	260	200	220	450	500	22	26
115	250	270	220	245	500	550	24	27.5
120	265	285	235	260	550	625	27.5	31.1
125	275	300	255	290	600	675	30	34.

*Light output measured with no signal. Brightness and contrast at maximum position.

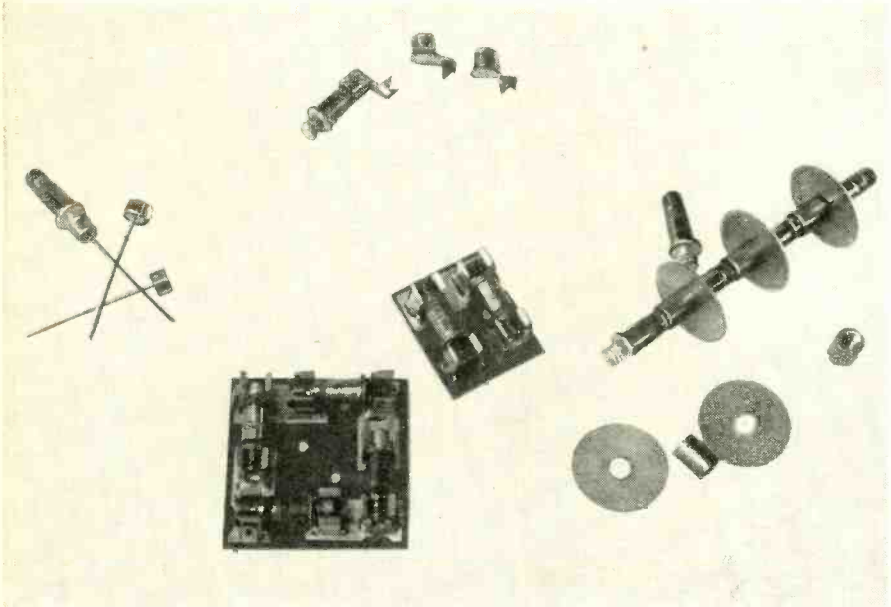


Fig. 2—Mountings for silicon cartridge rectifiers. On the right-hand side of the photo is a series arrangement which can handle 1,600 peak inverse volts.

back, you get a brighter picture than the customer had when the set was new, and this is not bad for customer goodwill and your reputation in the neighborhood. Moreover, unlike selenium, *silicon does not lose conductivity with age.* The voltage on the tube stays up to where you raise it when the silicon goes in.

The table compares B-voltage, current, beam current and picture brightness in an actual TV receiver, first with a new selenium and then with a new silicon rectifier.

Here's another one you've seen before. Many portable TV receivers and some portable radios are right on the edge as far as getting enough B-voltage is concerned. If used in a spot where the line voltage is, say, 100 volts instead of the rated 117, operation can be seriously impaired, especially if the selenium rectifier is somewhat old. The extra voltage margin you get with silicon works wonders with this class of portable equipment.

But this extra voltage can get you into trouble if a set is closely designed, with filter capacitors and other components operated at the limit of their voltage ratings. A 15% to 20% increase in B-voltage might shorten capacitor life or cause a breakdown. The remedy is simple—increase the value of the series resistor in the power supply enough to get the voltage down to normal. You will still have the advantages of the silicon rectifier. Watch the power rating on the resistor. Remember, power dissipated in the resistor goes up in proportion to the voltage drop, if the current remains the same. A set that is close to ratings on voltage is likely to have resistors operated close to their wattage ratings, too.

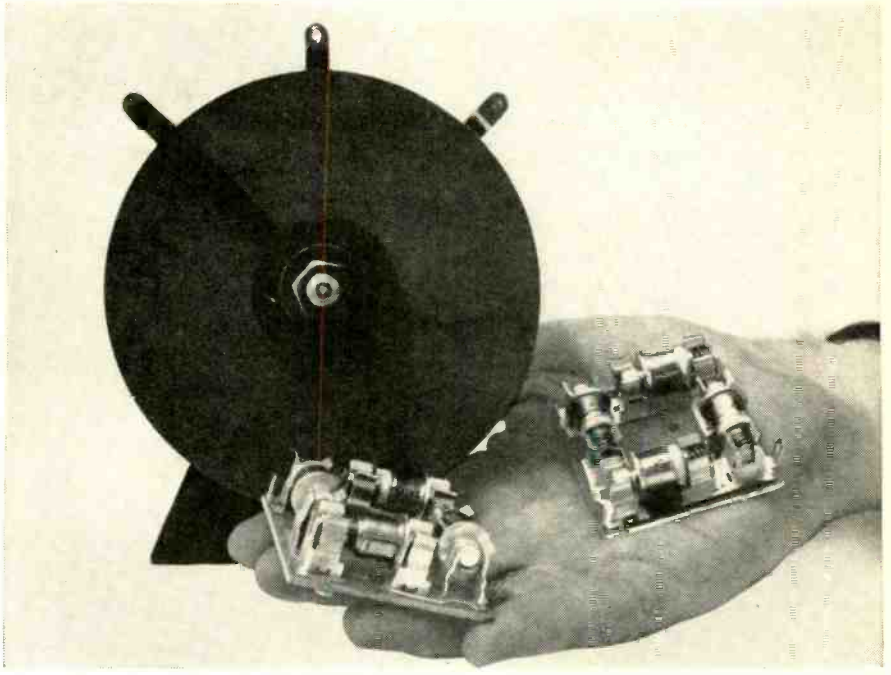
Crowded chassis and heat

Here are a couple of old familiars. One is the small TV receiver or radio with an underchassis packed so tight that replacing parts is a time-killing dismantling and rebuilding job. There are few short cuts in such sets. You just have to take a lot of things out, make your replacement and try out

your best profanity as you rebuild the set.

Silicon units are much smaller than the rectifiers they replace. The extra space you get eases the dismantling and rebuilding process in many crowded sets, saving you as much as half to three-fourths of the time needed to do the job.

Here is the last one out of the daily book. It's the TV receiver that loads a costly callback on you because the new rectifier blows after a week or so. What is the usual cause for such short rectifier life? For seleniums, it is *heat*. A crowded chassis, with heat producers packed around the rectifier, and no place for the heat from the rectifier itself to go, can get up to egg frying levels. Selenium is quickly degraded by these temperatures, but silicon operates continuously at full rating at temperatures up to 212°F. Moreover, since the voltage drop is lower in the silicon unit it has less power to dissipate and produces less heat on its own. So chassis temperature is somewhat lower with silicon to start with.



(Photographs courtesy Audio Devices, Inc., New York N.Y.)

Another selenium rectifier silicon units will replace is the large circular type shown here. It is used for high-current low-voltage applications—6 amps at 26 volts—for operating the solenoids in a professional type tape recorder.

For higher voltages

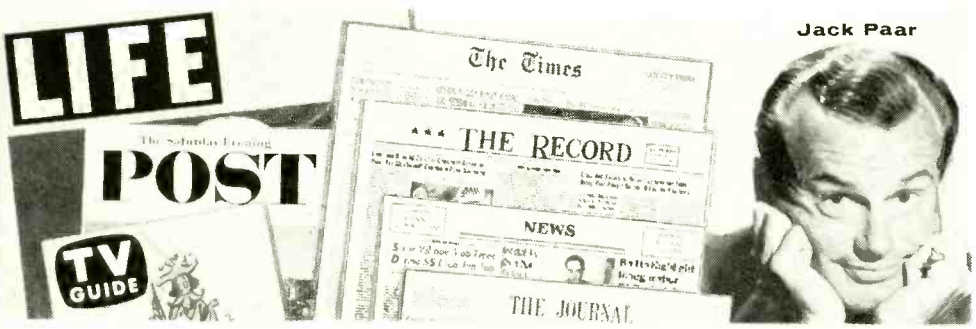
For a set which has an inverse voltage rating higher than that supplied by individual silicon units (400 volts for those shown in the picture), a series connection method has been developed which makes it a cinch to produce a multi-unit rectifier for any rating you need, up to 20,000 or 30,000 volts, in a matter of seconds. The equipment used is shown in Fig. 1. The silicon units themselves are threaded on each end. Threaded couplings available from the manufacturer are used to connect the units into series chains. Also avail-

NOW FROM RCA...TWO

ALL-NEW

RCA Silverama®

SILVERAMA is RCA's premium tube—and that means tops in the industry! Manufactured with all-new glass and parts, it's the finest picture tube made—for the customer who prefers top-quality. RCA SILVERAMA—a premium tube that merits a premium price—and commands premium profits for you!



RCA is telling every TV owner the facts about RCA's BIG 2 IN PICTURE TUBES in the most informative and hard-hitting advertising campaign ever undertaken in the tube industry—directing all sales to you, the independent TV service technician.

GET THE PRICE AND PROFIT STORY

LINES OF PICTURE TUBES

FACTORY-REBUILT

RCA Monogram

RCA MONOGRAM is the finest rebuilt picture tube made. Factory-rebuilt by RCA to high quality standards, this tube assures dependable performance and fewer call-backs. It is backed by a brand name *you sell* with confidence—a brand name *they buy* with confidence. RCA MONOGRAM is economy-priced for the economy-minded buyer.

NOW you will be able to offer your customers a choice between an ALL-NEW, PREMIUM RCA SILVERAMA TUBE, the finest tube in the business, and an RCA MONOGRAM, the best REBUILT made. Yes, RCA manufactures both—and *warrants both for a full year*. Satisfy the needs of every customer with the right tube for virtually every set on the market.

Now, *you* call the signals. Now, *you* supply the very best tube in both price ranges—all-new or factory-rebuilt! Both lines of tubes now available from your RCA Distributor.

FROM YOUR RCA DISTRIBUTOR TODAY

RADIO CORPORATION OF AMERICA
Electron Tube Division *Harrison, N. J.*

able are the circular cooling disks shown in the picture, which increase the current rating of the string. The particular units shown are made by Audio Devices, Inc., Santa Ana, Calif.

As an example, the string shown in Fig. 1 has four individual silicon units in it, and thus has a peak inverse rating of 1,600 volts. Current capacity, using the cooling fins and a moderate amount of cooling air—enough to keep the case temperatures from rising above 212°F—is 750 ma; 500 ma without the cooling disks. The expandable-rectifier system opens to the technician an inexpensive source of high-voltage rectification, adapted to whatever ratings he may encounter.

Let's summarize

Silicon rectifiers maintain conductivity with age, so B-voltage does not drop because the rectifier is old; take up less space than comparable selenium units; stand temperatures up to 212°F at full rated loads, or even higher temperatures at moderate loads; develop little heat themselves; have a voltage drop of only 1 or 2 volts; have rectification efficiency around 99%; in a single 500-ma model will conveniently replace the whole range of selenium models used in home TV and radio equipment.

When you replace any rectifier with a silicon unit, *make sure there is an undamaged resistor of at least 5–15 ohms in series in the rectifier circuit.* If such a resistor is already in the circuit, check to see whether it was damaged when the old rectifier went out. If the circuit has no series resistor, put one in. The resistor protects the silicon rectifier, with its very low forward resistance, from high-voltage starting surges.

One more warning. Some technicians short the dc end of the rectifier to ground with a screwdriver as a check for B-voltage. If they get a big fat spark, the B-voltage is there. But a silicon rectifier, because of low internal resistance, will try to deliver a heavy current when it is shorted. It will quickly burn out, the victim of its own superior quality.

So use a meter for testing B-voltages. Only a few technicians—if any—can judge voltage accurately from the spark at the end of a screwdriver. If you don't know exactly what the B-voltage is, how can you really tell what is going on in a TV or radio receiver? If you apply these two precautions, you have everything to gain from using silicon rectifiers. The author thanks Sigma Electric Co., New York, N. Y. for their help in obtaining the photographs for this article. END

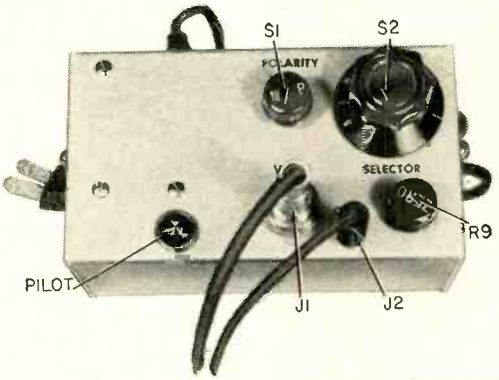
IMPEDANCE

By Phyllis Barlow

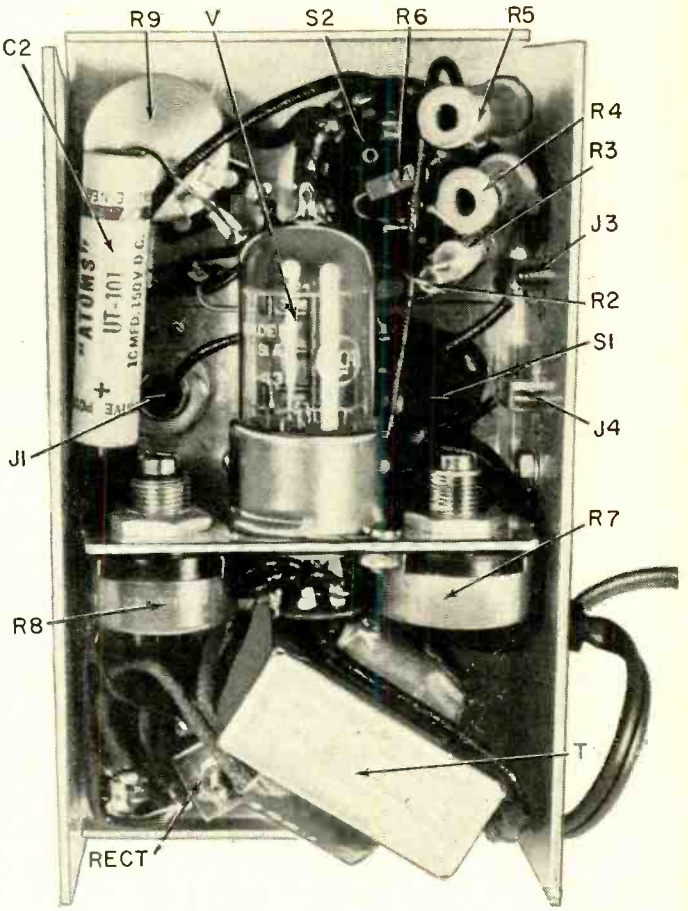
Each time I make
A needless callback
I sit and watch
My profits fall back!

VTMM modernizes your MULTIMETER

One-tube unit adds four vtvm dc voltage scales to your multimeter



(Above) Finished unit fits into a 5 x 3 x 2-inch case.

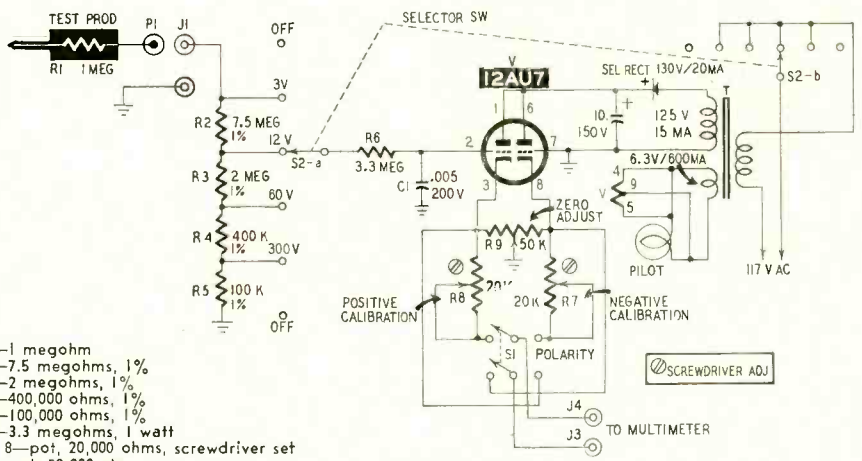


(Right) Positive and negative calibration controls are inside the case.

By JOSEPH CHERNOF

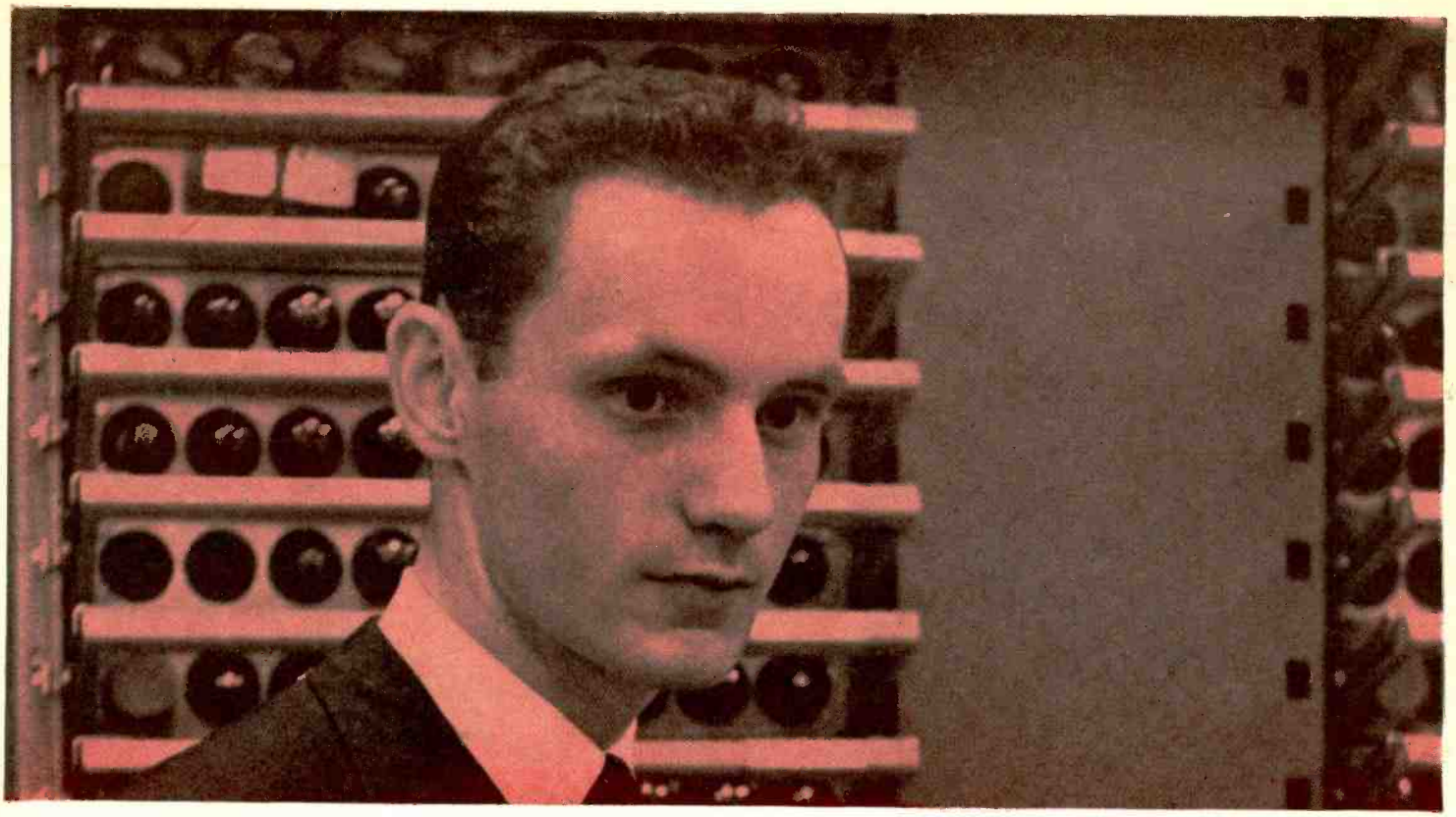
THE tremendous growth in variety and complexity of electronic equipment during the past few years has made using a vtvm for service work practically a necessity. Its extremely high input impedance makes it much more useful than the multimeter when making measurements in circuits where meter loading could have adverse effects. The vtvm is a fairly costly instrument, even in kit form, so many part-time service technicians and experimenters, myself included, have tried to get along with their original multimeters. This procedure has given varying results, some of them not too good. A logical compromise would be to modify the existing multimeter to give vtvm performance at as low a cost as possible. Since the average multimeter is pretty crowded, an external unit is indicated. The vacuum-tube meter modifier (vtmm) described here is a successful attempt at such a compromise.

The vtmm is designed to adapt the Simpson 260, Triplett 630 or any other similar multimeter with a basic 50–100-μa movement to dc vtvm operation. Voltage measurements are taken with a dc probe which connects to the vtmm, and a two-wire cable from the vtmm is the only connection to your multimeter. The entire unit is housed in a 5 x 3 x 2-inch case and has its own power supply which connects to the 117-volt line. Your multimeter's range switch is left on its most sensitive current scale and the range switch on



R1—1 megohm
R2—7.5 megohms, 1%
R3—2 megohms, 1%
R4—400,000 ohms, 1%
R5—100,000 ohms, 1%
R6—3.3 megohms, 1 watt
R7, 8—pot, 20,000 ohms, screwdriver set
R9—pot, 50,000 ohms
All resistors 1/2 watt 10% unless noted
C1—.005 μf, 200 volts, paper
C2—10 μf, 150 volt, electrolytic, miniature
J1—coaxial connector, male
J2—banana jack, uninsulated
J3, 4—banana jack, insulated
P—coaxial connector, female
RECT—20 ma, 130 volts, selenium
S1—dpdt rotary
S2—2-pole 6-position rotary, single deck
T—power transformer: primary 117 volts; secondary, 125 volts, 15 ma; 6.3 volts, 600 ma (Stancor PS-8415 or equivalent)
V—12AU7
Pilot-lamp assembly with No. 47 bulb
Test prod
Chassis (case), 5 x 3 x 2 inches
Miscellaneous hardware

Circuit of the inexpensive vtmm.



HOW FAR CAN YOU GO IN ELECTRONICS WITHOUT A DEGREE?

LESS THAN TWO YEARS AGO, 20-YEAR-OLD TIM WICKHAM HAD ASKED HIMSELF THIS QUESTION. Today, firmly established as a Computer Units Field Engineer with IBM, Tim knows some of the answers. His story of how he assumed important engineering responsibilities on one of our country's biggest electronics projects makes encouraging reading for every technician who feels himself handicapped by lack of a formal degree.

"I always wanted to be an electronics engineer," Tim says, "ever since I first tinkered with hi-fi in my high school days. But my formal education ended when I entered the Marines in 1953. In spite of the excellent radar training I received in the Service, I still had doubts as to how far I could go in my chosen field without a degree."

HEARS ABOUT IBM—AND SAGE

A few months prior to his discharge, Tim began to look into the opportunities for a civilian career. He heard about IBM, learned that IBM was willing to invest thousands of dollars training the right men to assume engineering responsibilities in the Project SAGE program. "Would I qualify?" Tim asked himself. To be brief, Tim did qualify, and upon discharge, reported to Kingston, N. Y., to begin training as an IBM Computer Units Field Engineer.

SAGE—PROJECT OF NATIONAL SIGNIFICANCE

SAGE—for which Tim was trained—means Semi-Automatic Ground Environment. It is part of America's radar warning system—a chain of defense that will ultimately ring our country's perimeter. At the heart of this system are giant electronic computers, built for the project by IBM. These computers receive data from Texas towers, picket ships, reconnaissance planes, radar stations—analyze the data for action by the Strategic Air Command and other defense units. "These computers are the largest in the world," Tim points out. "Each contains 58,500 vacuum tubes plus 170,000 diodes."

BECOMES FIELD ENGINEER

"My five months' training at Kingston were a revelation," Tim remembers. "Here were top-notch courses in advanced electronics, taught by instructors who really knew their business—and had a personal interest in our progress. We had classroom lectures in which we learned about basic computers, logic, programming, general machine operation—how everything worked together. Instead of a lab, we worked in actual test areas, along with the regular test area personnel. Incidentally, IBM went out of its way to make our stay at Kingston pleasant. They helped us with housing accommodations and we received a living allowance over and above salary during our training period."

INSTALLS WORLD'S LARGEST COMPUTER

His training completed, Tim was assigned to the Project SAGE site at Newburgh, N. Y. "The giant computer was ready for installation," Tim recalls, "but before it could be moved into its new building, 300 miles of cable had to be laid. Then we made interconnections and brought in the power. Next came the testing phase—a long procedure, as you may imagine, for a computer of this size. Then we set

up the auxiliary equipment. Finally, when everything was ready, the Air Force ran its acceptance tests—a stiff trial with no if's, and's or but's permitted. I'm happy to say we got an unqualified OK.

"My present work," continues Tim, "is in the Tape Section of the computer. I'm responsible for the maintenance of the Central Computer Tape System which includes eight tape drives (a means of storing information) and two tape adapter frames which adapt information for admittance into the Central Computer. A Computer Units Field Engineer like myself works in several areas of the computer, thus learning something about the whole system."

A NEW ENGINEERING DIMENSION

"IBM has proved to me," Tim says, "that a degree is not the only measure of a man's ability, or the only indication of what he can do when given the opportunity. Around me at the site I see a lot of men who were once considered 'just technicians'—men who have had a new engineering dimension added to their careers—all because IBM will spend time and money to train technicians for engineering responsibilities. I know this better than ever, now that I'm on the job. I'm on the Education Committee at the Newburgh site and I see what IBM will do to train men. My job on the committee is to find out what the men want. Then, IBM supplies courses, instructors, classrooms—everything that's needed."

YOUR CAREER OPPORTUNITY WITH IBM

Since Tim Wickham joined IBM and the Project SAGE program, opportunities are more promising than ever. This long-range program is destined for increasing national importance and IBM will invest thousands of dollars in the right men to insure its success.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 5 months as a Computer Units Field Engineer. While training, you receive full pay plus living allowance before assignment to a permanent location. You are paid a salary, not hourly wages, plus overtime.

From then on, you can go as far as your abilities and ambition will take you. IBM is the leader in a field that offers you unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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TEST INSTRUMENTS

the vtmm is then used for switching scales. The vtmm has an output impedance of 11 megohms which is comparable to that of most low-cost commercially available vtvm's.

The unit's circuit is shown in the diagram. A twin triode (V) is used to compare the voltage to be measured against a fixed potential—in this case, ground. The cathode currents of the tube's two sections will then differ by an amount proportional to the voltage being measured. The basic movement of your multimeter is connected between the two cathodes of the twin-triode so that, with zero input voltage applied to the first grid, the voltage drop across each portion of ZERO ADJUST control R9 is the same. The multimeter then indicates zero. With a voltage applied to the first grid, the balance between the cathode circuits is upset and current flows through the meter. Linearity is very good.

The SELECTOR switch (S2) allows the following full-scale readings on your multimeter: 3, 12, 60 and 300 volts—×1, ×4, ×20 and ×100 of the basic scale. A meter-reversing switch (S1) permits measuring positive or negative voltages without having to reverse the test leads manually. While the unit as shown can be used to measure only dc voltages, an ac rectifier probe will adapt it for measuring ac voltages.

A conventional power supply is used. Transformer T isolates the ground lead of the vtmm from the ac power line. A miniature 20-ma selenium rectifier (RECT) supplies about 150 volts dc output. Capacitor C2 provides ample filtering action. One gang of the SELECTOR switch is used as the on–off switch for the unit. A No. 47 pilot light is connected across the heater winding of the power transformer to show when the unit is on.

For best results, follow the parts layout as indicated in the photographs. Use only rosin-core solder in your wiring work. If the component values and characteristics specified are adhered to, the vtmm's accuracy will be limited only by the accuracy of your original multimeter. Note that all resistors on the SELECTOR switch must be within 1% tolerance or the unit's accuracy will be directly affected.

The test-prod lead is fabricated by soldering 48 inches of test-lead wire to one end of resistor R1. Insert and connect the opposite end of the resistor to the prod tip. Solder coaxial connector P1 to the other end of the test lead. The ground lead is made by connecting a banana plug to a 48-inch length of test-lead wire. Solder an alligator clip to the opposite end of the wire.

Calibration is short and easy. Obtain a fresh 1.5-volt flashlight battery and measure its voltage with your multimeter. Record the measured voltage. Now, connect the vtmm to the basic movement of your multimeter by plugging the two leads from J3 and J4 into the current-measuring jacks on the multimeter and setting the multimeter

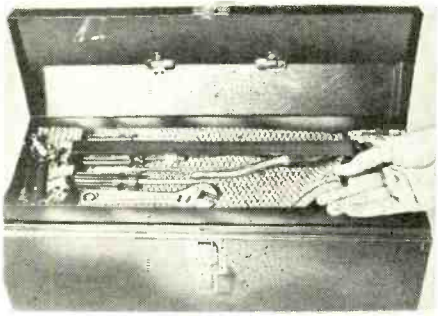
range switch to its most sensitive current range. Set the vtmm SELECTOR switch to its most sensitive voltage range (3 volts). Take the dc leads from the vtmm, short them together and adjust ZERO SET potentiometer R9 for zero meter deflection.

Next, measure the voltage of the flashlight battery with the dc probe lead of the vtmm going to the positive terminal of the battery and the ground lead to the negative terminal. Should your multimeter indicate a negative deflection, reverse POLARITY switch S1. Label the correct position of the switch under these conditions positive. Now adjust POSITIVE CALIBRATION control R8 so that the voltage reading on the scale of your multimeter is the same as that originally recorded. Next reverse the battery polarity and move POLARITY switch S1 to its opposite position which should then be labeled negative. Again short the dc leads together and check for zero on your multimeter. Adjust R9 if necessary. Then measure the battery voltage again and adjust NEGATIVE CALIBRATION potentiometer R7 until your meter reading again agrees with the previously recorded one. The vtmm is now calibrated.

NOTE: Always recheck the meter zero when switching from positive to negative. END

SPONGE SILENCES TOOLBOX

To silence the annoying racket made by loose tools rolling around in the metal trays of my toolbox, I purchased some sponge-rubber rug padding, cut



it to shape and placed it in the bottoms of the tray compartments. The sponge padding effectively damps out all of the noise made when I'm carrying the box (it used to attract attention from neighbors) and also treats the tools with the best of care.—*J. A. Stockton*

"Try reversing the plug."

ELECTRONICS

ECCLES-JORDAN CIRCUIT

A flip-flop or trigger circuit with some special advantages

By EDWIN T. BOHR

NOT too many years ago the Eccles-Jordan circuit was almost unheard of, but now it is one of the fundamental circuits of modern electronics. The name, especially, is still unfamiliar to most people in the field of communications.

At the transmitting end, the basic Eccles-Jordan circuit is used in some TV apparatus. The fancy chrome-trimmed machinery seen with the twinkling neon lights at atomic energy and Civilian Defense exhibits all use it. It is even probable that the can of beans you opened the other day had an E-J circuit hidden away in the manufacturing process.

The circuit is indispensable when it is desirable to time an event down to

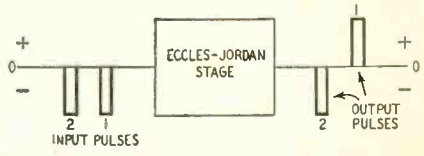


Fig. 1—Negative pulses fed into an E-J stage come out as alternate positive and negative pulses.

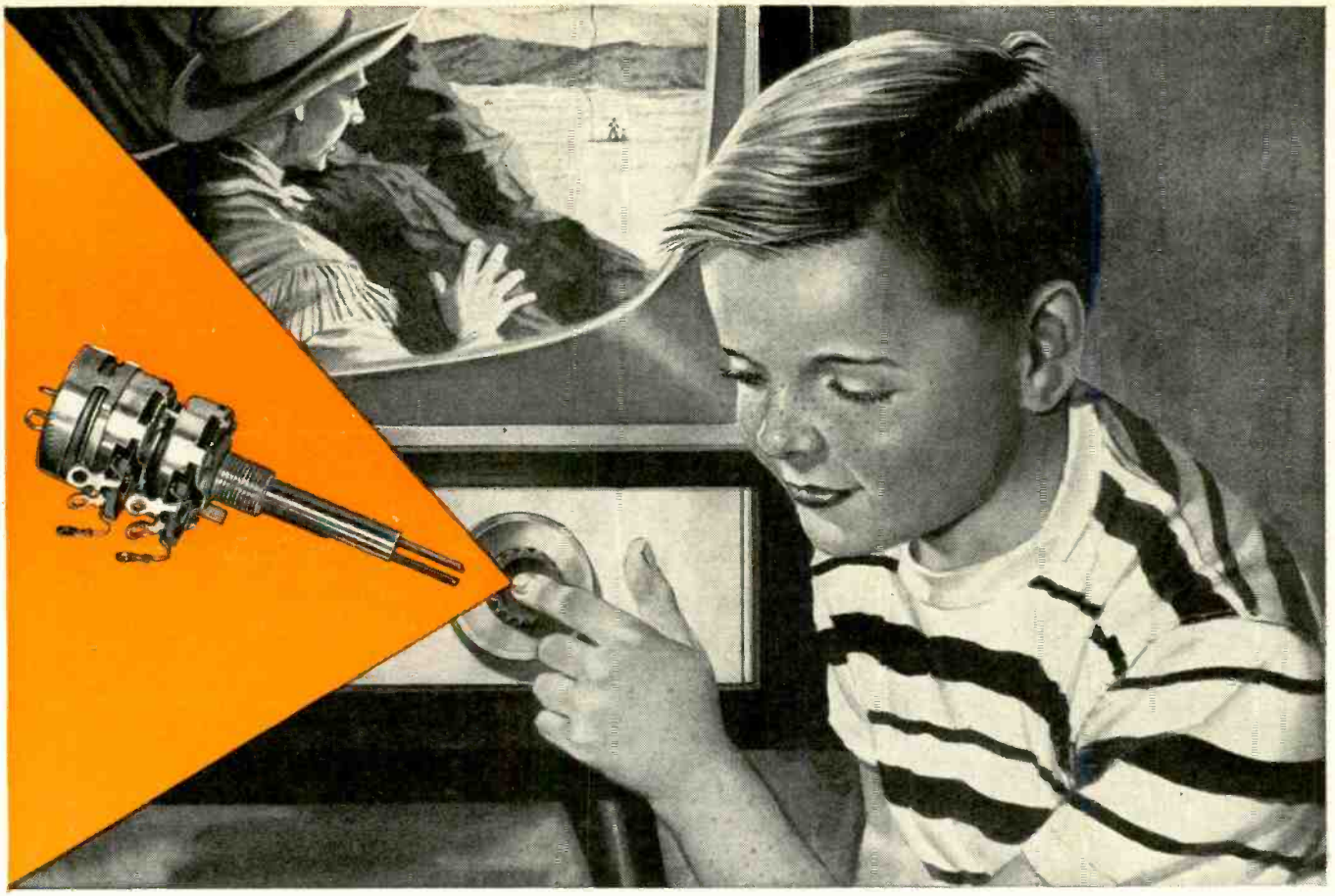
say .00001 second. Manufacturers of quartz crystals use E-J circuits to count exactly how many times a crystal oscillates in a second! Everyone in electronics should have some idea of how this versatile circuit functions.

The E-J circuit is a reversing switch that responds only to negative pulses. In other words, the E-J circuit is like a boxer who feels only left-hand blows and who responds with first a right jab and then a left. Fig. 1 shows this clearly. Two negative pulses are fed into the E-J stage. (Positive pulses may be mixed with the negative pulses but they do not affect the E-J stage.)

The first negative pulse produces a positive pulse in the stage's output; the second produces a negative pulse. *All odd-numbered pulses are changed to positive pulses and all even-numbered pulses remain negative pulses.* Only half as many negative pulses appear at the output as appear at the input. This results in a scale-of-2 action which, together with the proper indicating devices, can count thousands of times faster than any human or mechanical counter.

Circuit operation

Here is how the Eccles-Jordan cir-



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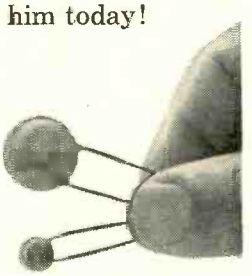

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cuit operates. Fig. 2-a gives the basic circuit. Assume that the two triodes have been disabled by breaking the plate leads, as shown in the diagram.

The cathodes of both tubes are 125 volts positive with respect to ground —this potential can be supplied from a voltage tap in the power supply.

The grids are connected in a voltage-divider circuit (from B plus to ground) composed of resistors R1, R2, R3 for V2 and R4, R5, R6 for V1. Typical values for these resistors are shown in the diagram. Notice that the grid bias for each tube is obtained from the voltage-divider circuit for the other tube—

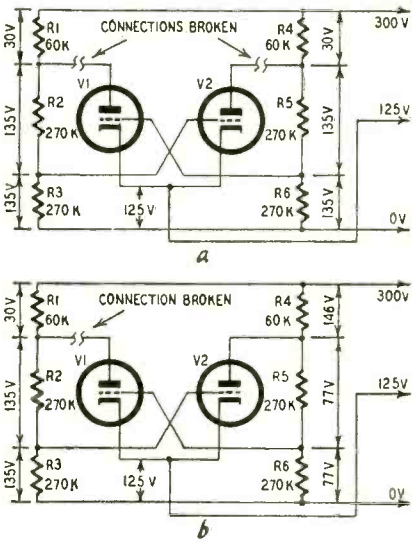

Fig. 2—Circuit examination shows why only one triode can conduct at any given moment.

they are cross-connected. There is a total of 600,000 ohms resistance in each divider. With the plates disconnected, 0.5 ma flows through each divider. A 30-volt drop appears across R1 and R4, and 135-volt drops across R2 and R3, and R5 and R6. This places the grids at a higher positive potential than the cathodes, causing the grids to have a positive bias. However, in actual operation grid current in the voltage dividers brings the grids and cathodes to about the same potential.

Each tube is capable of conducting current if its plate is tied into the circuit. Nevertheless, a further examination will show why it is impossible for both tubes to conduct current simultaneously.

Fig. 2-b shows what happens when the plate of only the right-hand triode (V2) is connected into the circuit. There is now a much larger voltage drop across R4 since the plate current of V2 must pass through R4. The grid of V1 is now 77 volts positive with respect to ground while the cathode is still 125 volts positive. V1's grid is now biased more than 40 volts negative into its cutoff region and is incapable of conduction. The plate of V1 may now be connected into the circuit, but the tube will pass no current.

If the tables were turned and V1 allowed to conduct first, V2 would be

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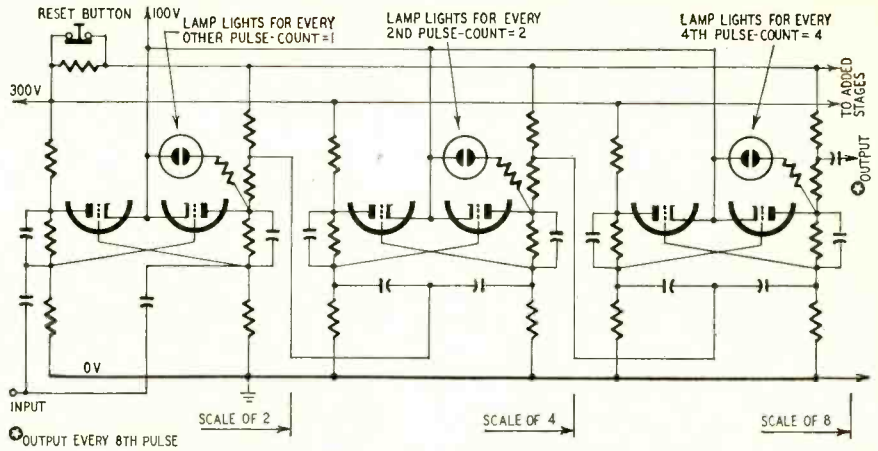


Fig. 3—A complete scale-of-8 Eccles-Jordan circuit.

biased to cutoff. Whichever triode conducts first will take preference and bias the other to cutoff.

The working voltages given here are merely representative—each circuit is always designed for optimum results with a given set of working conditions.

A negative pulse will cause the triodes to swap operating conditions—if V1 is conducting and V2 is cut off, a negative pulse fed into the circuit causes V1 to be cut off and allows V2 to conduct. Here is why.

A negative pulse of sufficient height or amplitude drives the *conducting* triode to cutoff, lowering the bias on the other tube and enabling it to conduct and take preference.

Positive pulses, within limits, have no effect on the circuit since they do not tend to reverse the operating conditions of the conducting tube.

Flip-flop counting

A complete scale-of-8 Eccles-Jordan circuit is shown in Fig. 3. Coupling capacitors have been added to permit application of switching pulses.

Neon glow lamps are incorporated into each stage. Whenever the triode across which the lamp is connected conducts, the lamp goes out. If the triode is cut off, there is enough voltage across the neon lamp to cause the gas to ionize and light. Output pulses are obtained from a tap on one of the plate load resistors.

The first negative pulse, as shown in Fig. 1, causes a *positive* pulse to appear in the output as operating conditions are swapped. Now look at Fig. 3. This first negative pulse turns on the neon lamp in the first stage. The second pulse turns off the lamp in the first stage and turns on the lamp in the second stage. The circuit has counted and indicates 2 pulses. A third pulse relights the first neon lamp and sends on a positive pulse to the second stage. Stage two is not affected by this pulse so its light stays on.

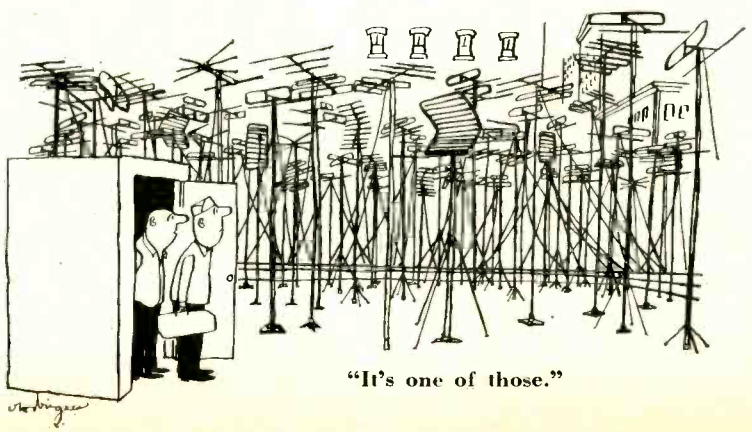
The neon lamps numbered 1 and 2 are now lit, indicating a count of 3 pulses. The procedure continues for any number of pulses.

The incoming pulses are reduced by a factor of 2, 4, 8, 16, 32, 64 and so on. A scale-of-64 circuit requires 6 stages. Each negative output pulse from such a circuit represents 64 input pulses. The neon lamps will indicate the pulses up to 64. An electromagnetically actuated mechanical counter can usually be used to count every 64th pulse.

A reset button momentarily causes all triodes shunted by neon lamps to conduct. This condition is stable and all neon lights remain off until more pulses arrive.

Some special Eccles-Jordan circuits have an automatic forced reset feature on the 10th pulse. With this method, pulses are counted as 1's, 10's, 100's, 1,000's and so on.

Be on the lookout for the E-J circuit in schematic diagrams. It is now used in everything from audio test equipment to timers for hot-rods. END



"It's one of those."

GUIDANCE—SIMPLIFIED

The following item on inertial guidance was sent to us by Colonel William J. Stover, Headquarters Fifth US Advisory Group, St. Paul, Minn.

Dear Editor:

Having just completed Philip Julian's excellent article titled "Inertial Guidance Directs Planes and Missiles" which appeared in your December, 1958, issue, it occurs to me that your readers might be interested in the enclosed nontechnical explanation of inertial guidance:

The following are excerpts from a report explaining, in simplified terms, the operation of a typical inertial guidance system.

". . . The missile knows where it is at all times. It knows this because it knows where it isn't. By subtracting where it is from where it isn't, or where it isn't from where it is (whichever is greater), it obtains a difference or deviation. The inertial guidance system uses deviations to generate corrective commands to drive the missile from a position where it is, to a position where it isn't; arriving at the position where it wasn't, it now is. Consequently the position where it is, is now the position where it wasn't, and it follows the position where it was is the position where it isn't. In the event that the position where it now is is not the position where it wasn't, the system has acquired a variation (variations are caused by external factors, and the discussion of these factors is not considered to be within the scope of this report), the variation being the difference between where the missile is and where the missile wasn't. If variation is considered to be a significant factor, it too may be corrected for by the use of the Mark II system; however, the missile must now know where it was also. The "thought process" of the missile is as follows: because a variation has modified some of the information which the missile has obtained, it is not sure where it is. However, it is sure where it isn't (within reason), and it knows where it was. It now subtracts where it should be from where it wasn't (or vice versa) and by differentiating this from the algebraic difference between where it shouldn't be and where it was, it is able to obtain the difference between its deviation and its variation, which is called error. . . .

. . . This company also produces an extremely accurate command-guidance system".

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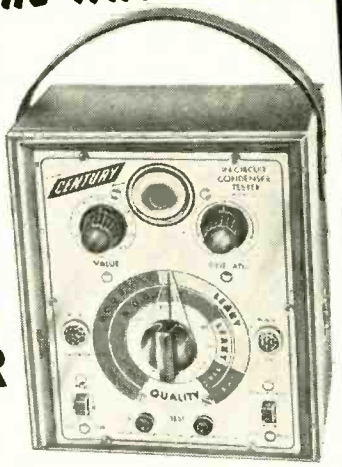

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- Quality of all electrolytic condensers (the abiilty to hold a charge)
- Transformer, socket and wiring leakage capacity

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- Quality of 100% of all condensers . . .(leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
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IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished at no cost.

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Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

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MANY readers ask about converting receivers to larger picture tubes. Hence, we are listing the more usual requests, with notes concerning the conversions.

7JP4 to 12-Inch Tube: Not a practical conversion. Too much rebuilding.

9CP4 to 21-Inch Tube: Not practical.

10BP4 to 12KP4: No circuit changes necessary. Ion trap not needed.

12LP4 to 16LP4: The conversion can be made, but picture brightness will be low unless a higher-voltage flyback is used.

12LP4 to 17ATP4: Conversion is practical, with replacement of the flyback and vertical output transformer.

12LP4 to 21FP4-A: Not advisable. Requires extensive electrical and mechanical changes.

16GP4 to 16RP4: Mechanical changes are required, but is a practical conversion.

17AHP4 to 21EP4: Few changes required. Yoke sometimes needs to be changed.

17BP4 to 21EP4: No modifications of sweep and high-voltage system are required.

17CP4 to 19JP4: Conversion is practical; replacement of flyback gives a brighter picture. The same double ion trap can be used.

19AP4 to 21EP4: No change of output transformers required. Mechanical changes only.

19VP22 to 21CPY22: Use the CBS conversion kit. Conversion is practical, with the necessary mechanical changes.

20BP4 to 21EP4: No change of output transformers required. The 21EP4 is easier to sweep than a 20-inch tube.

21AMP4-A to 21CP4-A: Flyback, yoke and vertical output transformer must be changed. It is advisable to use a standard 90° conversion kit.

21MP4 to 21XP4: Mechanical changes only are necessary.

24AP4 to 27RP4: New yoke and flyback are required.

24AP4-A to 24CP4-A: Use a standard conversion kit, with matched yoke and flyback for a 24-inch 90° tube.

24BP4 to 24DP4-A: Not a completely practical conversion. Extensive mechanical changes are necessary.

Poor vertical sync

I'm up a stump on a complaint of poor vertical sync and bottom fold in a Truetone 2D3814A. All tubes have been changed, and dc voltages measure OK. Alignment checks with the service data. Could any of the parts have changed to cause this trouble?—W. P. V., Vale, Ore.

Your report has a familiar ring. I ran into a very similar problem recently, in which the symptom was the same. After a lot of wasted time in re-

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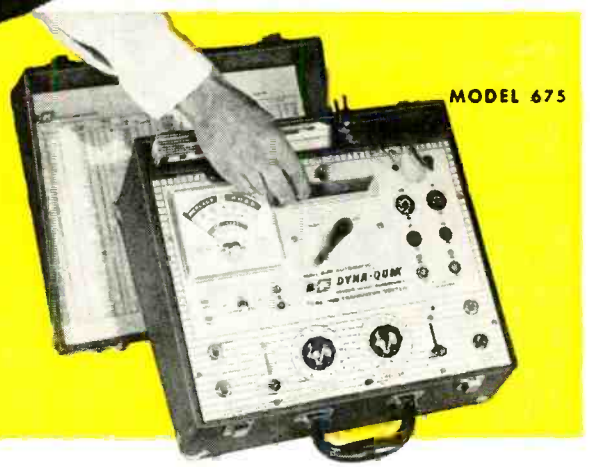

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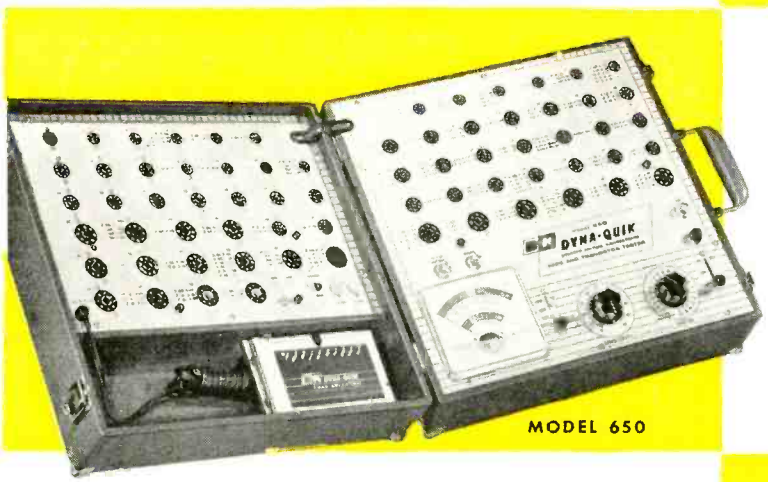

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placing components which "must be" bad, a scope check showed that spurious ac voltages were getting into the sync and vertical oscillator circuits via marginal decoupling electrolytic capacitors. After pointing out this basic possibility several times in the Clinic, my own face gets red when I forget it myself.

Residual bright spot

I would like to eliminate the bright spot which remains on the picture-tube screen after switching the power off, in an Admiral model 330. I will welcome any help on this problem.—J. P. R., Ridge, Md.

Several methods can be used, as discussed in the "TV Technotes" book published by Gernsback Library. A simple method which often works out satisfactorily is to shunt a 500-megohm resistor from the picture tube's second anode to chassis. The resistor must have suitable high-voltage construction, such as a multiplier resistor for a high-voltage dc probe.

Pincushioning

I would appreciate any suggestion on a cure for curved raster lines (pincushioning) on an RCA KCS-40. This trouble showed up after replacing the yoke.—S. C., Baltimore, Md.

The pincushioning has been caused by a mismatch between the picture tube and the new yoke. However, instead of obtaining an exact replacement for the yoke, I would suggest using anti-pincushion magnets. In some sets, the magnets can be taped to the side of the picture tube, near the face, in a location which clears up the pincushioning. In others the magnets have to be spaced a bit from the sides of the picture tube.

No alignment data

I would like to realign a Philharmonic 8200 receiver, but cannot obtain data. Perhaps you can help out.—L. H., Philadelphia, Pa.

You can get the receiver into reasonably good alignment without data, by proceeding as follows:

1. Use a good sweep generator and scope, with a crystal-calibrated marker generator.
2. Disable the local oscillator.
3. Apply a modulated marker signal to the mixer grid. Connect the scope at the picture-detector output, through a 75,000-ohm isolating resistor.
4. Clamp the agc line at −3 volts with battery bias.
5. Tune the marker generator and watch the scope screen to determine whether the if amplifier operates in the 23-mc or the 41-mc band.
6. Connect the sweep-generator output (with marker) to the mixer grid. Adjust sweep-generator tuning for correct center frequency.
7. Select a reasonable frequency for the picture-carrier point on the curve.
8. Stagger-tune the if stages for 3.5- to 4-mc bandwidth. That is, if the grid of one tube resonates in the low end of

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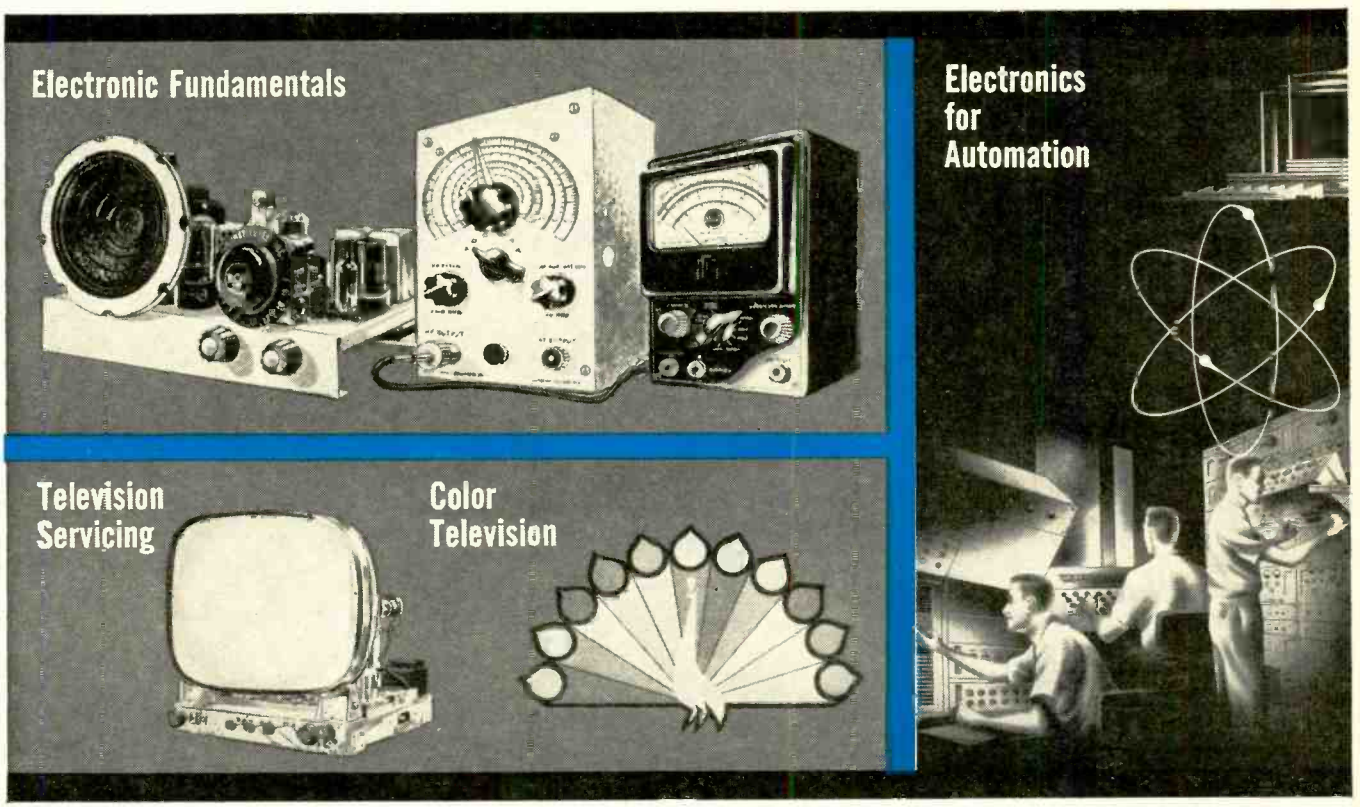

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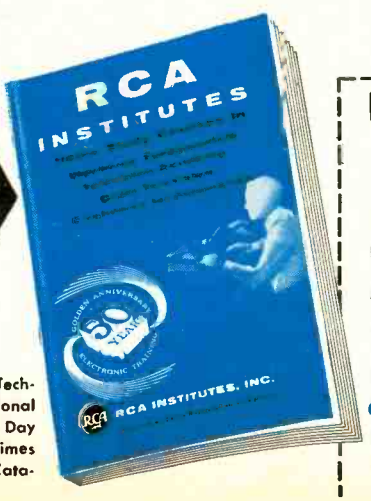

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the band, resonate the plate circuit in the high end of the band.

9. Tune sound traps for dip 4.5 mc from the picture-carrier frequency. (Traps operate on the low end of band — picture carrier on the high end.)

10. Make necessary compromise adjustments of if trimmers to obtain a reasonably flat-topped curve. (Remember that the first if coil may be mounted on the rf tuner.)

11. Disconnect the sweep and marker generator from the mixer grid, and start up the local oscillator.

12. Apply rf sweep and marker signals to the receiver's antenna input terminals. Sweep in turn each active channel.

13. Adjust rf and mixer trimmers for maximum height of overall response curve, without changing the original bandwidth of the if strip. (This is a compromise adjustment, as response will vary from channel to channel.)

14. Finally adjust local oscillator for proper fine-tuning range, using TV station signals.

Hot flyback

The flyback overheats in an Emerson 120129-D. Most of the sweep-circuit components have been checked as OK or replaced. The waveforms have correct shapes, except at the Synchroguide output terminal. The B voltages are close to normal. Yet, the flyback transformer overheats.—W. S., Saco, Me.

Your data sheet indicates the use of a direct probe. This distorts the waveform at the Synchroguide test point. A low-capacitance probe must be used, as shown in Fig. 1. Flyback overheating can usually be run down by checking voltages at the horizontal output tube. Normal voltages are: grid, −17; cathode, 10; screen, 125. Plate voltage cannot be measured without damaging the meter, but is not normally a trouble source. Dc checks will probably indicate the faulty circuit, but if further tests are required, the sweep-circuit waveforms and peak-to-peak voltages should be checked against the service data.

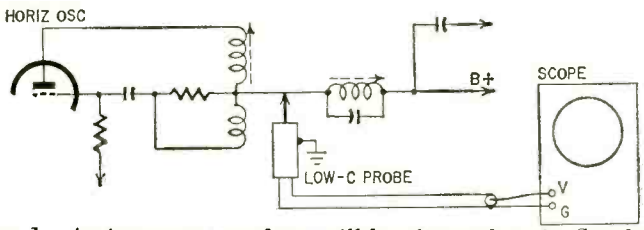


Fig. 1—An incorrect waveform will be observed at the Synchroguide test point unless a low-capacitance probe is used.

Pix and sound don't track

I realigned the video and sound if amplifiers in a Craftsman RC-200, but picture and sound do not track. I followed the service instructions carefully. However, I can't get a meter null on the sound traps. I used a marker type generator and a vtvm. Thank you for your reply.—A. P., Portland, Ore.

This difficulty appears to be caused by lack of marker-generator accuracy. The picture carrier is falling too low on the overall response curve when the local oscillator is tuned to bring the sound if in. The RC-200 is somewhat more critical to align than various other receivers because it has a split-sound system. Marker frequencies must be determined accurately. Crystal calibration is advised. Better alignment is generally obtained by using a good sweep generator and scope, in conjunction with a crystal-calibrated marker.

Light on one side of screen

I am having some difficulty with a Motorola TS-236. It has a very good picture, with no pulling, but at times there is a sort of light at the left side, which covers about one-third of the picture. It moves as persons move on the screen. At times it is not noticeable when there are no moving objects. Any help you can give will be appreciated. —E. J. S., St. Louis, Mo.

This varying film of light is caused by video information caught on horizontal retrace. The cause can be due to a marginal fault in the flyback, which will sometimes lengthen the retrace interval. It can also be caused by a replacement yoke that has too much inductance for the flyback. There is also the possibility of a defect in the phase detector circuit, which throws the video somewhat out of time with the horizontal sync interval. Any circuit modifications which add capacitance to the flyback system will tend to cause this trouble. For example, I have seen this film of light appear in receivers having too much capacitance added across the width control, to increase picture width. High-voltage leads from the flyback transformer running against the cage or chassis also increase the flyback time.

Foldover and poor height

I am having difficulty with a Zenith 21K20. After installing a new picture tube (21FP4C) and a Merit MDF72 yoke, height is insufficient, with bottom foldover. All voltages and components check OK.—A. J. E., Jr., Somerville, N. J.

It would appear from your report that the new yoke does not match the vertical output circuit as well as the original yoke. I assume, of course, that you have tried new tubes. On the basis of the data submitted, it would be advisable to obtain an exact replacement for the yoke. END

fm tv dx

By ROBERT B. COOPER, JR.

IN the November, 1958, FM–TV Dx Column, we asked for comments on the pros and cons of continuing the predictions portion of this column. And we received an enthusiastic "yes." This we are happy to do, although some modifications will be made. More emphasis will be placed on meteor-shower reception dates, and on the "annual" tropospheric dx conditions, in hopes that more serious-minded dxers will make special efforts during these high dx potential periods, and report in detail.

F2 surpasses 1957–8 season

Readers of the June, 1958, TV Dx Column will remember reports carried of the first F2 television dx reception between the East and West coasts of the US. Several dxers in Oregon, Washington and extreme northern California logged Maine, New York and New Brunswick channel-2 video signals during Jan. 1–9, 1958.

In the third week of October, 1958, F2 conditions were improving at such a rapid rate that Amateur Radio 6-meter (50–54 mc) enthusiasts were making two-way contacts of a transcontinental nature on an almost daily basis.

As the maximum usable frequency (muf) continued to rise, lines and other signs of video information began to be noticed on channel 2 by alert California dxers for a few minutes each day during peak periods, and have been reported by dxers on Nov. 7, 11, 12 and 22. On the morning of the 23rd, Rick Stauduhar, Carnichael, Calif., found channel 2 jumping with fast fading, highly distorted video signals from 0850–1005 hours PST. But the morning of the 24th proved to be the cincher. Your column conductor was caught away from his dxing setup in Fresno, Calif., but managed to make a hastily erected dipole of 300-ohm twin lead deliver a very watchable signal from WCBS-TV, channel 2, New York, from 0910–0947 hours PST, in San Jose, Calif. It was interesting to note that an outside antenna (double-stacked all-channel Yagi) produced such severe video distortion that watching the picture was not possible.

The multiple-path images present caused such severe distortion that the picture resembled 50 secondary images superimposed upon the primary image, and all 51 of them were fading at separate intervals! The dipole antenna provided a much lower overall signal level, but at the same time it reduced the signal level of the multiple-path secondary images so they no longer caused bad ghosting on the primary "direct-path" image. Net result was a very watchable picture (in itself unusual for F2 reception) with a minimum of distortion and fading.

International F2 dxing

Reception along the eastern coast of the US and Canada of European TV transmissions between 40 and 54 mc has been with us since the fall of 1956 when the present high sunspot peak first made itself felt in the world of vhf. On days of particularily calm conditions in the earth's magnetic field, European TV signals have been picked up on the western coast of the United States by the half dozen or so enthusiasts equipped to receive the various sets of European standards. Gordon Simkin of Loma Linda, Calif., has been

TELEVISION

a leader in the field of European TV reception, having furnished information on receiver modifications to all interested parties. Gordon's dxing locale is especially unruly in that he receives grade-A signals from all seven of the Los Angeles stations and fights the hundreds of commercial FM two-way stations in the 40–50-mc region for his European dx reception. On Nov. 7, Gordon got video signals in Loma Linda from one station in France, one in Belgium and six in Great Britain!

Other than the great quantity of stations present on this date, it is particularly interesting to note that signals extended as high as 53.75 mc; certainly a record high F2 muf for a television path nearly 6,000 miles long. Similar reception was noted on Nov. 16, plus a second French station operating with a video carrier on 52.4 mc.

Although F2 TV conditions will end by March 1, the potential may exist again next fall provided that the sunspot count holds up one more year. (The F2 dx season in the Northern hemisphere runs from Nov. 1-Feb. 1 with reception along east–west radio paths). Want to see BBC, direct from London, in your own home? Reception next fall is likely to be the last for at least 8 years.

Early hours' dxing

With increased network programming, TV stations are finding it increasingly difficult to perform normal transmitter tests. The available hours have shrunk until the only feasible period seems to be between 0130 and 0630 LST. Thus, many transmitters are using these hours to test new equipment and tune the old. This is an encouraging note to the TV dxer with a multitude of local and semi-local stations filling every vhf channel with signals much too strong for weak dx to ride over. As most stations test only one or two mornings a week, it is usually possible to find nights when dx stations are testing and local stations are off the air. And early-morning dx conditions (ground wave) are usually very good, especially in the 0500–0700 LST segment.

John T. Sowders, Richmond, Ky., has noted most stations transmit test patterns while testing, facilitating weak-signal and meteor-scatter identification. John's early morning logs have frequent mention of stations in the 200–400-mile range during the late fall.

Eastern dxer moves west

Bob Weems, formerly of State College, Mississippi, one of our champion dxers of 1955 moved to Reno, Nev., in 1956. The drastic change in dx conditions has led him to several conclusions.

"One of the greatest jolts that can come to an Eastern dxer is to move to the Western states. Prior to moving to Reno on July 1, 1956, I had logged 175 stations representing the US, Canada, Mexico, and including a substantial number of uhf stations. One of the latter was channel 23, Miami, Fla. (no

TABLE OF METEOR SHOWERS

Name	Date	Time of Max. Burst Rate	Direction of Best Reception	Grade
Bootids	March 10–12	2330–0030		
		0530–0630	north–south	C
		0030–0330	east–west	C
Coma Berenicids	March 20	2000–2300		
		0100–0300	north–south	C
		0300–0430	east–west	C
Lyrids	April 19–23	2330–0100		
		0230–0530	north–south	A
		0700–0830	east–west	A
Aquarids	May 1–6	0830–1000	north–south	A
		0500–0830	east–west	A

longer on the air), a distance of 750 miles. All of the above were duly reported to RADIO-ELECTRONICS and have been carried in the annual summaries.

"Believing that it would take me only a short time to get back into the league, I took all my dxing equipment with me to Reno. Although I have been working on dx as diligently as ever, it has taken me over 2 years to get back into the Over 50 TV Dx Club. E skip has been about the same, but tropospheric dx is altogether missing, and uhf out of the question. I, for one, am ready to state positively that the Western dxer has natural odds of 3 to 1 against him."

However, Bob did have the thrill of logging WCBS-TV, channel 2, New York, by F2 skip on Jan. 6, 1958; a feat also enjoyed by several others on or near the West Coast.

Predictions

The following data on meteor showers are consistent with information now being used by professional "scatter circuit" engineers and may be considered 100% reliable. Unlike "unpredictable" Es and trops openings, meteor showers are recurring on an annual basis (some exceptions will be discussed in a future issue) and can provide excellent results year after year. The grade of meteor showers (potential) begins with A (top grade) and descends to D (low burst rate, mediocre results).

To illustrate the use of the meteor-shower table, let's take a practical example. You live in upstate New York and want to make a try at WBRC-TV, channel 6, Birmingham, which you know will be testing on the morning of March 10, during the Bootids shower. As Birmingham is south of you, pick a time when north–south radio paths are best during the shower. The chart tells us that 2330–0030 and 0530–0630 hours are the best periods. As you have a local on the same channel until 0100, the only period remaining is 0530–0630. Simply follow normal meteor-scatter techniques during this period, and you have yourself a new station!

Trops

The period of March 15–April 30 is regarded as excellent for long-range tropospheric conditions along the coast of the Gulf of Mexico and across the southern US. Reception is usually associated with the movement of wet–humid air masses originating in the Gulf and moving into the Southern states. Watch your TV and newspaper

TELEVISION

weather maps for signs of large-scale changes in the overall weather pattern.

This period is an excellent one for dxers to log many high-band channels (7–13) and uhf stations in the 200–1,000-mile range, especially those which come to your receiver over the water of the Gulf. Be familiar with the high-band vhf and the uhf channels available to you in this range. When the general tropospheric conditions improve, warm up the uhf converter, point the uhf antenna in the correct direction and keep your eyes open. Dxers in Southern US are missing a sure bet at some fabulous conditions if they pass up this period without some concentrated effort. Best hours are 1700–0200 and 0600–0900 LST.

E skip

An occasional Es opening may be expected over the western and southern areas, especially during mid-March and late April (after April 15). The hours of 1500–2200 LST will be the most productive. Watch channels 2, 3.

Auroral Es

Great Lakes and northeastern Canadian dxers should be aware of the probable dx openings on channels 2–6 during heavy auroral conditions. March and April 1959 should produce some of the heaviest aurora sessions ever recorded by man. Watch your low-band channels for signs of aurora (very blurry-hazy lines sliding across the screen in a vertical movement, with the antenna pointed to the north) which may develop into auroral skip. The best hours continue to be 1700–0100 LST.

Fm dx record

The rise of the F2 maximum usuable frequency has provided us with what is probably a new world FM Dx record, and has served to remind us that the FM band was not always in the 88–108-mc region. Gordon Simkin, Loma Linda, Calif. notes the reception of HLKA-FM, Seoul, Korea, on several occasions in November, and with special emphasis on Nov. 4 when their 46.3-mc signal was S9 "with full fidelity" for an hour, between 1600 and 1700 PST. Gordon notes that they gave their call sign in English at 1630 PST. This is an unofficial distance of 5,600 miles, probably the longest haul yet of a regularly scheduled FM station.

FM dxers should pay particular heed to the predictions information found elsewhere in this column, with emphasis on meteor shower and tropospheric conditions. We have yet to receive a report of a FM-band haul via either MS or aurora propagation.

Report forms

RADIO-ELECTRONICS continues to provide readers of the FM–TV Dx Column with the chance to report their dxing activities on special report forms. The forms are free, easy to use. Send postcard to FM-TV Dx Column, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

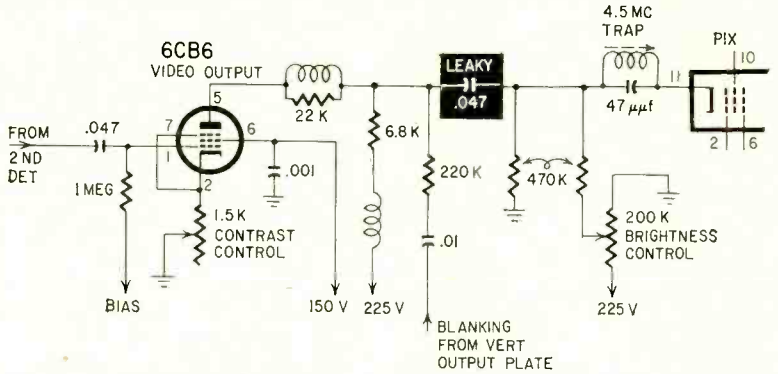
END

Technotes

EMERSON CHASSIS 120192

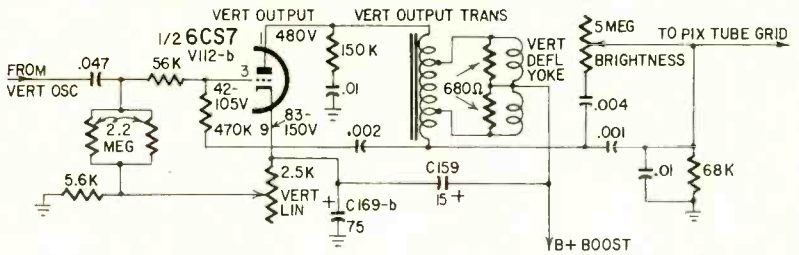
Intermittently the picture and raster would disappear for a few minutes at a time after the set had warmed up for 20 or 30 minutes. Cutting off the power would restore normal operation for another 20 or 30 minutes.

In several of these sets, this problem was linked to intermittent leakage in the .047-μf coupling capacitor between the video output tube and the picture-tube cathode. Replace with a high-grade 600-volt capacitor.—*Lawrence Shaw*



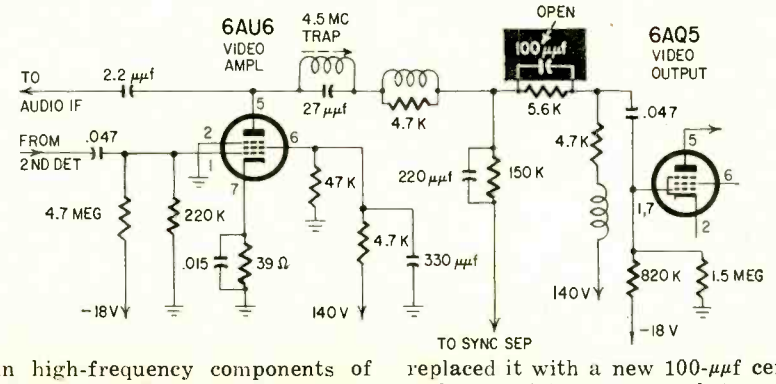
CROSLEY 472

Symptoms: no vertical deflection, insufficient horizontal deflection and a very peculiar distortion in the middle of the short horizontal line remaining visible on the screen. Voltages shown are proper, but the voltages I found were: control grid, 150 volts negative; cathode, 10 volts positive; plate, 250 volts positive. An oscilloscope showed vertical sweep to the grid but tremendous horizontal pulses at the cathode. C169-b was open, permitting damper pulses to feed through C159 to the cathode, causing the cathode to act as a plate and the grid as a cathode. Of course, replacing C169-b with a 75-μf electrolytic capacitor restored normal operation.—*Larry South*

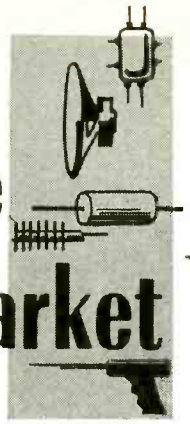


PHILCO CHASSIS R-191

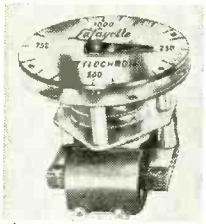
The set came in with loss of picture detail, which immediately indicated a loss in high-frequency components of the video signal. The 100-μμf capacitor which passes the high-frequency components from the video amplifier tube to the video output tube was open. We replaced it with a new 100-μμf ceramic, and the picture returned to normal. —*A. R. Clawson.* END



On the Market

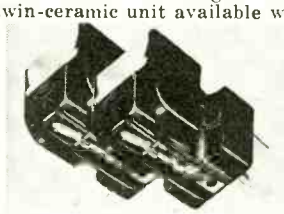


STYLOCHRON, *model PK-224.* Guide for stylus replacement. Basically a 1,000-hour clock movement with dial calibrated in 50-hour units. Acti-



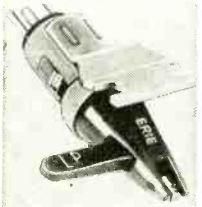
vated by turntable or changer motor, unit records time motor is in operation. Mounts on motorboard.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

STEREO CARTRIDGE LINE. 4 models of *Constant Displacement* stereo cartridge. Basic twin-ceramic unit available with



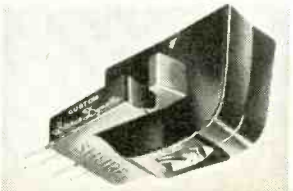
either diamond or sapphire stylus and in either "in-phase" or "out-of-phase" connection.—**CBS-Hytron,** Danvers, Mass.

STEREO CARTRIDGE, *model 1304 ST-ERIE-O.* Single ceramic element. Oil-damped to prevent resonance peaks. Turnover unit has 0.7-mil diamond



and 3-mil sapphire styli. Response 20—16,000 cycles. 0.5-volt output per channel at 1,000 cycles. Compliance 3 × 10^{-6} cm/dyne, vertical and lateral.—**Erie Resistor Corp.,** 644 W. 12 St., Erie, Pa.

MAGNETIC STEREO CARTRIDGE, *M7D Custom Stereo Dynetic.* Moving-magnet type.

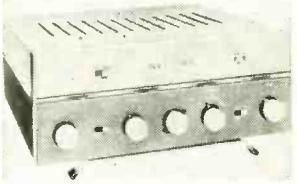


Response 20–15,000 cycles. 20-db channel separation at 1,000 cycles. Output, 5 mv per channel at 1,000 cycles. Vertical and lateral compliance 3.5 × 10^{-6} cm/dyne. Tracking force, 4–7 grams. Replaceable 0.7-mil diamond stylus.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

STEREO AMPLIFIER, *Knight model KN-1515.* Two 15-watt amplifiers on single chassis. Basic amplifier has no controls. Response flat within ½ db from 20–20,000 cycles. Harmonic distortion never exceeds 1.5%. 4-,

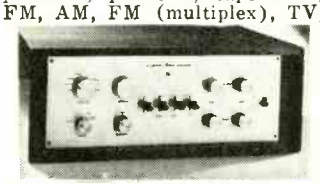
8-, 16- and 32-ohm outputs.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

STEREO PREAMP - AMPLIFIER, *model DB 230.* Dual-channel unit provides two 30-watt stereo channels. Frequency response flat within ½ db from 20–20,000 cycles. Harmonic distortion less than 1% at full out-



put. Has function selector, volume, bass, treble, balance, high-low filter and speaker phasing controls. Inputs for tape, phono, radio, auxiliary.—**David Bogen Co.,** Rt. 4 at Forest Ave., Paramus, N. J.

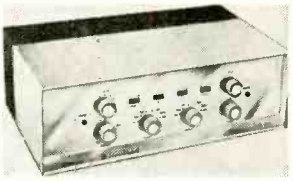
STEREO CONSOLE, *model 7.* Self-powered stereo preamp. 9 inputs for each channel—mike, phono 1, phono 2, tape head, FM, AM, FM (multiplex), TV,



auxiliary. 1 recording and 2 amplifier outputs for each channel. 6 ac outlets (117 volts), all but one controlled by master power switch. Selector, mode, volume, balance, bass, treble, record equalizer, tape playback or monitor, high filter, rumble filter and master power controls. IM distortion better than

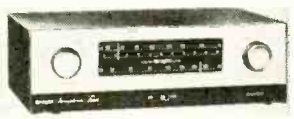
0.1%. — **Marantz Co.**, 25-14 Broadway, Long Island City, N. Y.

STEREO CONTROL CENTER, *model CS-28*, kit or wired. Combination dual preamps and



amplifiers. 14 watts per channel. Response 20–20,000 cycles. IM distortion 1% at 14 watts. Harmonic distortion less than 1% from 30–20,000 cycles at rated output. Hum–noise—70 db for low-level inputs, 80 db for high-level. 4-, 8-, 16- and 32-ohm speaker outputs.—**Arkay Inc.**, 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y.

STEREO FM–AM TUNER, *Knight Bantam KN-130*. Independent FM and AM sections. FM response flat within 0.5 db from 20–20,000 cycles. FM sensitivity 4 μv for 20-db quiet-



ing. AM sensitivity 10 μv for 20-db signal-to-noise ratio. Selector, tuning, afc controls. 8 tubes plus selenium rectifier. Supplied with two 36-inch audio cables. Dual outputs provide for stereo or monaural taping of program material.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

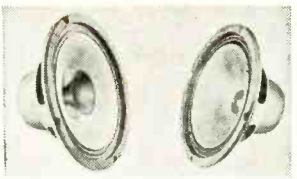
STEREO RECORD PLAYER-CHANGER, *Miracord XS-200*. Push-button-controlled unit acts as turntable or changer,

just change spindle. 4 speeds. Intermixes 10- and 12-inch records. 4-pole motor. – **Audiogersh Corp.**, 514 Broadway, New York 12, N. Y.

SPEAKER SYSTEMS. *Mardi Gras. ALC1* and *ALC2*. Response: 50–15,000 cycles. 10–15 watts continuous power-han-

dling capacity. 4-, 8-, and 16-ohm taps. Blond, walnut and mahogany cabinet finishes.—**JFD Electronics Corp.**, 6101 16th Ave., Brooklyn 4, N. Y.

HI-FI SPEAKERS. *Model F-8-HF* (right), single-cone wide-range unit. 60–12,000 cycles within 5 db. Extended-range *F-8-HFD*, dual-cone unit. 60–17,000 cycles within 5 db.

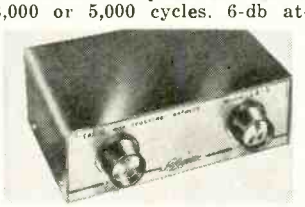


Both rated at 8 ohms, power rated at 12-watts continuous program material.—**Minneapolis Speaker Co.**, 3806 Grand Ave. So., Minneapolis 9, Minn.

SPEAKER BAFFLES with speakers installed. *WB-8AS*—

8-inch wall baffle. *WB-12AS*—12-inch wall baffle. *SCB-8AS*—8-inch slanting corner baffle. *SCB-12AS*—12-inch slanting corner baffle.—**Argos Products Co.**, Genoa, Ill.

CROSSOVER NETWORK, *model LN-5*. For 2- or 3-speaker systems. Crossover frequencies at 350 or 700 cycles and 2,000/3,000 or 5,000 cycles. 6-db at-



tenuation per octave. For 8- or 16-ohm speakers. — **Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

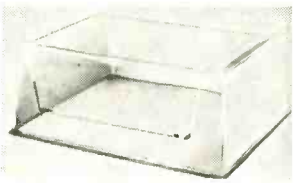
AUDIO BATON, *model B-9*. 9-channel tone-control system. Goes between preamp and amplifier. Can amplify or attenuate level of each octave throughout full audio range. Provides infinite selection of audio-frequency responses for optimum

tonal balance.—**Blonder-Tongue Laboratories Inc.**, 9 Alling St., Newark 2, N. J.

TURNTABLE KIT, *model TDX 101*. ½-hour assembly time. Idler automatically disengages when unit is turned off. Adjustable speed (±3%). Built-in strobe disc. Drive mechanism completely enclosed. Belt plus

idler drive.—**Thorens Co.**, New Hyde Park, N. Y.

CHANGER COVER, for GS Seventy Seven record changer, protects against dust and dirt. Rigid, tinted Plexiglas cover is used when changer is stored

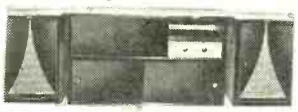


or in use. Keeps records dust-free during changer operation. —**Glaser-Steers Corp.**, 20 Main St., Belleville, N. J.

MIKE DESK STAND, *model A-7* designed for manufacturer's M-330, M-332 and M-332-S mi-

crophones. Adjustable swivel. High-impact satin-black plastic case and holder.—**Astatic Corp.**, Conneaut, Ohio.

EQUIPMENT CABINETS, for use with pair of manufacturer's 12-inch speaker enclosures. For stereo components. Additional



space for records, tapes, etc. Available as kits, unfinished assembled and finished assembled. —**Karlson Associates Inc.**, 443 Hempstead Ave., West Hempstead, N. Y.

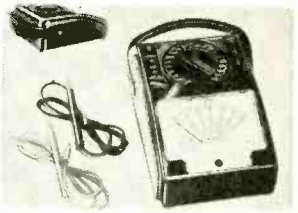
MICRO - MINIATURE BATTERY, *type RM-312.* Mercury battery only 0.3 inch in diameter, 0.125 inch high. Life is ap-

proximately 36 ma-hours at a discharge rate of 2 ma. Delivers 1.22 volts. — **Mallory Battery Co.**, 13000 Athens Ave., Cleveland, Ohio.

VTVM, *model VT-10,* kit or wired. 6-inch meter, 400-μa movement. 7 ac (rms) ranges and 7 dc ranges cover 0 – 1,500

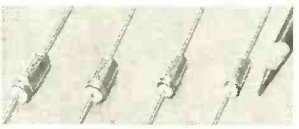
volts. 7 ac (peak-to-peak) ranges, 0 – 2,000 volts. Resistance, 0 – 1,000 megohms. Db scale.– **Arkay Inc.**, 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y.

POCKET-SIZE VOM, *model 457.* Dc sensitivity—20,000 ohms per volt. **Ac** sensitivity—1,000 ohms per volt. Measures ac volts —0–1,200 in 6 ranges. Dc volts —0–1,200 in 6 ranges. Resistance—0–100 megohms in 4 ranges. Current—50 μa; 1, 10, 100, 1,000 ma; 10 amps. Center scale—5, 500, 5,000 500,000 ohms. Db— —18–57 in 5 ranges. Frequency compensated over



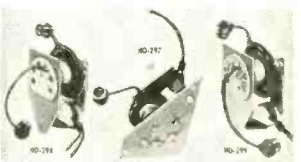
entire audio range.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 8, Ohio.

REPLACEMENT ELECTROLYTICS, *Littl-lytics.* Subminiature units for transistor equip-



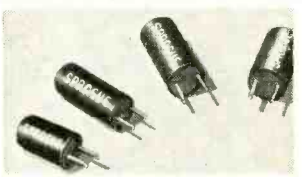
ment. Voltages from 1–150. Capacitances from 1–500 μf.— **Sprague Products Co.**, 81 Marshall St., North Adams, Mass.

REPLACEMENT FLYBACKS. *Stancor HO-298* replaces G-E and Hotpoint RTO-207. *HO-299* for 30 models of G-E and Hotpoint series M3 chassis. *HO-297* replacement for Hallicrafters, Coronado, Truetone and Firestone parts 55-301, 55-304, 55-307, 55C-301, 55C-304, 55C-



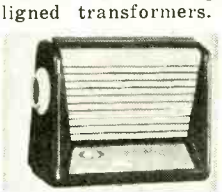
307, 55A33, 055-300301.—**Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

ELECTROLYTICS, *Verti-lytics.* Vertical mounting type. For replacement use on printed-wiring boards. Keyed terminals



indicate polarity. Available 1–290 μf at 3 volts and 1–200 μf at 6 volts. Phenolic cases.— **Sprague Products Co.**, 81 Marshall St., North Adams, Mass.

TRANSISTOR PORTABLE RADIO, *model XR-1P* kit (illustrated). Broadcast band. 6 transistors. 4 x 6-inch speaker. Prealigned transformers. Size-

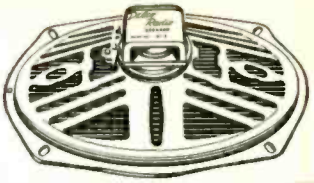


D flashlight cells power receiver. *Model XR-1L* identical except for leather case with carrying strap.—**Heath Co.**, Benton Harbor, Mich. END

All specifications on these pages are from manufacturers' data.

Use Delco Radio Service Parts!

DS501—Highest power transistor used in auto radios.



SPEAKERS

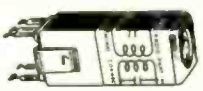
IRON CORES

RESISTORS

CAPACITORS

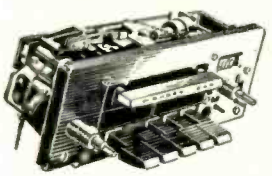
CONTROLS

TUBES

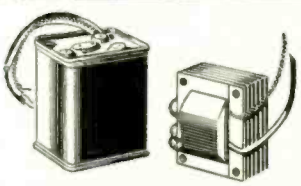


COILS

VIBRATORS



TUNER PARTS



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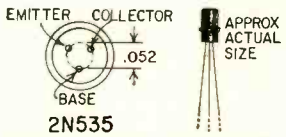
DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

NEW TUBES and SEMICONDUCTORS

VARIETY is the keynote this month—both tubes and semiconductors appear. There is a micro-miniature audio transistor, a 9-pin miniature phase-splitter, high-gain voltage amplifier for audio amplifiers, a fusion alloy-junction transistor for computers and switching, a couple of high-speed switching transistors and an n-p-n transistor intended for complementary-symmetry audio output circuits.

2N535

Here is a germanium micro-miniature p-n-p alloy-junction transistor intended for use in low-level low-frequency amplifiers and switching circuits.



2N535
RED LINE OR SILVER DOT ADJACENT TO COLLECTOR LEAD

Tentative maximum ratings for the Philco 2N535 are:

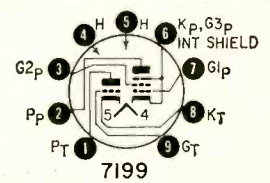
V_{CB}	20
V_{CE}	20
V_{EB}	20
I_C (ma)	20
P_c (mw) (at 25°C)	50

Typical small-signal parameters are:

h_{ib} (ohms)	33	($V_C = -5$, $I_C = -1$ ma, T = 25°C)
h_{ob} (μmhos)	0.4	"
h_{fe}	100	"
$f_{\alpha b}$ (mc)	2	"

7199

A medium-mu triode, sharp-cutoff pentode in a 9-pin miniature envelope, it is designed for use in high-quality high-fidelity audio equipment where low hum and reduced noise are necessary design requirements. Can be used in tone-control, phase-splitter and high-gain voltage amplifier and preamp circuits, if input signal level is 100 mv or higher.



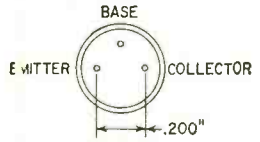
7199

Characteristics of this RCA tube in class-A1 amplifier service are:

	Triode unit	Pentode unit	
V_P	215	100	230
V_{G2}		50	130
V_{G1}	−8.5		
$R_{cath\ bias}$ (ohms)		1,000	62
μ	17		
R_P (approx) (megohms)	.0081	.1	0.4
gm (μmho)	2,100	1,500	7,000
I_P (ma)	9	1.1	12.5
I_{G2} (ma)		0.35	3.5
V_{G1} (for 10 μa I_P)	−40	−4	

2N659

A germanium medium-frequency p-n-p fusion alloy-junction transistor.



2N659

It is intended for computer and switching applications.

Maximum ratings of the Raytheon 2N659 are:

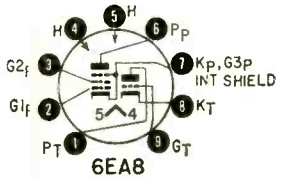
V_{CB}	25
V_{EB}	12
V_{CE}	14
I_C (dc) (amps)	1
V_{CE} (V_{BE}=0.1)	20
I_C (peak)	limited only by power dissipation

Average electrical characteristics are:

h_{FE}	70	(I_B = −1 ma, V_{CE} = −0.25)
$f_{\alpha b}$ (mc)	10	(V_{CB} = −6, I_E = 1 ma)

6EA8

A multi-unit tube in a 9-pin miniature envelope. Contains a sharp-cutoff pentode and a medium-mu triode. De-



6EA8

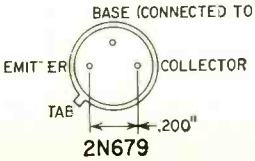
signed primarily for use as a combined oscillator and mixer in TV receivers that have a 40-mc if. The tube has a 450-ma heater with controlled warmup for use in series-string heater circuits.

Maximum ratings of the RCA 6EA8 in converter service (triode as oscillator pentode as mixer) are:

	Triode	Pentode
V_P	330	330
V_{G2}		330
V_{G1} (pos bias value)	0	0
P_P (watts)	3	3.1
$G2_{input}$ (watt) (for G2 voltages up to 165)		0.55

2N679

An n-p-n, medium-power transistor for general-purpose computer use.



2N679

NEW TUBES & SEMICONDUCTORS *(Cont'd)*

Absolute maximum ratings of this Sylvania unit are:

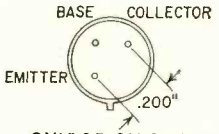
V_{CB}	25
V_{CE} ($V_{BE} = -5$, $R_{BB} = 5K$)	20
P_{total} (mw)	150

Electrical characteristics are:

h_{FE} (minimum)	20	($V_{CE}=0.5$, $I_B=30$ ma)
$f\alpha_b$ (minimum) (mc)	2	($V_{CE}=6$, $I_C=1$ ma)

2N1005, 2N1006

Two high-speed switching transistors with round welded cases and an ac for-



2N1005, 2N1006

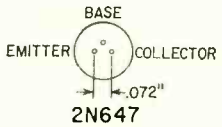
ward-current transfer ratio greater than 1 at 50 mc.

Design characteristics of these Texas Instruments transistors at 25°C are:

	2N1005	*2N1006*	
I_{CBO} (max) (μa)	0.1	0.1	($V_{CB}=10$, $I_E=0$)
BV_{CBO} (min)	15	15	($I_{CE}=50$ μa, $I_B=0$)
BV_{EBO} (min)	0.5	0.5	($I_E=50$ μa, $I_C=0$)
h_{FB} (min)	20	45	($V_{CE}=5$, $I_C=10$ ma)

2N647

This n-p-n transistor is a germanium alloy-junction unit, specially designed for use with its p-n-p counterpart—the 2N217—in class-B complementary-symmetry power output stages



2N647
RED DOT NEAR COLLECTOR PIN

of compact, transformerless battery-operated portable radio receivers, phonographs and audio amplifiers. It can also be used in standard class-B push-pull and class-A audio amplifier circuits.

Maximum ratings of this RCA transistor in class-A and -B audio amplifier service are:

V_{CB} (peak)	25
V_{CE} (peak)	25
I_C (dc) (ma)	50
(peak) (ma)	100
V_{EB} (peak)	12
I_E (dc) (ma)	50
(peak) (ma)	100
P_c (mw) (at 25°C)	100
(mw) (at 55°C)	50
(mw) (at 71°C)	20

Other types

3YP1 announced by Waterman Products is a rectangular scope tube that can be operated with anode potentials as low as 500 volts with vertical and horizontal sensitivities of 26 and 40 volts dc/inch, respectively.

Fansteel Metallurgical Corp. has introduced a line of subminiature silicon rectifiers, types 1N1655 through 1N1653. PIV ratings from 50–600 at 750 ma.

The 7265, 14-stage, head-on multiplier phototube offered by RCA. END

TECHNICIANS' NEWS

FRTSAP SETS UP LAB

The Federation of Radio & Television Service Associations of Pennsylvania (FRTSAP) has established a research division to test hi-fi equipment as a guide to members buying, selling and installing systems. FRTSAP will supply complete information on the various makes of hi-fi equipment to all members. Some equipment manufacturers and parts distributors have offered equipment. Tests will be conducted on any products supplied.

TECHNICIANS COMMENDED

New York State moved ahead on several fronts in its consumer protection program. In Binghamton, the regional member of the state's 16-member Advisory Committee on Consumer Frauds was informed in a conference with local Better Business Bureau executive secretary Frank E. Smith that virtually no complaints had been received about the ethics or prices of the area's TV technicians.

In New York City, state Attorney General Louis J. Lefkowitz outlined his consumer-protection legislative program—and technician licensing was notable by its absence, although it had been recommended by service associations at meetings with the Attorney General. One requested bill would require sellers of TVs, radios and appliances to label them with the year of manufacture.

In a separate action, the Attorney General began legal action aimed at dissolving 13 tube and parts distributor firms on charges of dealing in "counterfeit" tubes, which were rebranded or had altered warranty numbers.

SERVICE–MANUFACTURER RELATIONS IMPROVING?

Relationships between independent technicians and some of the large TV manufacturers, which were at a low ebb as 1958 ended, now appear to be improving—thanks to the concerted (though sometimes disunified) drives conducted by organized technicians.

There are signs that both RCA and G-E are modifying some of their policies which have been attacked by independent technicians as captive service, and the Electronic Industries Association—spokesman for most TV manufacturers—adopted a program aimed at better communications between the service and manufacturing industries.

EIA's Service Committee, headed by S. R. Mihalic of General Electric, issued a statement saluting independent service, which, it said, "has more than played its part in this phenomenal growth" (of television), and announced

a 4-point program of discussion of mutual problems with service leaders, representation at service association conventions, promoting public relations to enhance the prestige of independent technicians, and distribution of technical and business articles to independent service.

General Electric's television receiver department disclosed a new program for its distributors to "permit the company to work in harmony with independent service dealers in their vital and constructive functions."

Service manager S. R. Mihalic advised G-E distributors to "develop communications and relationships with independent service organizations," pointing out that "manufacturing and marketing television receivers is our prime business motive." Highlights of G-E's new service program:

(1) "G-E's TV service operations must be financially self-sufficient; their service charges . . . must be competitive [and] computed fairly." (2) Distributors should work with technician groups to resolve local difficulties, "particularly in the areas of warranties and parts availabilities." (3) Qualified independent service organizations will be appointed as authorized G-E service points in both rural and urban areas. (4) Independent technicians will be invited to attend G-E service schools and to subscribe to company service publications.

At least one G-E distributor is already puting the new program into effect by ending its practice of including 90-day warranties in the selling price of TV sets to dealers. It is G-E's wholly owned Michigan district distributor in Detroit that took a full-page ad in *TSA News* to inform technicians of its action. The distributor is recommending that dealers continue to offer 90-day warranties through their own service departments, independent service groups or through G-E.

That RCA is heeding the voice of independent service is indicated by recent assurances given technicians' associations by RCA Service Co. officials. *TESA News*, voice of the Television Electronic Service Association of Missouri, reports a meeting between RCA Service Co. president Don Kunsman and other officers with TESA and NATESA officials. The RCA spokesmen reportedly told TESA that its future advertising and its TV instruction books would not mention RCA Service Co. unless equal mention is made of local authorized service dealers. RCA is also turning over to technician associations figures on the cost of operating 90-day service contracts.

"TV PLUGS" FOR SERVICE

"Give the technician credit," writes editor W. C. Pecht in *TEAM News*, publication of the Electronic Association of Missouri, St. Louis. He suggests the screen credits at the end of each TV show include this announcement:

"The TV technician in your neighbor-

hood mace this program possible by his skill, his knowledge and his devotion to the welfare of the radio-television industry and the people it serves."

Pecht's proposal was not without a barb, as TEAM has been active in protesting "free tube check" commercials, televised by a local station, which have aroused widespread resentment among qualified technicians.

In San Jose, Calif., meanwhile, TV technicians *are* getting screen credits as a result of an agreement between the Radio Television Association of Santa Clara Valley (RTASCV) and TV station KNTV. The station has agreed to run at least one spot daily showing the RTASCV emblem and advising viewers, "For better service call an RTA member—look for this seal of confidence." In exchange, *RTA Magazine* will publish news of KNTV programming and technical developments.

TV TECHNICIANS' WEEK

The last week in March (23 through 28) has been registered with the US Chamber of Commerce as National Television Technician's Week. This is the fifth anniversary of an event originated by RCA which honors independent service dealers and technicians throughout the US.

ANOTHER "EXPOSÉ"

The flames of the "TV repair gyp" controversy were kept burning brightly by a new "exposé" in a consumer magazine—this one in the Jan. 23 *TV Guide*.

The frightening title "Exposing the TV Repair Racket" is only partly borne out by the story, which contains the usual "most-TV-men-are-honest" preface. The article details a campaign by Washington, D. C., radio station WWDC, which farmed out for repair—over and over again—three gimmicked TV sets. According to *TV Guide*, half the technicians called in had "good reputations," half did not.

The article said about one-third gave honest service at honest prices, one-third charged "exorbitant fees based on false diagnoses" and the remaining third "made proper repairs but at prices somewhat higher than the station considered fair."

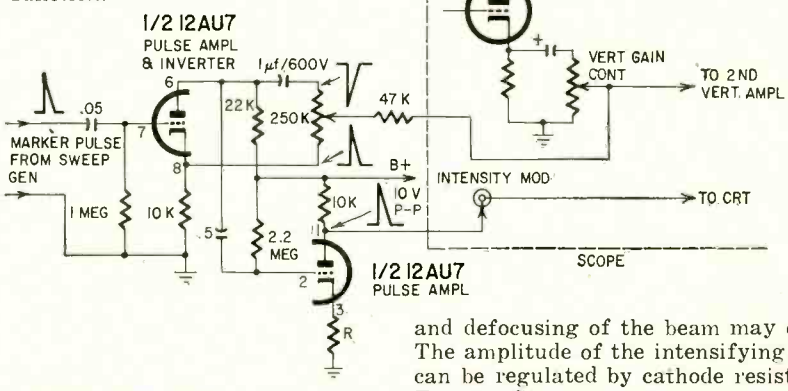
The article concludes with a list of rules for selecting technicians, which was approved by the Television Service Association (TSA) of Metropolitan Washington. Among them: Is he active in a service association? Does he make clear that his home call will cost from $3.50 to $6? Does he leave the parts he has removed from the set? Does he give you an itemized bill? Receive checks made out to his firm's name?

Also listed are five questions for set owners, pointing out the dangers of falling for "$2 per call" ads and emphasizing that "a big repair bill does not automatically mean you've been taken," that technicians should be treated courteously, that a set may develop new troubles the day after it's been properly repaired. END

NOTEWORTHY CIRCUITS

ADD MARKERS TO SCOPE

A simple one-tube addition to existing scopes (see diagram) can facilitate alignment work. It lets you permanently connect pulse type markers from your sweep generator to the scope's vertical input circuit without disturbing its ordinary waveform measurement function.



The pulse type marks are much brighter than normally because the circuit intensifies the beam at the exact instant a mark occurs. The marks are variable in both direction and amplitude.

The marker generator output is fed to the grid of the first section of the added 12AU7. The output, selected as to size and direction by the 250,000-ohm pot, is fed to the center arm of the scope's vertical gain control. It is essential that this control be in the cathode circuit.

The second 12AU7 section supplies a proper polarity pulse to the scope's intensity terminal. The size of this pulse must be adjusted, otherwise blooming and defocusing of the beam may occur. The amplitude of the intensifying pulse can be regulated by cathode resistor R. For the Sylvania 400 scope a pulse of 10 volts peak-to-peak was ideal.

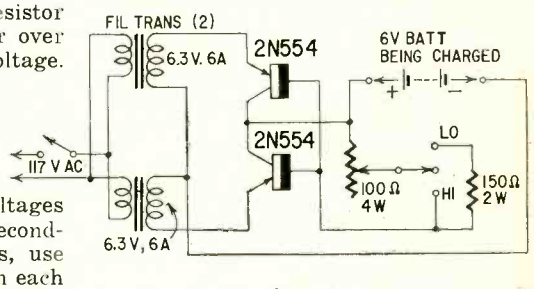
Most scopes have plenty of chassis space for an additional tube. Some even have a prepunched extra socket hole. And, as the slight additional current drain of the 12AU7 will not overload the scope's power supply, you shouldn't have any trouble adding the necessary circuit to your scope.

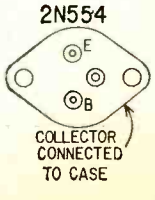
The main advantage of this modification is that it makes for easier and more convenient alignment checks.—*M. Schleicher*

BATTERY CHARGER OR MODEL POWER SUPPLY

This circuit provides a full-wave rectifier using 2N554 power transistors. A base-current-control resistor smoothly varies the output power over wide ranges of current and voltage. In low-impedance loads, as in battery charging, current may be varied from 0.5 amp or less as a trickle charge to 6 amps or more. For higher voltages use transformers with a higher secondary voltage. For higher currents, use two or more 2N554's in parallel on each side of the center tap.

For high-current applications, the power transistors must be attached to an appropriate heat sink. Filtering may be provided by connecting a 1,000-μf or larger capacitor across the output to reduce output ripple to very low values. —*Motorola Semiconductors* END





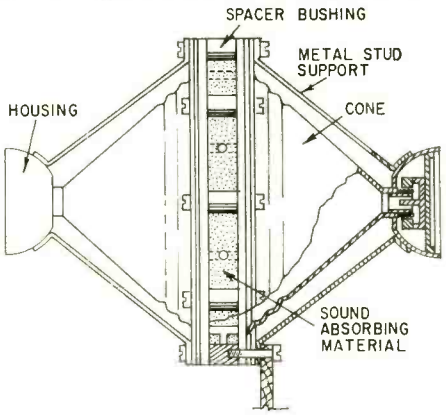
PATENTS

DUAL SOUND REPRODUCER

Patent No. 2,832,843

Benjamin F. Miessner, Harding Township, N. J. (Assigned to Miessner Inventions, Inc., Harding Township, N. J.)

A large speaker is needed for efficient reproduction at low frequencies. On the other hand, only a small speaker can avoid highly directional radiation of high frequencies. This inventor suggests coupling two large speakers



front to front to achieve a nearly spherical sound source—the convex rear of the speaker cones. This results in a nondirectional sound radiator for *all* frequencies.

The speakers are held together by spacer bushings. A disc of sound-absorbing material damps out acoustic energy between the cones, with breather holes to permit some passage of air. A round housing covers each magnet assembly to reduce the shadow effect and resulting dead area in the high-frequency range.

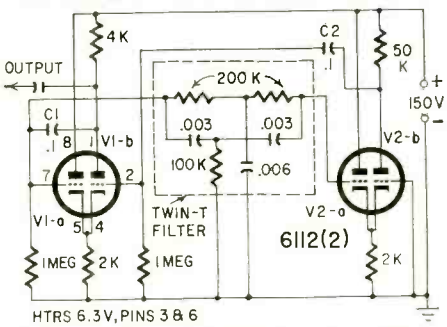
Input to the voice coils must be polarized so both cones move in or out together.

STABILIZED OSCILLATOR

Patent No. 2,827,569

Phillip L. Jessen, Albuquerque, N. M., and Harold L. Price, N. Weymouth, Mass. (Assigned to United States of America as represented by US Atomic Energy Commission)

This precise audio oscillator can be adjusted for a single frequency. The diagram shows components needed for a frequency of 263 cycles. Variations from 100 to 200 plate volts, 5.7 to



7.8 heater volts and temperature from 70° to 205°F changed frequency less than 0.2%.

V1-a and V1-b are cathode-coupled. Output from V1-b is fed through C1 as *positive* feedback to V1-a's grid. It also sends a signal through a twin-T network and to a second dual triods, V2. Voltage through C2 feeds V1-b's grid as *negative* feedback. At the resonant frequency of the network there will be no negative feedback, so only the positive feedback will exist. Thus the circuit oscillates at the network frequency.

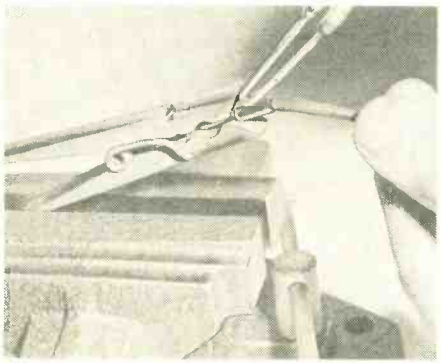
Oscillation is maintained at a constant amplitude as follows: V2, the negative feedback amplifier is biased in the square-law region where *stronger* signals receive *greater* gain than weaker ones. Therefore, degeneration is greater for strong signals, and oscillation at V1 tends to remain constant

END

TRY THIS ONE

HEAT-CONDUCTIONLESS SOLDERING

When you have some small work that has to be soldered, it's practically impossible to clamp the work in a vise, as the metal jaws drain off most of



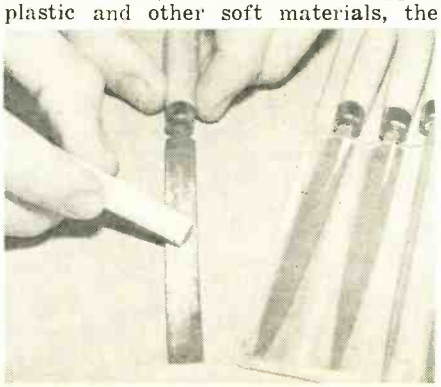
the heat. You can avoid this difficulty by using a wooden clothespin clamped in the vise to grip the work. Wood has a much lower heat-conduction factor than metal, so the jaws of the clothespin don't drain off the heat.—*John A. Comstock*

CABLE CLAMPS ARE HANDY

You may not keep an assortment of cable clamps around the shop, but they are useful. I often use them for mounting parts such as large insulated resistors on a chassis. They are also useful for mounting odd-shaped components such as mercury switches and pilot lamps.—*J. C. Alexander*

CHALK PREVENTS FILE CLOGGING

When those fine-cut jeweler's files used by the radio–TV technician are used on solder, aluminum, brass, copper, plastic and other soft materials, the

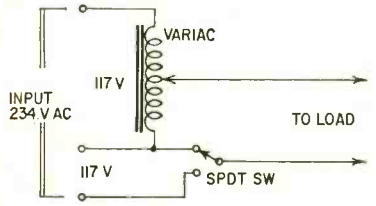


teeth tend to become clogged and dull the file's bite. This can be largely pre-

vented by rubbing the file with ordinary blackboard chalk just before it is used. The chalk dust in the flutes keeps the filings from adhering.—*John A. Comstock*

VERSATILE VARIAC

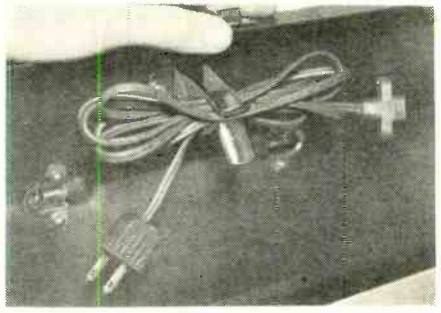
To get a range of 0–250 volts with a 0–135-volt Variac, connect the Variac and load to the 115/230-volt three-wire



system with a spst switch as shown in the diagram. Depending on the switch position, the Variac covers 0–135 or 115–250 volts.—*Albert H. Taylor*

TOOLKIT CHEATER HOLDER

A spring type broom clip attached to the underside of the cover of your tool box makes a handy cheater-cord



holder. By keeping the cord in this handy holder, there's no danger of losing it. What's more, it's always within an arm's reach when needed.—*Scot Mock*

END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In March, 1909, *Modern Electrics*

Talking Dynamos and Transformers, by the Berlin Correspondent.
Increased Sensitivity of Electrolytic Detectors.
Wireless To and From Train.
Microphone Detector, by Alfred P. Morgan.
Wireless Association of America
Radio-Goniometer of the Bellini-Tosi System, by A. C. Marlowe.
Wireless Telegraphy, by Melville Eastham and O. Kerro Luscomb.
Development in Wireless Telephony, by William Maver, Jr.
A Tuning Transformer, by Charles Cheever.

BUSINESS and PEOPLE

Robert E. Lewis, senior vice president of Sylvania Electric Products Inc., New York, was elected president of the company. He succeeds **Don G. Mitchell,** who continues as chairman of the board. It is anticipated that Mr. Mitchell will become president of the combined companies when Sylvania merges with General Telephone to become General Telephone & Electronics Corp.

James J. Shallow joined CBS-Hytron as vice president. He will also serve as general manager of the Columbia Phonograph Department. He comes to CBS-Hytron from Philco Corp. where he was general manager of merchandise for the Consumer Products Div.

Dr. James B. Fisk, executive vice president of Bell Telephone Laboratories, was elected president to succeed **Dr. Mervin J. Kelly.** Dr. Kelly was elected chairman of the board of directors. **Estill I. Green,** vice president in charge of systems engineering, is now executive vice president.

Raymond T. Leary was elected a vice president of Cornell - Dubilier Electric Corp., South Plainfield, N.J. Until his promotion, he had been sales manager of the Distributor Div.

Dr. Mervin J. Kelly, newly elected chairman of the board of Bell Telephone Laboratories and a director of the company since 1944, was elected a director of Tung-Sol Electric, Inc., Newark, N.J. He is also a director at Sandia Corp., the Prudential Insurance Co. of America and Bausch & Lomb Optical Co.

Bill Clancy, former general sales manager, and Hubert Daubs, former

assistant sales manager, were promoted to vice president in charge of sales and distributor sales manager, respectively, for Thordarson-Meissner, Mt. Carmel, Ill.

John D. Michael joined the executive sales staff of the Distributor Div. of Quam-Nichols Co., Chicago, as an assistant to **Mel Krumrey**, manager of the division.

Larry Eugene joined Electro-Voice Inc., Buchanan, Mich., as manager of the Cartridge Division. He was most recently sales manager of the Howard Co., a subsidiary of Howard W. Sams & Co., and has held advertising and sales excutive positions at Permoflux Corp. and Allied Radio Corp.

Joseph N. Benjamin, president of Bogen-Presto Div. of Siegler Corp., was re-elected president of the Institute of High Fidelity Manufacturers. **George Silber**, president of Rek-O-Kut Co., was renamed chairman of the board. Other officers are: **Philip Gundy**, Ampex, vice president; **Saul Marantz**, Marantz Co., secretary, and **Milton Thalberg**, Audiogersh, treasurer.

John H. Beedle (left), manager of the old Commercial Equipment Div. of Raytheon Manufacturing Co., Waltham, Mass., heads the new Equipment

and Systems Div. **J. Penn Rutherford**, assistant manager under the old setup, now manages the new Industrial Apparatus Div. The two divisions will be fully separated and will operate as integrated units.

RCA Electron Tube Div., Harrison, N. J., is now marketing two separate lines of TV picture tubes for black-and-white sets—the new premium Silverama—and the factory-rebuilt Monogram line. The most popular 17 inch new tube has a suggested retail price of $33.25 while a similar rebuilt tube is tagged with a suggested list of $23.50

with the customer's old tube. A kickoff advertising campaign announcing the two lines appears in RADIO-ELECTRONICS and other leading trade magazines. The company is following through with advertisements in consumer publications in addition to radio and TV programs.

Electronic Instrument Co., Inc., Long Island City, N. Y., launched a dealer-relations program to familiarize distributors and hi-fi dealers with its facilities for making its EICO line of test instruments, hi-fi equipment and ham

gear in kit and wired form. Harry R. Ashley, EICO president, is explaining the operation of one of the conveyor lines in the company's packaging department to personnel of Grand Central Radio, a New York distributor handling EICO products.

JFD Electronics Corp., Brooklyn, N. Y., is introducing distributors to its exact-replacement portable TV antenna merchandising kit which contains five antennas which will cover 85% of the portable television sets that are now in use.

American Microphone Manufacturing Co., Rockford, Ill., designed a new counter display as a point-of-purchase promotion for its tape recorder microphone.

Pyramid Electric Co., Jobber Div., North Bergen, N. J., celebrated the sale of its 3,500,000th Gold Standard Mylar capacitor in January. The line

was introduced in September, 1958. Pyramid Electric is continuing its Gold Rush advertising and promotion campaign.

ANNUAL UNIT PRODUCTION AND SALES

	1958 (estim.)	1957
Retail TV Sales	5,250,000	6,560,220
Retail Radio Sales	12,700,000	15,217,059
Factory Phonograph Sales	3,800,000	4,978,520
TV Set Production	5,300,000	6,399,345
Radio Set Production	13,000,000	15,427,738

Source: EIA president David Hull.

Obituary

Alexander M. MacLennan, recently retired as assistant vice president, public relations, of ITT, died of a heart attack in Delray Beach, Fla., at the age of 64. He had been active in public relations for over 30 years and was associated with ITT since 1929. END

LITERATURE

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.

ELECTRONIC EQUIPMENT *Catalog 591* has 180 pages of industrial, amateur, radio, television and high-fidelity items. Profusely illustrated.—**Burstein-Applebee Co.**, 1012-14 McGee St., Kansas City 6, Mo.

TELEVISION ANALYZING SIMPLIFIED, written by Milton S. Kiver, is a 104-page illustrated text that discusses TV servicing methods. It illustrates and explains latest technique of point-to-point signal injection for rapid trouble-shooting of monochrome and color television receivers.—**B & K Mfg. Co.**, 3726 N. Southport Ave., Chicago 13, Ill. **$1.00.**

GERMANIUM DIODES, gold-bonded types, are listed in 4-page *bulletin 158.* Various operating characteristics are listed to ease selection of desired units. —**Ohmite Mfg. Co.**, 3683 Howard St., Skokie, Ill.

HIGH-FIDELITY COMPONENTS, stereo and monophonic, are presented in 2-color 20-page booklet. Amplifiers, preamps, tuners, stereo adapter, turntable, pickup arm and cartridge are included. Complete specs for each unit listed.—**H. H. Scott Inc.**, 111 Powder Mill Rd., Maynard, Mass.

STEREO, *the new hi-fi sound,* is the subject of the September–October Issue of *Service News.* Text covers what stereo is, the 45/45 stereo recording system, the playback cartridge, the stereo changer, service and installation, stereo speaker locations, speaker phasing and various stereo service hints.—**Motorola Inc.**, 4545 W. Augusta Blvd., Chicago 51, Ill.

PULSE TRANSFORMER CATALOG, *December 1958,* is a 24-page catalog filled with tables, charts and schematics to assist engineers in applying transformers to their needs. Catalog section lists some of manufacturers' line of 2,000 standard design transformers.—**PCA Electronics Inc.**, 16799 Schoenborn St., Sepulveda, Calif.

PRECISION TAPE REEL for instrumentation recording is described in *Sound Talk Bulletin No. 36.* 4 illustrated pages

LITERATURE *(Continued)*

of text point out the need for such a reel.—**Minnesota Mining & Mfg. Co.**, 900 Bush St., St. Paul 6, Minn.

SUBMINIATURE SILICON DIODES. Glass general-purpose types are detailed in *Catalog Sheet B 217A-2*. 30 types are listed, along with specifications and dimensional diagram.—**Clevite Transistor Products**, 241 Cresent St., Waltham 54, Mass.

DIAL EQUIPMENT for mobile radio and radio telephone systems is described in an 8-page illustrated brochure. Similarities and differences between dial signaling on private mobile radio systems and radiotelephone systems are clarified.—**Secode Corp.**, 555 Minnesota St., San Francisco 7, Calif.

REPLACEMENT GUIDE lists line of exact replacement controls for auto radios. Set up alphabetically by auto manufacturers' names. Lists original radio manufacturer, radio model number and original part number. It also lists the replacement and gives its price.—**Centralab**, Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

ELECTRONICS COURSES. Home-study texts for radio-electronics or television are detailed in a 4-page folder. Other technical publications are also described.—**Supreme Publications**, 1769 Balsam Rd., Highland Park, Ill.

REPLACEMENT CHART *CRC-58* is a cross-reference arrangement which shows proper replacements for phono cartridges used in many makes of commercial equipment.—**Astatic Corp.**, Conneaut, Ohio.

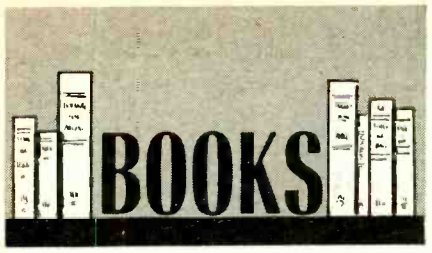
SOLAR-POWERED RADIO described and illustrated in full-color 4-page brochure. Complete specs and operating instructions included.—**Hoffman Electronics Corp.**, Dept. K, 3761 S. Hill St., Los Angeles 7, Calif.

MAGNETIC TAPE APPLICATIONS, a photo brochure, shows some of the ways magnetic tape has been used to solve a myriad of scientific and industrial problems.—**Ampex Corp.**, Instrumentation Div., 934 Charter St., Redwood City, Calif.

GENERAL CATALOG, *No. 33-3*. 8 pages of phono cartridges, pickup arms, phono styli and microphones.—**Astatic Corp.**, Conneaut, Ohio.

BUTTON-CELL BATTERIES, their features, design potentials and specifications are highlighted in 4-page *Bulletin No. VO-110*. These nickel-cadmium button-cell batteries come in more than 50 sizes and voltages.—**Gulton Industries Inc.**, Alkaline Battery Div., Metuchen, N. J.

NYLON SCREWS AND NUTS are presented in an illustrated 4-page folder. Designed for electrical installations where high dielectric strength and resistance to corrosion are important.—**Weckesser Co.**, 5701 Northwest Highway, Chicago 30, Ill. END



SERVICING TRANSISTOR RADIOS, by Leonard D'Airo. Gernsback Library Inc. (No. 76), 154 W. 14 St., N.Y. 11, N.Y. 5½ x 8½ in., 224 pp. $2.90.

Transistors have largely supplanted tubes in radio receivers. If you wish to know how to repair, adjust and align the new sets, you will find this book the quickest and easiest way to learn. This qualified author discusses home and auto radios, portables, solar-powered types, converters, preselectors, short-wave and hi-fi sets. He tells exactly how to proceed for troubleshooting, testing and how to use test equipment.

An entire chapter tells about transistor testing. An extensive transistor listing plus a chart of replacement types will save you lots of time on your service jobs.—*IQ*

SERVICING HI-FI. Howard W. Sams, & Co., Inc., 221 E. 46th St., Indianapolis 5, Ind. Vols. 1 and 2. 8½ x 11. Each volume $2.95, approximately 150 pages.

Here are two "musts" for service technicians and for hi-fi listeners who prefer to repair and adjust their own. Each volume describes approximately 25 preamps, amplifiers and FM tuners. For each model there are clear photos with code numbers identifying the components. In addition, there is a large and clear schematic, alignment data, dial drive drawing, replacement parts list plus resistance and voltage readings. In short, you will find here anything that can help adjustment, repair or replacement in the shortest time.

An introduction to Vol. 1 describes typical hi-fi installations and gives general service information. The introduction to Vol. 2 covers stereo home systems, speaker placement, etc.—*IQ*

ENGLISH–RUSSIAN RUSSIAN–ENGLISH ELECTRONICS DICTIONARY. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y. 6 x 9 in., 943 pp. $8.

Prepared for US Army, this pioneer work translates about 22,000 Russian terms and abbreviations into English and 25,000 terms from English into Russian, based on up-to-date sources in both the US and USSR. With the increasing availability of Russian technical publications and works in this country, the value of this book to the serious engineer or researcher is obvious.—*DL*

FEEDBACK THEORY AND ITS APPLICATIONS, by P. H. Hammond. MacMillan Co., 60 Fifth Ave., N.Y. 11, N.Y. 5½ x 8½ in., 348 pp. $7.

This book is written for the post-graduate student who wants to learn

about feedback, linear and nonlinear. The first chapter reviews Laplace transformers and the Heaviside unit function, which are used extensively thereafter.

The first part studies electronic circuits and the criteria for stability. The second part analyzes servo-mechanisms and other control systems. One chapter concerns the design of electronic simulators.—*IQ*

BASICS OF DIGITAL COMPUTERS, Vols. 1, 2 and 3, by John S. Murphy. John F. Rider Publisher, 116 W. 14 St., New York 11, N.Y. 6 x 9 in. Vol. 1, 116 pp.; Vol. 2, 133 pp.; Vol. 3, 136 pp. $2.50 each. $6.95 set.

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CLOSED CIRCUIT TV SYSTEMS. RCA Service Co., Camden 8, N.J. 8½ x 11 in., 333 pp. $4.50

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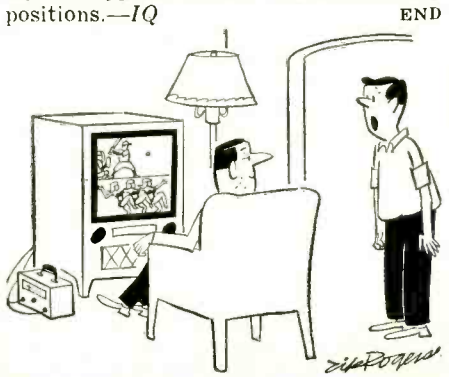
The text is nontechnical and diagrams are in block form since the book does not attempt to teach circuit theory. It does explain basic TV techniques, optics and illumination, and shows how to lay out typical studios and monitoring positions.—*IQ*

END



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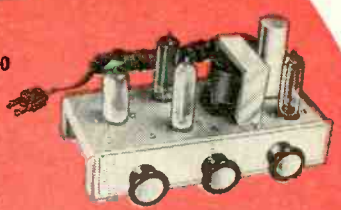

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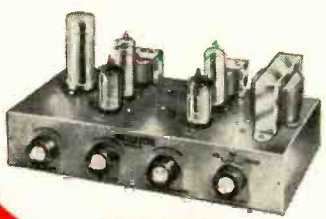

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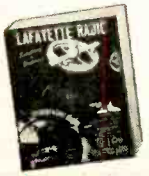

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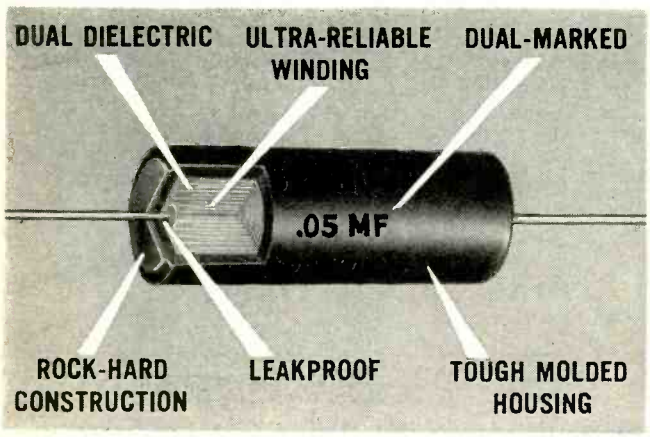

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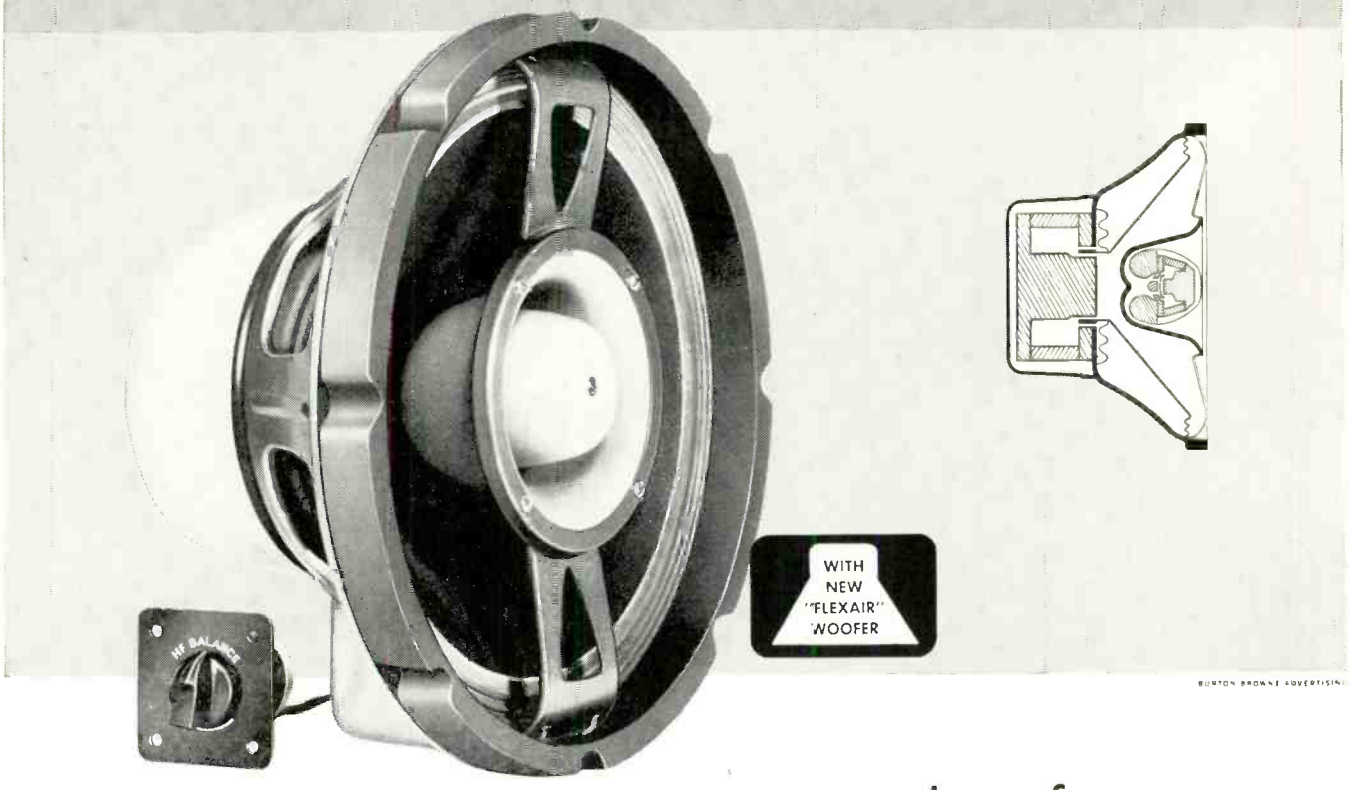

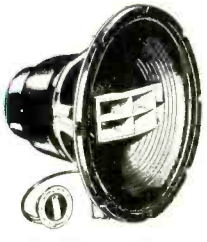

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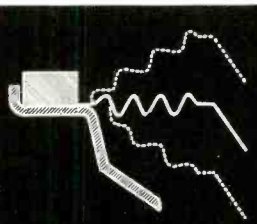

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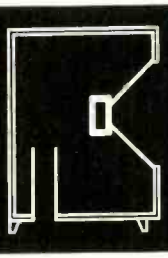

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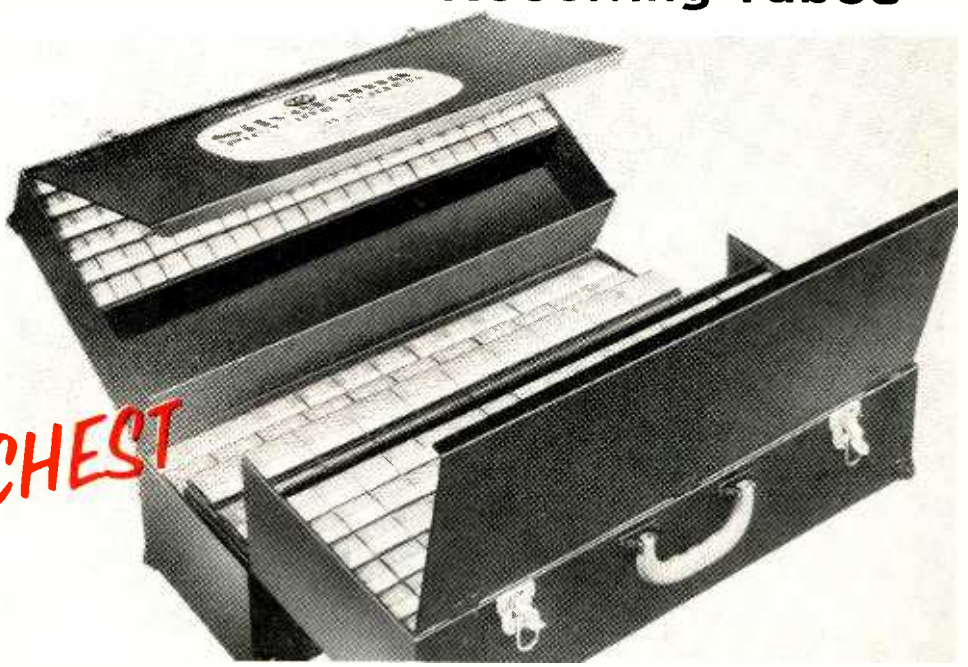

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